

brewers association

# draught beer quality manual

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Prepared by the  
Technical Committee of  
the Brewers Association

**SECOND EDITION**

**B  
A**  
**BREWERS  
ASSOCIATION**®



# preface

**t**he Draught Beer Quality working group was formed in March 2007 under the direction of the Brewers Association Technical Committee. Our overriding mission was to improve the quality of draught beer dispensed to our customers. We seek to preserve the great flavor and aroma of beer created by the brewer, and to deliver it to the consumer at retail. Great beer must be handled conscientiously to arrive in the glass in perfect condition.

Distributors, wholesalers, retailers, or draught installation teams may install a draught system. But once in place, each system commonly pours a wide range of brewers' and suppliers' products. We have sought to bring the industry together to agree upon guidelines that present everyone's beer in an optimal condition.

When handled properly from brewery to bar to glass, draught beer delivers what many consider to be the freshest, most flavorful beer available to the customer. But the job does not end once the keg is tapped and the beer begins to flow. Good beer quality depends on proper alignment of the dispense variables and consistent housekeeping practices. As one industry insider quipped, "Even the Mona Lisa would look terrible in a museum with lousy lighting."

The draught quality group focused on these and other areas to develop a clear and well-researched resource of best practices for draught beer. Of course, individual brewers may have additional quality requirements or recommendations for various brands beyond these commonly agreed upon guidelines.

## our mission

**To improve the quality of draught beer for all beer drinkers.**

## our goal

**To make our website information available to as many beverage industry members and consumers as possible, and work toward being the definitive draught quality resource for the USA.**

**[www.draughtquality.org](http://www.draughtquality.org)**

This second version of the Draught Beer Quality Manual includes several updates, and we will continue to refine it in the future. Our goal is to provide useful and current information for all industry members, manufacturers, distributors, retailers, and consumers.

This manual and excerpts from it are available at [www.draughtquality.org](http://www.draughtquality.org). This website is in wiki form, and also contains far more information than this manual, in the form of downloadable forms and links to technical and supplier resources. For example, the website contains beer line cleaning logs you can download, print, and post on your walk-in coolers to encourage routine cleaning every 14 days. We encourage all industry members and affiliated groups to link to the website. ■



# acknowledgements

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**Anheuser-Busch InBev:** Cian Hickey, Tim Raw

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Bob Pease, Tim Sloan, Chris Swersey

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# introduction

**W**alk into nearly any establishment that serves beer these days and you're likely to find draught beer for sale. But these days you'll also see fancy options like nitro beers, highly spritzzy German weissbier, and lightly carbonated English-style "cask" ales. Glassware varies from run-of-the-mill pints to shapely half-liters and diminutive snifters with every possible shape and size in between.

We find draught taps so often that we assume it must be relatively simple to keep and serve beer this way. But behind the simple flick of a handle that sends beer streaming into our glass at the bar, you'll find systems that require precise design, exact operating conditions, and careful, regular maintenance to ensure the proper flow of high-quality beer.

In this guide, we'll consider the equipment and anatomy of draught systems, then look at their operation and maintenance. We'll include a brief discussion of temporary systems such as picnic taps and jockey boxes, but the majority of our attention will be given to systems usually seen in permanent installations: direct-draw and long-draw draught equipment.

While equipment and system layout drive the initial performance of a draught system, other factors play an equal role in the consumer's experience. To help you understand and operate your draught system, we'll look at the balance equation that can keep perfect beer flowing from the taps. We'll also review pouring and glassware cleaning and show you how to check to see if a glass is "beer clean." Finally, we'll focus on the cleaning and maintenance of your draught system. Without regular—and proper—maintenance, your investment in draught technology won't bring you the dividends you expect. We'll conclude this manual by telling you what to look for in proper system maintenance, whether doing it yourself or supervising the work of a supplier.

To present this information, we have divided this manual into two sections. Section I focuses on draught system components and complete system layouts. From a simple party tap to a complex long-draw draught system, we reviewed all the options.

Section II of this manual covers all the operation and maintenance issues for draught systems. It begins with a look at system balance, then progresses to the details of pouring, glass cleaning, and other essentials of the perfect pint before finishing with cleaning and maintenance. ■



## section I

# draught equipment and system configurations

**a**mong draught systems, we find three general types based on equipment and design: temporary systems, direct-draw systems, and long-draw systems. In the course of this manual, we'll look closely at the layout, operation, and maintenance for each system. In Section I of this manual, we present four chapters that focus on system components from faucets to tubing connectors and see how they are assembled to create different systems. Along the way, we'll review important features of each component that can help prevent operating problems or beer quality issues in your system.

Before we jump into the components themselves, let's review some key concepts by looking briefly at the three sub-systems for draught: gas, beer, and cooling.

### Gas

Draught systems use CO<sub>2</sub> alone or mixed with nitrogen in varying proportions depending on the requirements of the system and the beers being served. When properly selected and set, dispense gas maintains the correct carbonation in the beer and helps to

preserve its flavor. In most draught systems, the dispense gas also propels beer from the keg to the faucet. Because the dispense gas comes into direct contact with the beer, it must meet strict criteria for purity. And because of the damage it does, ***compressed air should never be used to dispense draught beer.*** For the purposes of this manual, as a convention in discussions involving mixed gas, the proportion of CO<sub>2</sub> will always be shown first, followed by the proportion of N<sub>2</sub>.

### Beer

Most draught systems use the gases mentioned above to drive beer from the keg, through tubing and to the faucet where it will flow into the customer's glass. During the journey from keg to glass, we want to protect the beer from anything that would compromise its flavor or alter the carbonation created by the brewery. The beer should flow through well-maintained proper beer lines and avoid any contact with brass parts that would impart a metallic flavor. We also want the beer to flow at a specific rate and arrive with the ideal carbonation level. The key to getting

this right is balance between the applied gas pressure and the resistance provided by the tubing and fixtures the beer passes through during its journey to the bar.

## Cooling

The cooling system should hold beer at a constant temperature from keg to glass. Any increase in beer temperature between the cooler and the faucet can lead to dispense problems such as foaming. In a simple direct-draw system, a refrigerated cabinet maintains the temperature of the keg and provides cooling to the beer as it travels the short distance to the faucet. Many long-draw systems use a walk-in refrigerator to cool the kegs, plus chilled glycol that circulates in tubes next to the beer lines all the way to the faucet, to ensure that the beer stays cold all the way to the glass.

For each draught dispense system, suitable equipment and designs must be chosen for each of these three components—gas, beer, and cooling. In Section I of this manual, we'll examine the equipment used in draught systems and the various system designs commonly employed.

**Chapter 1** examines nine components common to nearly all draught systems, such as couplers, faucets, and beer lines. Understanding these basic elements will help you operate every draught system you encounter. Of course, additional components play a role in sophisticated systems—we'll introduce and discuss those as we encounter them in Chapters 3 and 4. Once we've reviewed the common draught components, we'll be ready to see how they get used in various system designs.

The simplest draught systems serve a temporary need. We find these systems at picnics, beer festivals, and other short-term events. In **Chapter 2**, we cover

## temporary systems

- Picnic Tap
- Jockey Box

## direct draw

- Keg Box
- Walk-in Cooler

## long draw

- Air-Cooled
- Glycol-Cooled
- Beer Pump
- Mixed Gas Dispense

the design, setup, use, and maintenance of the two main systems: picnic taps and jockey boxes.

Moving to permanent draught installations, direct-draw systems offer the simplest approach. In **Chapter 3**, we'll talk about the anatomy of a keg box or "kegerator" and discuss how this basic approach is implemented in a walk-in cooler design. Both here and in Chapter 4, we'll find some new components beyond the nine "guidelines" from Chapter 1. In each chapter, we'll learn about the new components before looking at the anatomy of the overall system.

Permanent installations where the kegs cannot be located near the serving bar require long-draw draught systems. **Chapter 4** delves into the anatomy and operation of air-cooled and glycol-cooled long-draw systems, and also looks at beer pumps and mixed gas dispense solutions to moving beer through long-draw dispense systems. ■





## chapter 1

# essential draught system components

**a**s a prelude to studying different draught system designs, let's review the equipment commonly found in all draught dispense setups, from the backyard picnic tap to the ballpark beer vendor. Here we cover nine components:

Refrigeration/Cooling	Gas Source
Keg	Regulator
Coupler	Gas Line
Beer Line	Tail Pieces and Connectors
Faucet	

### Refrigeration/Cooling

Consistent and controlled beer dispense requires that the beer traveling from keg to glass be maintained at a temperature of 34° to 38°F. While temporary service may employ ice for cooling, most permanent installations employ refrigeration systems.

Cold box refrigeration systems can provide cooling for a small direct-draw box cooler or a large walk-in. The refrigeration itself can either be self-contained with the compressor and condenser mounted on the unit or with a remotely mounted compressor and condenser. Remotely mounting the compressor can

benefit the installation by removing the source of heat from inside a room or building; however, this requires additional refrigerant piping and possibly higher cost.

Condenser cooling can utilize either air or water; both methods have their strengths and weaknesses. In warm climates, air-cooled compressors can lose significant cooling capacity on a hot day when it is needed most. Water-cooled systems operate more efficiently, but require more maintenance and investment cost. Proper preventive care for either system is imperative, such as regularly cleaning condenser fins for air-cooled systems, and cooling water treatment for water-cooled equipment to prevent condenser fouling, which diminishes cooling capacity. Acid cleaning or "roding" out the heat exchanger may be required to remedy this. Many draught system problems are revealed on the first hot day of the season due to a lack of preventive maintenance. Although R22 refrigerant is still in use, most new installations will utilize a more environmentally friendly substitute such as 404a.

Glycol systems are also used, as we will see when we examine long-draw systems.

## Keg

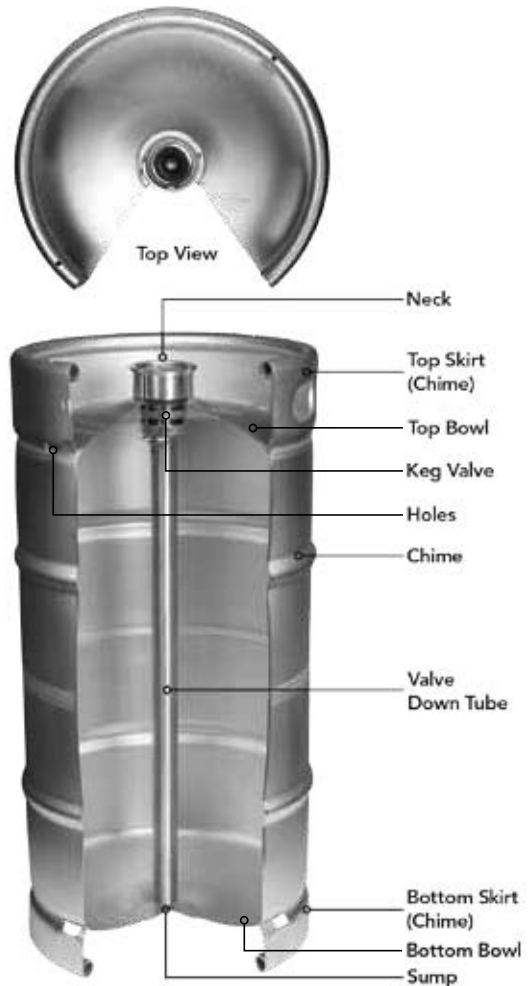
Kegs enable beer transport and dispense while maintaining its quality and integrity. Their design protects beer from both air and light while enabling easy and rapid dispense. Most brewers use kegs made of stainless steel, but you also see rubber-coated, aluminum, steel—and recently plastic—kegs in the marketplace.

When tapped, the keg's valve admits gas to the head space where it applies the pressure needed to push beer up through the spear or down tube and out of the keg, while maintaining correct carbonation in the remaining beer.

## Keg Valve

Kegs are pressurized vessels and can be dangerous if mishandled. Nearly all modern kegs use some form of Sankey valve and stem. There are two main types of Sankey valves and corresponding keg necks: "drop-in," and threaded. From a user standpoint, the valves function identically; from above, they appear nearly indistinguishable to the untrained eye. Drop-in Sankey valves are held in place by a lock ring or circlip. The lock ring and valve should never be removed in the field. Very rarely a lock ring can fail, possibly loosening the valve, creating a potentially dangerous situation. Threaded Sankey valves screw into the neck of the keg. Very rarely a threaded valve can inadvertently loosen or become unseated when disengaging a coupler, creating a potentially dangerous situation. Keg valves should never be removed in the field. Kegs should only be serviced by trained personnel.

Older keg designs, although rarely encountered, utilize different tapping methods not covered here. Keg sizes vary from approximately 5 to 15.5 gallons.



## Sankey Valves and Keg Necks

### Threaded



Keg Neck



Valve

### Drop-In



Keg Neck



Lock Ring

Valve



Capacity	1/2 Barrel or Cylinder	Pony Keg (1/4 Barrel)	1/4 Barrel	Full-Size Keg (1/2 Barrel)	Euro Keg
Gallons	5- 5.16	7.75	7.75	15.50	13.2
Ounces	661	992	992	1984	1690
# of 12 oz. beers	55	82	82	165	140
Weight (Full)	58 Pounds	87 Pounds	87 Pounds	161 Pounds	137 pounds

## Coupler

Gas flows in and beer flows out of a keg through the coupler. While this device has many casual names in beer cellars around the country, the industry adopted the term “coupler” as the standard term for the device.

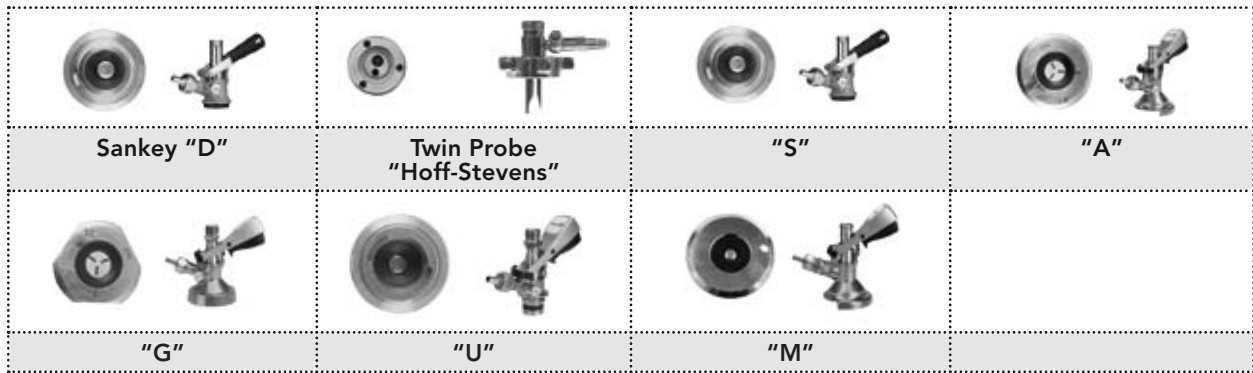
When you attach a coupler to a keg to tap it, a probe on the bottom depresses a ball or poppet in the keg valve, allowing CO<sub>2</sub> or mixed gas to enter the keg thereby applying pressure to the beer. This forces the beer to travel up the down tube (spear) and drive the beer to the faucet.

The coupler is attached to a jumper or a beer line using a washer, tail piece, and beer nut. In the US, the threads on beer nuts and couplers are standard sized with the “Cleveland thread,” which is 29/32” diameter, and 14 threads per inch pitch. Be aware that some couplers from other countries may use different sized threads. Check for leaks after installing a beer nut onto any coupler.

Couplers include two types of one-way valves:

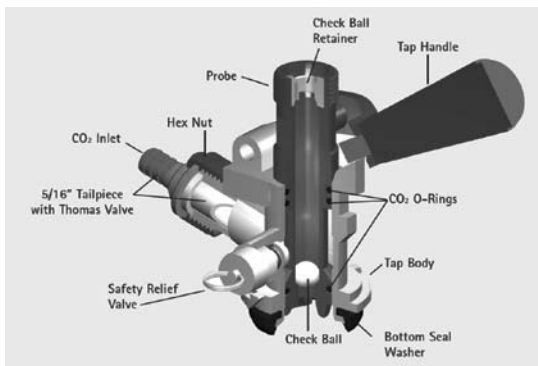
- Thomas valve – This valve allows CO<sub>2</sub> to flow into the keg but prevents the beer from backing up into the gas line if gas pressure drops. This protects the gas regulators from damage. (Thomas valves are removed when kegs are dispensed in series, see page 45)
- Check valve – When the coupler is disconnected from the keg, this valve prevents beer from the beer line flowing out through the coupler. This prevents beer spillage in keg tapping areas.

A keg coupler should also contain an integral pressure relief valve. If excessive gas pressure were applied to a keg, this valve would open to prevent damage to the keg and coupler. The valve can also be opened manually, and this should be done periodically to test the safety relief valve. The manual release usually looks like a small metal pin fitted with a wire ring. To test the valve, pull on the ring to slide the pin a short distance out of the coupler and release a small amount of gas.

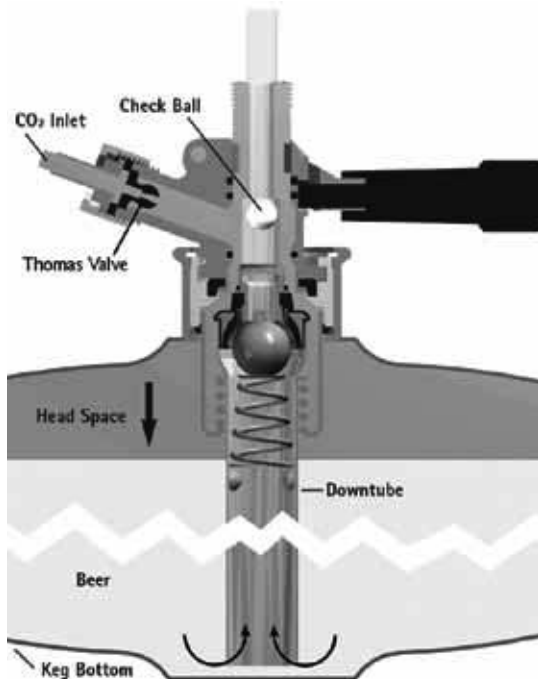


The diagram below shows all the features of a coupler

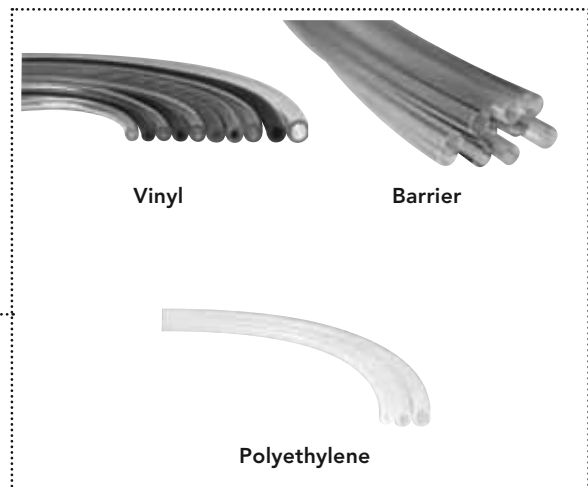
#### Cut-away of Sankey "D" Coupler



#### How Coupler Interacts with Keg to Draw Beer



At the time of this writing, most breweries worldwide use kegs valves compatible with one of six variations of the Sankey-type coupler (see images above). Most U.S. breweries use the Sankey "D" coupler, unless otherwise noted. A few U.S. breweries still use the twin probe Hoff-Stevens valve and coupler system.



#### Beer Line

Between coupler and faucet, beer travels through beer line selected to fit the needs of the specific draught application. Options range from vinyl to specialized barrier tubing and even stainless steel.

Most draught systems use clear vinyl tubing for all or part of the beer line. In picnic and direct-draw systems, beer often runs most or the entire route from coupler to faucet in vinyl tubing. In long-draw systems, beer commonly passes through two sections of vinyl hose but travels most of the way in special barrier tubing (See Chapter 4). While vinyl tubing is highly

flexible, it is best used where lines are not secured in place and where it can easily be replaced.

In later pages, we will encounter other types of tubing such as:

- Colored vinyl and braided vinyl used for CO<sub>2</sub> gas
- Stainless steel tubing found in jockey boxes and tap towers
- Barrier tubing; a low-resistance, easy-to-clean beer line for long-draw systems
- Polyethylene tubing used to carry glycol coolant

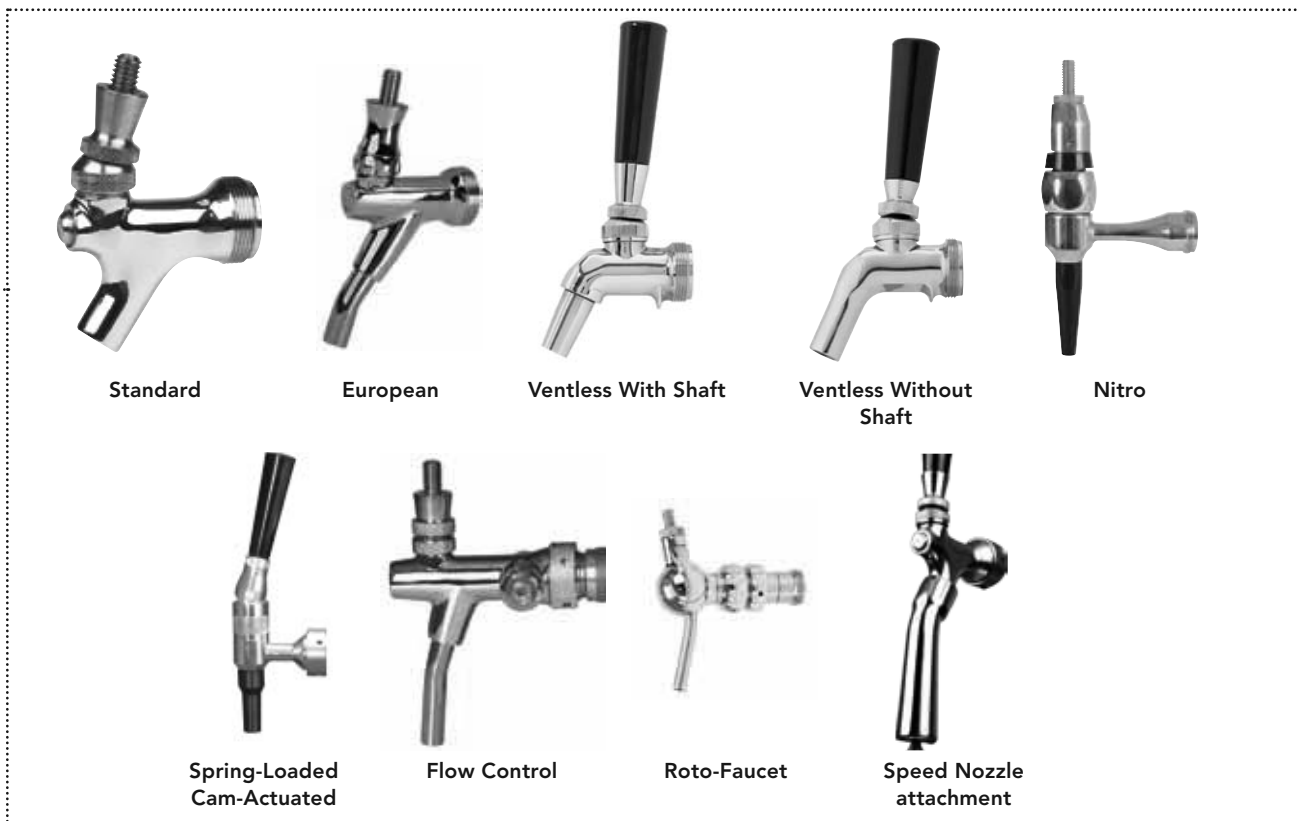
## Faucet

Faucets dispense beer to the glass. They also hold the tap marker to identify the type of beer being dispensed. The most common faucets are generally suitable for dispensing both ales and lagers. The most common or “standard” U.S. faucet is rear-sealing and has vent holes that need to be carefully cleaned and inspected during routine cleanings. Ventless or forward-sealing faucets are easy to clean and are available in stainless steel. Several

other designs are now becoming widely available and are used either for their aesthetic appeal or for serving a specific style of beer. Nitro-Beer faucets are used for nitrogenated beers, such as certain stouts. These faucets use a diaphragm and restrictor plate to “cream” the beer.

In the U.S., all faucets attach to shanks with a standard thread size of 1-1/8” diameter, and 18 threads per inch pitch. Be aware that some faucets from other countries may use different thread sizes, and may require adapters or special shanks. For example, the flow control faucet in the chart below is shown with an adapter to allow it to be used on a standard U.S. shank and tower.

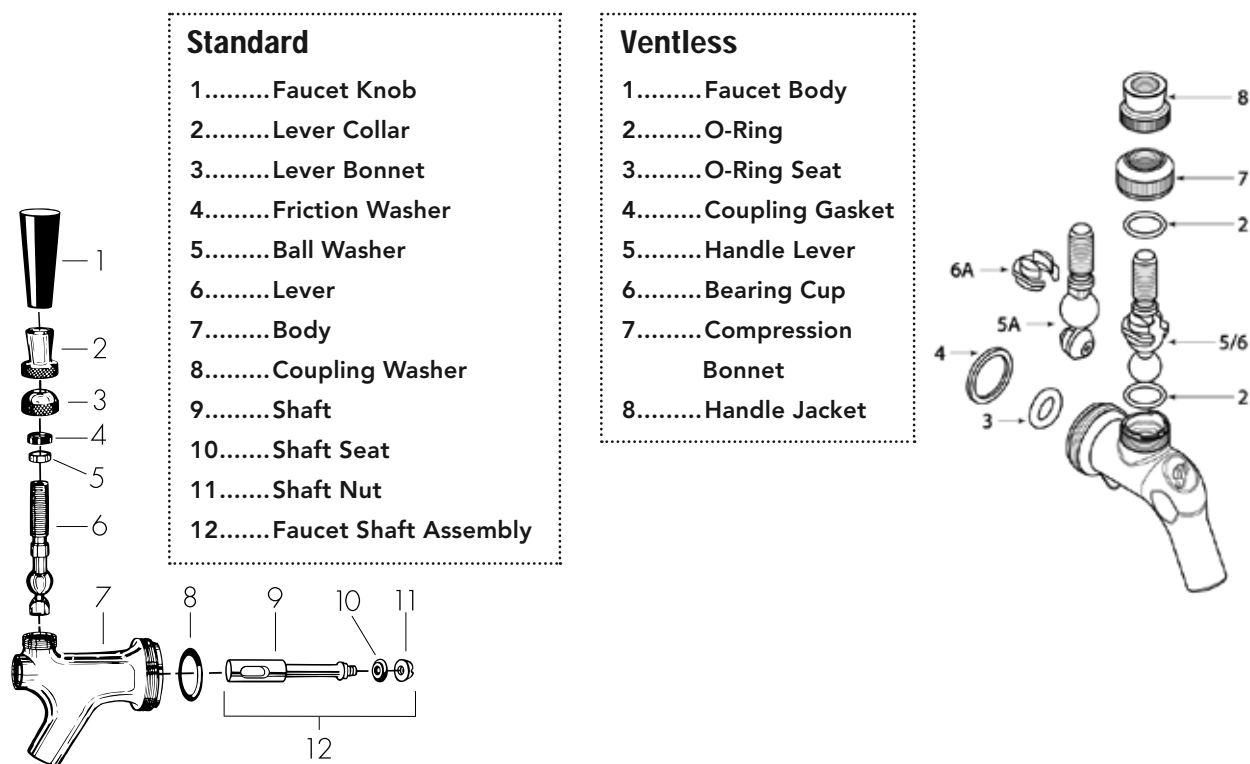
At retail, most faucets are fitted with tap markers that clearly display the brand being dispensed; in many states this is required. The tap marker must be aligned properly in order to be read easily by the consumer and sales staff. The tap marker is fitted with a standard-sized threaded sleeve for easy



## Pros and Cons of Various Faucet Designs

Type	Valve	Flow	Pro	Con
Standard	Vertical, seals in back of shaft	Smooth	Low velocity	Barrel interior susceptible to microbial growth
European	Vertical, seals in back of shaft	Smooth	Low velocity	Barrel interior susceptible to microbial growth; may have threads that differ from standard U.S. thread size
Ventless with Shaft	Vertical, seals in front of shaft	Slightly twisting	Low susceptibility to microbial growth	High velocity flow may result in turbulence
Ventless without Shaft	Vertical, seals in front of faucet body	Slightly twisting	Low susceptibility to microbial growth	High velocity flow may result in turbulence
Nitro-Beer	Spring loaded cam-actuated plunger style valve. Restrictor plate and flow straightener in nozzle	Cascade of tiny bubbles	Gives unique texture needed for nitro beers	Nozzle susceptible to microbial growth from beer retained inside narrow opening; small nozzle parts require manual cleaning; use only with nitro beers
Spring-loaded, cam-actuated	Horizontal, top of nozzle	Slightly twisting	Low susceptibility to microbial growth	Nozzle susceptible to microbial growth from beer retained inside narrow opening; many small parts to clean
Flow Control	Vertical, seals in back of shaft	Smooth adjustable flow rate	Adjustable velocity may allow for increased dispense pressure	Barrel interior susceptible to microbial growth; may have threads that differ from standard U.S. thread size
Roto-faucet	Internal, rotating ball	Rapid velocity	Few parts, simple to clean	Some flow turbulence
Speed-nozzle attachments	Attaches to traditional vented faucet	Rapid flow	Allows for increased pour rate for high volume dispense	Nozzle immersed in beer, compromising hygiene standards

## Faucet Designs - Standard and Ventless





installation onto the faucet lever; in many cases, however, the tap marker may not be aligned properly when seated fully on the lever. For this reason, nearly all faucets are also fitted with a lever collar or handle jacket on the lever (see images above). These allow the tap marker to be aligned properly, as well as installed securely. Install the tap marker on the faucet lever and check to make sure it's aligned appropriately. If not, unscrew the marker just enough to align it correctly, then back the lever collar up under the marker, and tighten the tap marker snugly onto the lever collar or handle jacket.

## Gas Source

Draught systems depend on gas pressure to push beer from the keg to the faucet. To achieve this, kegs should be pressurized with carbon dioxide, or a carbon dioxide and nitrogen mix.

Gas used for draught dispense should be “beverage grade.” Gas selection and purity affect the freshness and quality of the beer served through the draught system. Remember: The gas you use fills the keg as the beer drains. Thus, off-flavors or impurities in the gas quickly migrate to the beer to spoil its freshness and flavor. Compressed air should never be used

## No Air Compressors, Please!

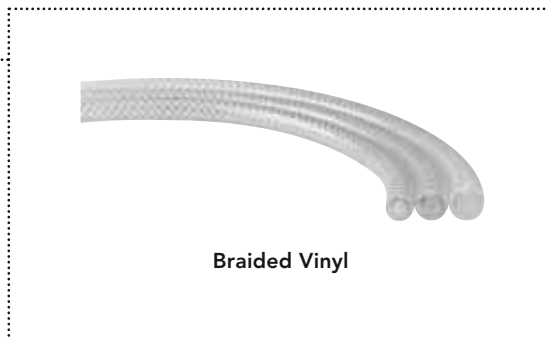
Systems that use compressed air as a dispense gas expose beer to oxygen, which produces stale paper- or cardboard-like aromas and flavors in the beer. Brewers go to great lengths to keep oxygen out of beer to avoid these undesirable stale characteristics. Air compressors also push contaminants from the outside atmosphere into the keg, increasing the chance of beer-spoiling bacteria and off-flavors. For these reasons, compressed air should never be used in direct contact with beer.

to pressurize a keg as the oxygen in the air generates stale flavors in beer within just a few hours. All gas used for beer dispense should meet the specifications of the International Society of Beverage Technologists or the Compressed Gas Association (See Appendix A).

Retailers may purchase beverage grade gas in cylinders that will be delivered by the gas vendor and swapped out when empty. Such cylinders are filled, maintained, and inspected by the vendor. High volume users may purchase a bulk gas vessel known as a Dewar that will be filled on location from a bulk gas truck. Bulk tanks can provide CO<sub>2</sub> for both soda and beer.

CO<sub>2</sub> tanks contain both liquid and gas phases. The tank pressure is dependent on ambient temperature and—regardless of tank fill level—will vary from 600 – 1200 psi until empty. For safety reasons, CO<sub>2</sub> tanks should never be located inside the refrigerator or walk-in cooler. A gas filter may be installed to help reduce the likelihood that any contaminants in the gas reach the beer (be sure to follow manufacturer recommendations for filter maintenance intervals; see page 32 for more information).

**Note: Breathing high concentrations of CO<sub>2</sub> can be deadly!** Take care to prevent CO<sub>2</sub> buildup in enclosed spaces such as cold boxes. System leaks or beer pumps using CO<sub>2</sub> can cause this gas to accumulate in the cooler. To prevent this, beer pumps driven by CO<sub>2</sub> must be vented to the atmosphere. CO<sub>2</sub> warning alarms are available and recommended for installations with enclosed areas such as cold boxes containing CO<sub>2</sub> fittings and gas lines.

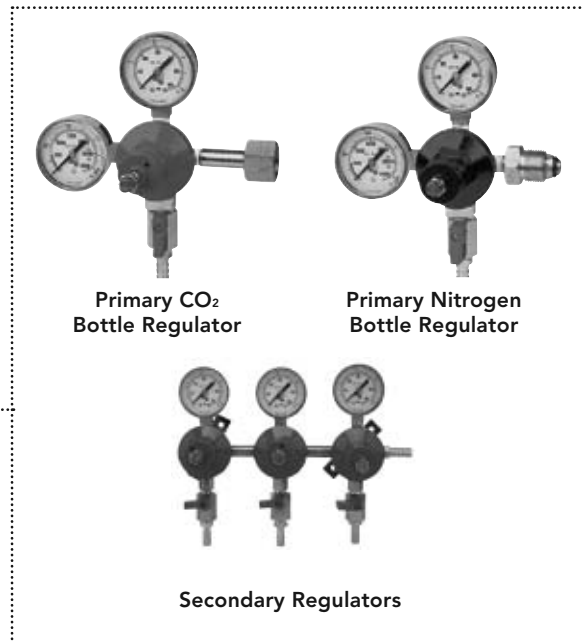


**Braided Vinyl**

## Gas Line

Gas line should be selected to withstand the pressures expected in the draught system. Vinyl tubing is often used as gas line. Vinyl tubing intended to be used as gas line often has a greater wall thickness than vinyl beer line tubing. To help distinguish between gas line and beer line, colored vinyl is used for CO<sub>2</sub> supply lines in some systems. Clear vinyl may also be used as it aids in troubleshooting by allowing you to see if beer has escaped the coupler and entered the gas line due to a faulty or missing Thomas valve. And because vinyl gas line will fail at lower pressures than braided vinyl or poly, it can also serve an important safety function in the event of secondary regulator failure by blowing off before a keg becomes overpressurized.

Braided vinyl is often used for CO<sub>2</sub>, particularly in high pressure situations (50+ psi) and in long CO<sub>2</sub> runs. Braided vinyl is commonly used in soft drink lines for both beverage and gas.



**Primary CO<sub>2</sub> Bottle Regulator**

**Primary Nitrogen Bottle Regulator**

**Secondary Regulators**

## Regulator

A regulator adjusts and controls the flow of gas from any source. Each regulator typically has at least one and often two pressure gauges that help in setting pressures and monitoring gas levels. Valves and an adjustment screw control the actual flow of gas from source to destination.

All gas systems employ a primary regulator attached to the gas source, namely a portable bottle or bulk tank. This regulator typically contains two gauges: one high-pressure showing the tank or supply pressure, and a second low- or regulated pressure gauge showing what is being delivered to the keg. Some simpler regulators may contain only one gauge displaying the delivered pressure, making it more difficult to predict when the bottle is getting low on CO<sub>2</sub>. Some suppliers provide jockey box regulators preset with no gauges, since these are easily damaged in transit.

Regulators are attached to the gas bottle with either an integrated "O" ring seal in the face of the regulator fitting, or a fiber or Teflon flat washer. These parts need to be replaced occasionally to prevent



leaks and should be inspected every time the bottle is changed. Many regulators are also equipped with one or more shut-off valves located on the low-pressure outlet, allowing the CO<sub>2</sub> to be shut off without changing the set-screw or shutting off the main tank valve.

A primary regulator must also contain a safety relief valve to prevent dangerous system pressures in case of a malfunction or frozen regulator. Bottled CO<sub>2</sub> pressure can exceed 1000 psi, creating an extreme hazard if not handled properly.

Nitrogen regulators are designed for higher pressures and have a male thread with a conical fitting that (depending on the design) seats with or without an O ring.

## Pressure and Pressure Gauges

For the purposes of this manual, pressure is the amount of force acting on the surface of beer in a keg or serving vessel, and is often expressed in pounds per square inch (psi). **Absolute pressure** is the total pressure on the beer, and is the sum of atmospheric pressure plus any additional applied pressure from dispense gas. **Atmospheric pressure** is the amount of force exerted by the weight of air in the Earth's atmosphere above an object. At sea level, atmospheric pressure is equal to 14.7 psi. If the dispense gas is applied at 15 psi, then the absolute pressure on the beer is 29.7 psi (14.7 psi + 15 psi).

Pressure can be measured several ways. Most pressure gauges are designed to measure the pressure

of the dispense gas applied to beer beyond the local atmospheric pressure level. This is called **gauge pressure** or psig. Gauges in draught beer systems will nearly always read in psig. (Some specialized gauges are designed to measure the total pressure on the beer, or absolute pressure, in units of psia; these are very rare in draught beer dispense systems.)

As draught beer is dispensed, **the carbonation level will depend on the absolute pressure of the dispense gas, not the gauge pressure of the dispense gas.** This is true for both straight CO<sub>2</sub> as well as blended gas. The carbonation level in a beer is set by the brewer to maximize flavor, aroma, and presentation, and one goal of draught beer dispensing is to maintain this level. If the absolute pressure of the dispense gas is too high, the carbonation level of the beer will increase over time. If the absolute pressure of the dispense gas is too low, the carbonation level of the beer will decrease over time. More information about this very important topic can be found in Appendix C.

## A Few Words About Elevation

Because atmospheric pressure changes depending on elevation, therefore so does the absolute pressure. So we'll need to take elevation into account while designing draught beer dispensing systems and when we read carbonation tables. At higher elevations, the layer of air is thinner and therefore weighs less, so atmospheric pressure is also less. A good rule of thumb is that atmospheric pressure decreases by about 1 psi per 2,000 feet in elevation.

Elevation (feet above sea level)	Atmospheric Pressure (PSI)	Dispense Pressure (PSIG)	Absolute Pressure (PSIA)
0	14.7	15	29.7
2,000	13.7	15	28.7
4,000	12.7	15	27.7
5,000	12.2	15	27.2
8,000	10.7	15	25.7
10,000	9.7	15	24.7

Elevation (feet above sea level)	Atmospheric Pressure (PSI)	Dispense Pressure (PSIG)	Absolute Pressure (PSIA)
0	14.7	15	29.7
2,000	13.7	16	29.7
4,000	12.7	17	29.7
5,000	12.2	17.5	29.7
8,000	10.7	19	29.7
10,000	9.7	20	29.7

Let's look at an example in which the ideal dispense gas pressure for a beer brand in a particular draught beer system at sea level is determined to be 15 psig. At sea level, atmospheric pressure is equal to 14.7 psi, so at sea level a keg of beer with dispense gas pressure of 15 psig is under an absolute pressure of 29.7 psia (15 psig + 14.7 psi). That same keg of beer at an altitude of 5,000 feet with the same dispense gas pressure of 15 psig is only under 27.2 psia (15 psig + 14.7 psi - 2.5 psi). The chart on page 16 illustrates the absolute pressure on a keg of beer at different elevations, assuming 15 psig dispense gas pressure.

Even though the gauge pressure on the keg of beer reads the same, the absolute pressure of the dispense gas on the keg is decreasing with elevation. Over time, the carbonation level of the beer being dispensed at elevation will slowly decrease because the absolute pressure of the dispense gas is lower than at sea level.

The chart above illustrates that in order to maintain the carbonation level of beer being dispensed at elevation, the gauge pressure of the dispense gas needs to be increased above the calculated dispense pressure at sea level.

## Tail Pieces and Connectors

Tail pieces connect couplers, wall brackets, shanks—or any other piece of equipment—to vinyl tubing or other types of beer line. Chromed brass and stainless steel tail pieces come in several sizes to match common tubing diameters. They are held in place with a nut and sealing washer. A clamp secures the tubing to the tail piece on the barbed side. A nut and sealing washer



Step-less hose clamp



Hex Nut



Wing Nut



Tail Piece



Sealing washer



Beer nut and faucet wrench  
1 1/32" opening for beer hex nuts

attach the tail piece to the coupler or other equipment on its flat side. In the U.S., beer nut and coupler threads are one standard size, the so-called “Cleveland thread,” which is 29/32” diameter with 14 threads per inch.

## **A Few Words about Metal Parts & Hygienic Design**

For many years, suppliers made metal parts for draught systems with chrome-plated brass. While chrome has no negative effect on beer quality, beer that has any contact with brass reacts and picks up a metallic off-taste. Exposed brass is also difficult to clean. While the chrome coating on these parts rarely wears away on the outside, cleaning and beer flow eventually expose the brass on the inside of these parts, bringing the beer in contact with the brass.

To avoid brass contact, brewers recommend stainless steel parts for draught dispense. In addition to being inert in contact with beer, they are easier to clean and thus help to maintain high quality draught dispense.

Manufacturers offer all faucets, shanks, tail pieces, splicers, wall brackets, and probes mentioned in this manual in stainless steel. If your system already contains chrome-plated brass components, inspect the beer contact surfaces regularly for exposed brass and replace those components immediately when this is detected.

All system components should be designed to facilitate cleaning and to preclude contamination, particularly due to microbial growth. Indentations, recesses, dead space, and gaps should be avoided. If dead spaces cannot be avoided at the junction between tubing and fittings, their depth should be smaller than the smallest dimension of their cross section to facilitate cleaning. Edges at protrusions, transitions, and extensions should be rounded. Components should be designed so that they permit an unobstructed flow of liquids and are easy to drain. ■

## chapter 2



# temporary draught dispense

**d**raught beer goes great with outdoor events, but the temporary setting prohibits use of traditional direct-draw or long-draw draught equipment. Instead, we usually use one of two different systems: picnic pumps or jockey boxes.

### Picnic Pumps

Picnic pumps or party taps allow draught beer dispense for a one-day occasion or event. These systems compromise accepted standards of draught dispense in order to offer a simple method for serving draught beer.



Plastic



Metal



with CO<sub>2</sub> Cartridge

In the simplest systems, the beer flows to a simple plastic faucet attached to short section of vinyl hose. Gas pressure comes from compressed air introduced by way of a hand-operated pump integrated into the coupler. The pictures at left show plastic- and metal-construction examples of a picnic tap.

Since these systems introduce compressed air into the keg, they are suitable only for situations where the beer will be consumed in a single day. Also, these dispensing systems typically do not produce the best serving results, since balancing the correct top pressure is very imprecise. For best results, the keg must be kept in ice and consistently—but not excessively—pumped as the contents are dispensed.

Improved designs use single-use CO<sub>2</sub> cartridges with an integrated regulator. These units may also include a traditional vented faucet mounted on a short length of stainless steel beer line. This design overcomes the key shortcomings of hand-pumped picnic taps.



## Jockey Boxes

Jockey boxes offer another way to improve on the picnic tap as a solution for portable dispense. Here, a normal coupler is attached to the keg and CO<sub>2</sub> is used to pressurize the system. Beer in route from keg to faucet passes through a cold plate or stainless steel tubing inside an ice chest in order to cool it to the proper dispense temperature. A cold-plate-equipped jockey box uses ice to cool beer flowing through the cold plate. A jockey box equipped with stainless steel coils uses ice and water to chill beer flowing through the coil.

These systems are not appropriate for day-to-day use, as draught beer is perishable and room temperature storage accelerates that process. They are also used with high pressure CO<sub>2</sub>, which can over-carbonate a typical keg when tapped longer than a day. Partial kegs remaining from temporary service are not usable in other settings.

## Jockey Box Setup and Use

Because they have a relatively high surface area for chilling beer, coil-style jockey boxes can pour beer at a faster rate than those equipped with a cold plate. Thus, they better suit situations where faster pour rates and volumes are needed. With lower surface areas for chilling, the cold-plate style is appropriate when beer dispense needs are a bit slower.

Kegs used with a cold plate should be iced if the ambient temperature is above 55°F since they have limited cooling capacity; however, coil boxes can pour beer efficiently even with the kegs at room

temperature (64° – 74°F). If the ambient temperature is above that, the coil-box kegs should be iced as well.

Setup affects the efficiency of both jockey box styles.

### To set up a cold plate:

- **Tap** the keg and run beer through the faucet before adding ice to the jockey box. This removes water left behind during the cleaning process before temperatures in the plate get cold enough to freeze it, causing turbulence or blockage of the beer flow.
- **Place** ice both underneath and on top of the cold plate in the ice chest. As time passes, the ice will “bridge” and should be removed for better contact with the cold plate. Ice should be added periodically and water drained from the ice chest.
- **Set** CO<sub>2</sub> pressure to 25 to 35 psi. This will vary depending on how many lines are contained in the plate and thus how much resistance to flow is built into each line. Pressure can be adjusted to obtain desired flow rate.

### To set up a coil box:

- **Tap** the keg and run beer through the coil and out the faucet.
- **Add** ice to the ice chest and completely cover the coil.
- **Add** cold water to the top of the coil. This causes an ice bath, giving excellent surface contact.
- **Set** CO<sub>2</sub> pressure to 35 to 40 psi on 120 ft. coils. Shorter coils are not recommended, but if used, should dispense at 30 – 35 psi.

## Cleaning and Maintenance

Temporary dispense equipment must be cleaned immediately after use. It is nearly impossible to remove the mold and biofilms that can result from storing a cold plate or jockey box improperly, packed with beer.

For cleaning jockey boxes, refer to the detailed electric cleaning pump procedures outlined in Chapter 8. Afterwards, the water in the lines must be blown out to prevent mold growth.

- If the recirculation pump is capable of being run dry:
  - Before breaking down recirculation loop, remove inlet from rinse water with pump running so air pushes out all of the rinse water in the lines.
- If the recirculation pump is **not** capable of being run dry:
  - After breaking down the recirculation loop and reattaching faucets, tap an empty cleaning canister and use the gas pressure to blow all of the water out of the lines. ■



## chapter 3

# equipment and configurations for direct draw draught systems

**r**etailers use direct-draw systems in situations where the kegs can be kept refrigerated in very close proximity to the dispense point or faucet. In some cases, the beer sits in a cooler below the counter at the bar. In other cases, the keg cooler shares a wall with the bar, keeping the beer close to the point of dispense. Let's look at these two types of direct-draw systems:

- A self-contained refrigerator (keg box or "kegerator") where the number of kegs accommodated will vary based on box and keg sizes.

- A walk-in cooler with beer dispense directly through the wall from the keg to the faucet.

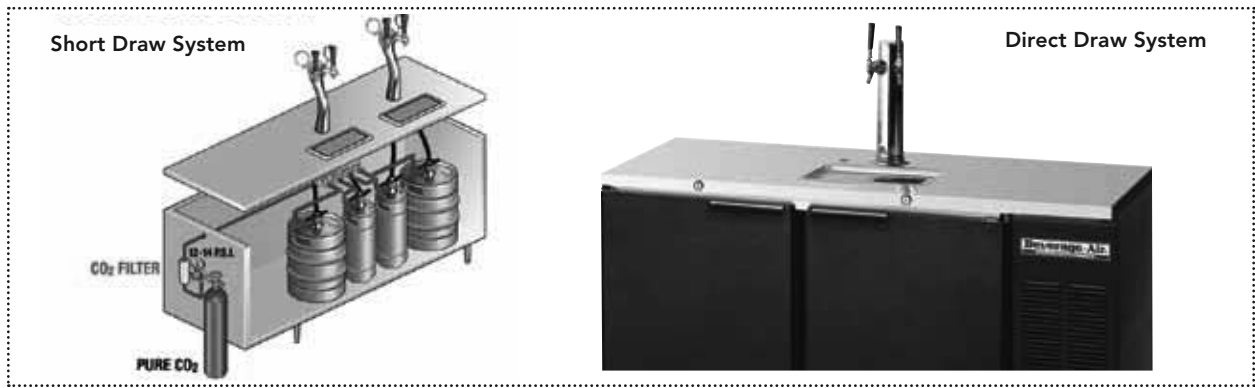
The nine components discussed in Chapter 1 appear in both direct-draw systems; only a little additional equipment comes into play. As with temporary systems, most direct-draw systems employ vinyl beer line and pure CO<sub>2</sub> gas. Compared to barrier tubing, vinyl beer line is relatively permeable to oxygen ingress, and the flavor of beer stored in these lines can change overnight. As part of their opening



Direct Draw Kegerator

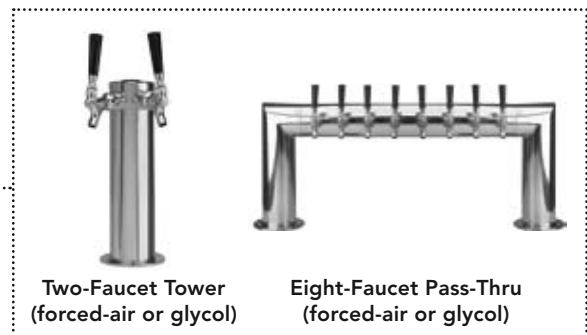


Walk-in Cooler



procedures each day, some retailers will dispense enough beer to repack their vinyl beer lines, and use the collected beer for cooking.

As permanent installations, direct-draw systems typically include a drip tray, and some systems also incorporate a tap tower. In addition, shanks support the faucets in either tower or wall-mount applications. The following sections discuss these elements of the system.



## Towers

Direct-draw keg boxes and most long-draw systems mount the dispensing faucet on a tower. This tower attaches to the top of the bar or keg box. Towers come in various shapes and sizes and may have anywhere from one to dozens of faucets.

To achieve proper beer service, the beer line running through the tower to the faucet must be kept at the same temperature as the beer cooler. Direct-draw systems use air cooling, while long-draw systems usually use glycol cooling. The air-cooled towers are insulated on the inside and cold air from the cooler circulates around the beer lines and shanks. This works with direct-draw systems thanks to the close proximity of the tower to the cold box. Some keg boxes have specialized corrugated tubing connected to the refrigerator's evaporator housing. This tubing is designed to be inserted in the tower to provide for cold air flow up to the faucet. Typically cold air is supplied directly from the discharge of the evaporator and is colder than the keg temperature.

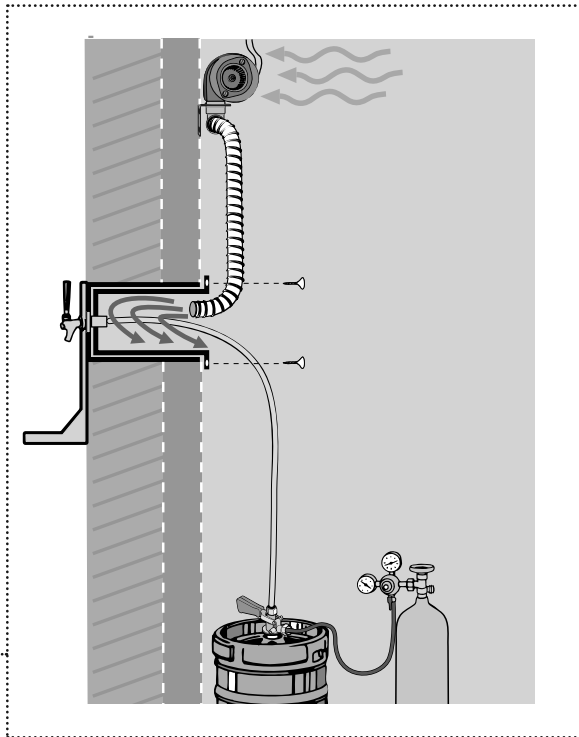


## Drip Tray

Many draught systems include a drip tray placed below the faucets and most health departments require them.

Many walk-in based direct-draw systems use a wall-mounted drip tray that includes a back splash. This design may be used on some air-cooled long-draw systems as well. Bars typically place surface or recessed drip trays under draught towers. The drip trays should be plumbed to drain into a drain or floor sink.





### Shadow Box

In some direct-draw applications inside a walk-in cooler, it may be necessary to cut a section out of the cooler wall where the shanks are placed. The wall is then recessed in a "shadow box" to minimize the shank length and keep foaming to a minimum.



Bent Tube Shank



Nipple Shank

### Shanks

Most draught systems firmly mount the faucet to either a tower or a wall, making it a stable point for beer dispense. A threaded shank with securing nuts creates the solid connection to the supporting tower or wall. The faucet then connects to one side of the shank and beer line connects to the other side by either an attached nipple or a tail piece connected with the usual washer and nut. Today, shanks with 1/4" and 5/16" bore diameters are most commonly available and recommended in the U.S., along with 3/16" bore diameter shanks, which are less common. The once-common practice of drilling out a 3/16" bore diameter shank to one of the larger sizes is not recommended as the resulting unfinished brass shank bore surface will be detrimental to draught beer quality, and because drilling will likely damage shanks and glycol chilled towers beyond repair, meaning expensive replacement will be necessary. ■

## chapter 4



# equipment and configurations for long-draw draught systems

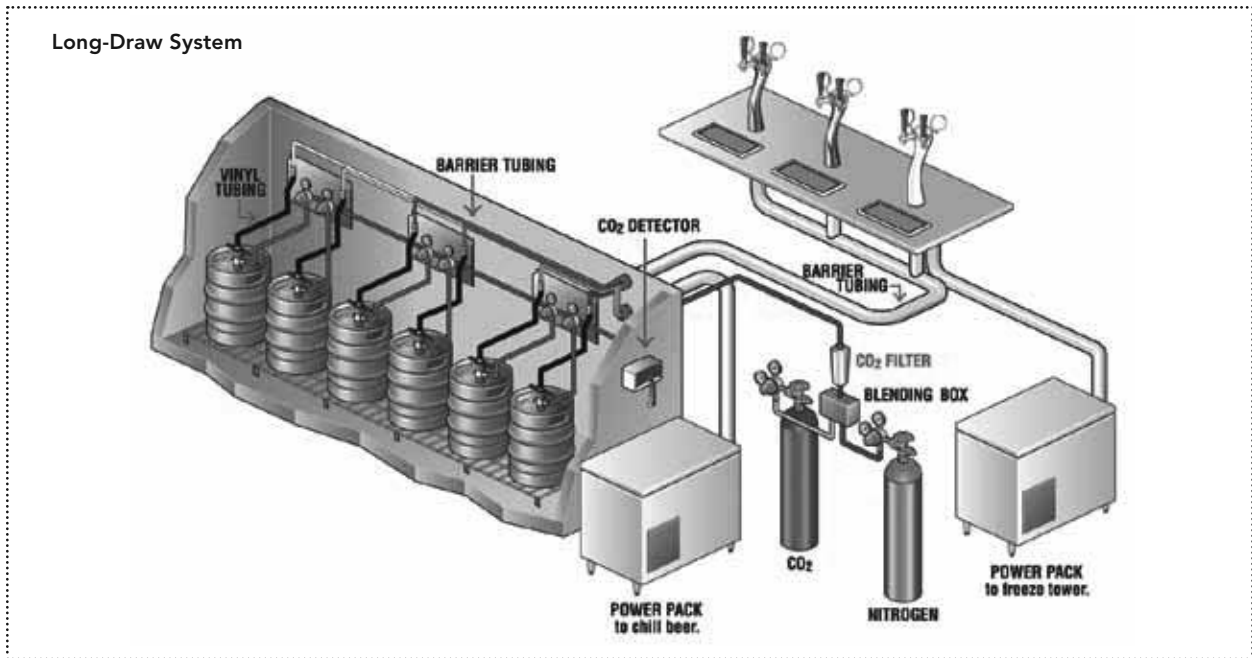
**t**he most complex draught systems fall into the long-draw category. Designed to deliver beer to bars well away from the keg cooler, these systems usually employ equipment not seen in temporary and direct-draw setups. From around 1990 to 2010, the average long draw system had doubled in complexity from roughly five faucets to more than 10 faucets. Today it's not uncommon to find very complex draught beer systems at retail with dozens of faucets, dispensing up to many dozens of beer brands. While long-draw systems offer designers the option to put beer far from the bar, providing keg handling or layout flexibility, the distances they cover come with increased opportunities for problems and increased costs for equipment, cooling, and beer waste. As with all systems, it's important to minimize line length and diameter where possible to minimize beer loss and facilitate cleaning.

Let's consider the three draught dispense sub-systems of beer, gas, and cooling to see what long-draw systems include.

### Beer

While exceptions exist, most long-draw systems still push beer from kegs. Beer exits the keg through a coupler and usually enters a vinyl beer line just as we have seen with temporary and direct-draw systems. But here the vinyl doesn't last long. It typically goes about six feet before connecting to a wall bracket that serves as a transition to specialized barrier tubing. Designed for minimum resistance and superior cleanliness, barrier tubing should carry beer most of the distance from keg to faucet in long-draw systems. But barrier tubing isn't the end of the journey; most draught towers use stainless steel tubing to carry the beer to the faucet. In addition, many systems install some length of narrow-gauge vinyl tubing called "choker" between the end of the barrier tubing and the stainless steel tubing of the draught tower, to provide a way to accurately balance the system. In the end, however, the beer flows through a faucet just as we saw with the direct-draw systems.

## Long-Draw System



You may also find Foam On Beer (FOB) detectors on the beer lines of many long-draw systems. Located in the cooler at or near the wall bracket, these devices fill with dispense gas when beer from a keg runs out, thereby shutting off flow to the main beer line. This prevents beer loss by keeping the main beer line full of pressurized beer while the keg is changed. The jumper line between the keg and FOB is then purged and normal beer service can resume. See page 27 for more information about FOBs.

## Components:

### Barrier Tubing

Barrier tubing has a “glass-smooth” lining that inhibits beer or mineral stone deposits and microbial growth to maintain beer freshness. Its properties make it the only industry-approved beer line for long-draw systems.

Barrier tubing may be purchased by itself in various diameters, but most suppliers sell it in prepared bundles (called bundle or trunk housing) with beer lines and glycol coolant lines wrapped inside an insulating cover. These bundles vary by the number of beer lines they carry with popular sizes matching the number of faucets commonly found on tap towers.

Many older long-draw systems installed single-wall polyethylene tubing. This relatively porous material allows oxygen ingress, carbon dioxide to escape, and makes cleaning difficult, resulting in stale, flat, and potentially tainted beer in the lines. Today, you may find blue and red polyethylene tubing carrying glycol from and to your glycol power pack; this is the only recommended use for polyethylene tubing in long-draw systems. Long-draw systems with vinyl or poly lines (typical of much older systems) should be repacked with fresh beer each day due to the detrimental effects of oxidation; the beer drained during this process can be used for cooking. This expense alone can significantly decrease the payback time when replacing an old long-draw system with barrier tubing.

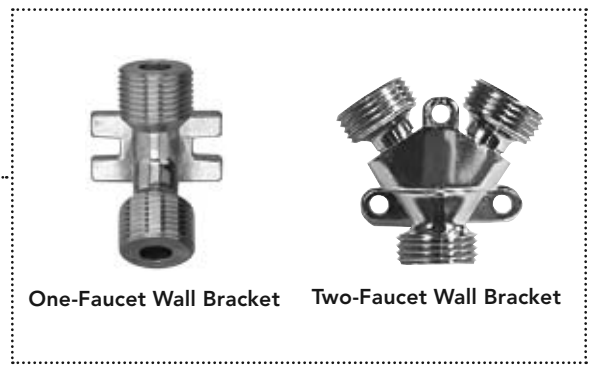
Vinyl tubing should only be used as jumpers between keg couplers and long-draw barrier tubing trunks, and as restriction tubing between barrier tubing trunks and faucet shanks. Vinyl and polyethylene tubing should never be used in long-draw bundles.

### Choker Line

Choker line, also known as restriction tubing, is a section of 3/16” ID vinyl tubing of variable length installed at the tower end of a long-draw system. The purpose is

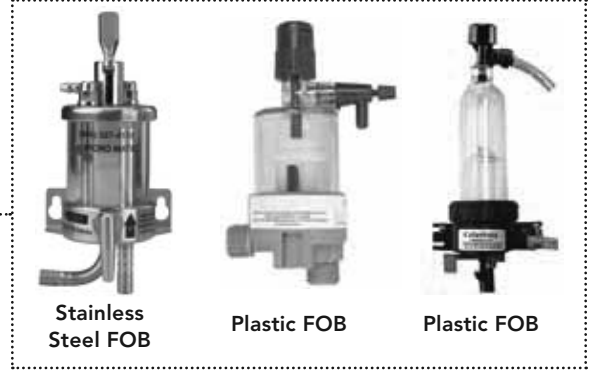
to add to the overall system restriction and thus achieve the target flow rate at the faucet. It is connected at one end to the barrier tubing in the trunk housing with a reducing splicer, and at the other to a hose barb on either the back side of the shank inside the tower, or to the stainless tubing extending from the tower.

A few different specially designed devices can be used as alternatives to constructing final choker restriction with long lengths of 3/16" ID polyvinyl hose. One such device is a series of plastic segments that are inserted into a short section of 1/4" ID barrier tubing just below the tower; another is a wire mesh device installed in the shank just behind the faucet. These devices are of varying restriction and, while potentially useful, also have some potential downside. For one, these items prevent beer line cleaning with sponges as an option. Additionally, the increased surface area may increase the likelihood of bacterial buildup or foaming.



### Wall Brackets

Wall brackets join tubing together in a long-draw cold box. The wall bracket gives a solid connecting spot for jumper lines from the keg. Tubing is connected with a washer, nut, tail piece, and clamp combination. (Most of these installed in the past were made of plated brass, and should be inspected for wear and replaced with stainless steel.)



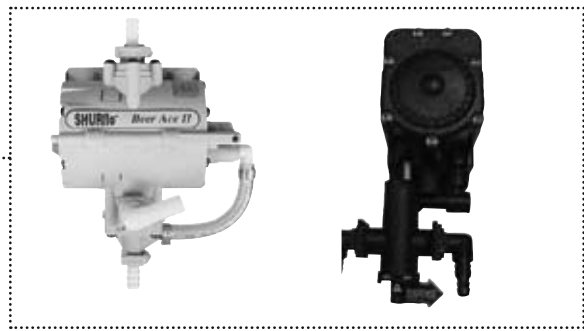
### FOB (Foam On Beer)

FOBs stop the flow of beer through a line once the keg empties. This reduces the beer loss normally associated with changing a keg and therefore reduces operating costs. While available in different designs, most feature a float in a sealed bowl that drops when beer flow from the keg stops. The FOB allows the beer lines to stay packed. This makes for less product loss and generates savings for the account. FOBs should be cleaned every two weeks when the draught system is cleaned and completely disassembled and manually cleaned quarterly to assure a clean system.



Another version of an FOB that performs the same function is available as an existing feature on a keg coupler, as shown above. This variety does not have a float but smaller moving parts that shut off the flow of beer when gas is present. It is not as easily disassembled or cleaned as the wall-mounted varieties

and must be removed and cleaned separately from the beer line system.



## Beer Pumps

Beer pumps draw beer from a keg or other beer-serving vessel and deliver it to the faucet. Rather than using gas pressure to drive beer, beer pumps use mechanical force to propel the beer through the system. We find beer pumps in draught systems when working pressures for gas dispense get too high (above 35 or 40 psi). This includes very long runs (>200 feet) or high vertical lifts. Above these pressures, beer will absorb enough nitrogen from the blended dispense gas to create longlasting, smaller-sized foam bubbles that in turn can cause problems dispensing beer. We also see beer pumps used on multi-barrel brewpub serving tanks that have low-pressure limits. Also, very few tanks are pressure rated for safely dispensing beer above 30 psi.

Beer pumps themselves are powered by high-pressure gas or compressed air that does not come into contact with the beer. Most retailers power their beer pumps with CO<sub>2</sub>; in these cases, **the pump exhaust CO<sub>2</sub> gas must be vented outside the cooler or building to avoid CO<sub>2</sub> buildup and asphyxiation.** CO<sub>2</sub> can be relatively expensive to use to power beer pumps compared to compressed air, but CO<sub>2</sub> is usually already available at any location serving draught beer, so is often simpler to use.

If using compressed air to drive beer pumps, pump and keg regulators must be separated—compressed air should never come into contact with draught beer.

Also, high quality air compressors that clean and dry the air must be used to avoid damaging beer pumps; smaller, less expensive air compressors can deliver air with small amounts of moisture or oil that can damage beer pumps over time. Air compressors can break down, leaving the retailer unable to dispense beer.

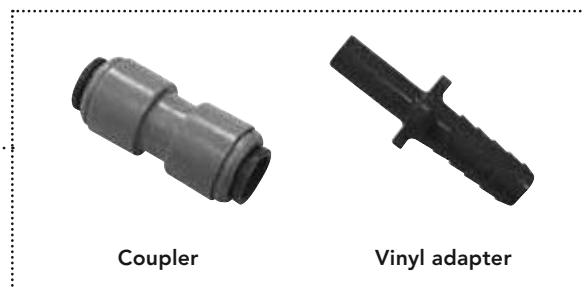
Some portion of the pump contacts the beer and like anything else, it must be regularly cleaned to prevent beer stone buildup and microbial infection. See special cleaning considerations on page 56 of this manual.

Beer pump setups require two operational pressures: CO<sub>2</sub> pressure on the keg or tank to maintain beer carbonation, and separate gas pressure to the pump to propel the beer to the faucet. There are two basic beer pump types: fixed pressure and additive pressure. Fixed pressure pumps are becoming much less common today. Because fixed pressure pumps deliver beer at the same pressure being applied to the beer keg or tank, they are less useful in systems balanced at higher pressures. Additive pressure beer pumps are most useful for very long draw systems, since the pressure applied to the keg is added to the pressure of the gas driving the beer pump. Additive pressure pumps have one other advantage—beer may still be dispensed (although much more slowly) if they fail; whereas beer cannot be served if a fixed pressure pump fails.

Here are some good rules of thumb for using beer pumps in draught beer dispensing systems:

- Be sure to refer to detailed cleaning procedures provided by the pump manufacturer, and to procedures found on page 56 of this manual. Don't let your cleaning solution get too hot, or you'll damage your pump.
- Only use beer pumps that come fitted with a diverter or backflush fitting, so the pump can be properly cleaned using recirculation pumps, in either forward or backward direction. One such pump fitted with a flow diverter is shown on the top of the page.

- Proper CO<sub>2</sub> pressure should be applied to the keg or tank to maintain the beer's carbonation level (See Appendix B). Here the only caveat is that this pressure must at least equal that required to maintain proper carbonation in the keg in order to prevent carbonation breakout in the beer lines.
- When using additive pressure type pumps, set pump pressure so that the sum total of the keg pressure plus pump pressure together equal system resistance pressure.
- Most draught beer systems with beer pumps also use FOBs placed immediately after the beer pump. This keeps the pump from running dry when the beer supply to the pump runs out, a primary cause of pump failure.



- Use the handy check valves supplied by the manufacturer.
- Vent CO<sub>2</sub> out of the cooler for the pump exhaust.
- Don't run more than two faucets per beer pump.
- Don't run more than two beer pumps per secondary regulator.
- Be sure to install beer pumps less than 5 feet above cooler floor height.
- Beer pumps should be installed below the level of the faucet at the bar.

### Quick-Connect (or Push) Fittings

Special fittings can join the different types of beer line found in long-draw systems. Quick-connect fittings work on hard or rigid tubing including polyethylene (used for glycol), barrier line, and stainless tubing. Couplers attach to square-cut tubing ends with an O-ring and gripper. Adding a vinyl adapter to the coupler allows for transition from barrier or stainless to vinyl tubing.

## Defining Mixed Gases

For the purposes of this manual, as a convention in discussions involving mixed gas, the proportion of CO<sub>2</sub> will always be shown first, followed by the proportion of N<sub>2</sub>.

### Gas

To push beer across the distances found in long-draw systems usually calls for gas pressures well above what is needed to maintain proper beer carbonation levels.

Most long-draw systems employ a CO<sub>2</sub>/N<sub>2</sub> blend to prevent overcarbonation of the beer. The use of blended gas to dispense draught beer can to some degree help eliminate foaming caused by temperature fluctuations in a walk-in cooler or in beer lines, by keeping beer packed several pounds above the carbonation breakout pressure. The exact blend needed will depend on the system parameters and operating pressure. The correct blend might be purchased pre-mixed in blended gas bottles, or custom blends can be mixed onsite from separate carbon dioxide and nitrogen sources. The use of custom gas blends brings new equipment into play, including gas blenders and possibly nitrogen generators.

In some long-draw systems, gas plays an entirely different role, powering beer pumps used to move the beer (see page 27-28).

### Carbon Dioxide Gas (CO<sub>2</sub>)

CO<sub>2</sub> is the primary gas used to dispense draught beer. CO<sub>2</sub> in the headspace of the keg or tank serves to maintain proper carbonation within the beer, and also provides pressure to help move the beer from the cooler through the beer lines to the faucet. CO<sub>2</sub> used for beverage dispense must be of suffi-

cient purity and free of off aromas or organic or other contaminants. See Appendix A for detailed purity specifications.

## Nitrogen Gas (N<sub>2</sub>)

Nitrogen gas (N<sub>2</sub>) is blended with CO<sub>2</sub> to aid in dispensing beers in systems requiring delivery pressures above CO<sub>2</sub> equilibrium. Nitrogen is not easily absorbed by beer. As an inert gas, it does not degrade the flavor of the beer, making it perfect for blending with CO<sub>2</sub>. A blend of these gases is one option for dispensing beer over long distances without overcarbonating the beer in the keg. Blended gases are also necessary for dispensing nitrogenated beers.

## Blended Gas Bottles

Blended gas bottles are vendor-mixed CO<sub>2</sub> and nitrogen gas mixes. It may not be possible to find the exact blend needed for a particular draught beer dispensing system. These blends are typically available in blends of approximately 70% CO<sub>2</sub>/30% N<sub>2</sub> for dispensing regularly carbonated beer, and approximately 25% CO<sub>2</sub>/75% N<sub>2</sub> used to dispense nitrogenated beers (often called “G-Mix” or “Guinness Gas”). In some markets, custom blends may be ordered from some vendors.

For simplicity, many retailers will opt for a default blended gas solution, although we don’t recommend this practice. In the past, the default blend for regularly carbonated beers was often 60% CO<sub>2</sub>/40% N<sub>2</sub>. Recent studies in retail establishments have shown that a 70% CO<sub>2</sub>/30% N<sub>2</sub> blend will more likely result in proper carbonation of draught beer in most retail draught beer systems. However, the best approach for high quality draught beer is to identify and use the exact correct gas blend for your particular draught beer system. See Appendix C of this manual for examples of this calculation, or consult your professional draught beer equipment installer or supplier for more advice.

The physical characteristics of CO<sub>2</sub> limit the amount of blended gas that can be stored in a blended gas bottle, compared to pure CO<sub>2</sub> or N<sub>2</sub>. CO<sub>2</sub> becomes liquid at the very high pressures needed to compress nitrogen, meaning the blended gas being dispensed from the headspace of the bottle will not be the blend proportion anticipated if the bottle is overfilled. For this reason, blended gas bottles are relatively expensive compared to gas blenders. Because bottled blends are relatively expensive, the payback period for a gas blender is usually under a year.

In addition, the tolerances of bottled blended gas are very difficult to manage during filling. And, unless the bottled blend is well mixed, or if the bottle is overpressurized and the CO<sub>2</sub> becomes a liquid, the gas being dispensed will likely vary considerably from the desired mixture. This deviation can result in over- or under-carbonated beer, therefore increasing expense and decreasing draught beer quality.

Pre-mixed cylinders containing a mix of between 30-25% CO<sub>2</sub> and 70-75% N<sub>2</sub> are intended for use with nitrogen-infused beers or “nitro” beers, such as some stouts. These blends are not intended for use with regularly carbonated beers (those with more than 2.0 volumes or 3.9 grams/liter of CO<sub>2</sub>), even in high-pressure long-draw systems. Use of “nitro” beer gas on regular beers causes the beers to lose carbonation in the keg, resulting in flat beer being served within three to five days. The flat beer is most noticeable near the end of the keg, with the amount of flat beer increasing the longer the beer is in contact with this gas. Similarly, straight CO<sub>2</sub> should not be used to dispense nitro beers.

Straight CO<sub>2</sub> should only be used in a long-draw system when 1) ideal gauge pressure is sufficient to produce the proper flow rate, and 2) there is absolutely no temperature increase in the draught lines outside the cooler, both of which are highly unlikely.



Single Mix Blender



Two Mix Blender



Three Mix Blender

Since ideal dispense pressure with straight CO<sub>2</sub> is relatively low, even a slight temperature increase from the keg cooler to the draught line can allow the CO<sub>2</sub> to escape from the beer in the draught line, causing foamy beer at the tap.

## Gas Blenders

Gas blenders mix pure tank CO<sub>2</sub> and pure tank nitrogen to specified ratios. Blenders can be ordered to specific ratios and provide one, two, or even three blends. Three product blenders will usually be set to dispense beers at 2.7 volumes of CO<sub>2</sub>, 2.5 volumes of CO<sub>2</sub>, and nitrogenated beers. Existing one and two mix blenders can sometimes be upgraded to two and three blends; be sure to check with your supplier. Recommended features for a gas blender include:

- Output mix is preset by the manufacturer and is not adjustable onsite.
- Blender shuts down when either gas supply runs out, preventing damage from running on only one gas.
- Blender produces two or three blends so that both “nitro” and regularly carbonated beers can be served. The blends for regularly carbonated beers can adequately serve products with a reasonable range of CO<sub>2</sub> volumes (e.g. 2.2-2.8 volumes of CO<sub>2</sub>).



Nitrogen Generator



Nitrogen Generator w/blender

## Nitrogen Generators

Nitrogen generators extract nitrogen from the atmosphere. Air is supplied by either a remote or



integrated air compressor. Nitrogen generators are typically equipped with a built-in gas blender.

To protect nitrogen purity from compromising draught beer quality, nitrogen generators should have the following features:

- Produce nitrogen with a purity of at least 99.7%.
- Have air inlets equipped with both an oil/water filter and a sterile air filter.
- Use "oil-free"-type air compressors.

All nitrogen generator filters should be inspected and replaced according to the manufacturer's specifications.



### Gas Leak Detectors

Gas leaks in a draught system can not only cost money in lost gas, but can also potentially cause pressure drops that can lead to foamy beer. In enclosed spaces, large CO<sub>2</sub> leaks can be extremely dangerous or even deadly. Gas leak detectors are available that are plumbed directly into the gas supply line to the draught system. When no beer is being poured, a float inside the device will rise if gas is leaking.

Electronic CO<sub>2</sub> monitors are also available for installation in walk-in coolers. Such devices can prevent serious injury or death from CO<sub>2</sub> inhalation by sounding an alarm when CO<sub>2</sub> levels are elevated.



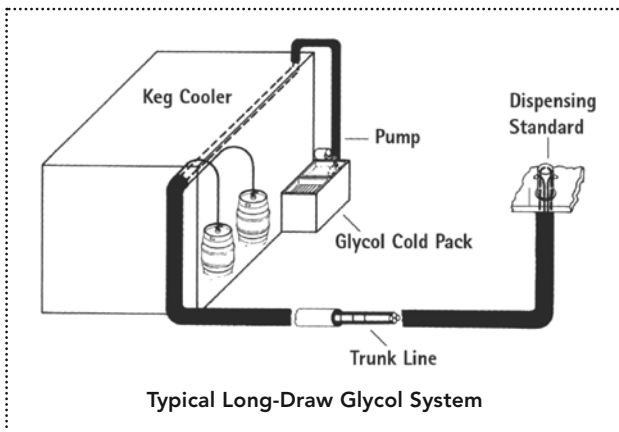
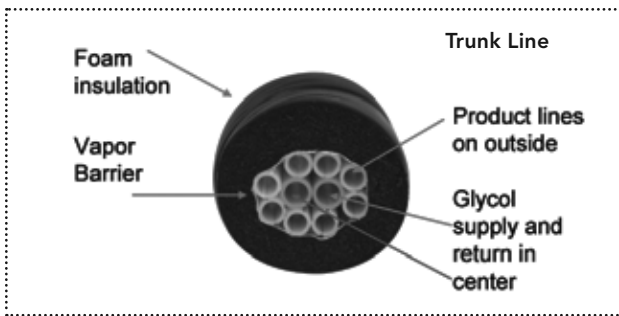
### Gas Filters

Beverage grade CO<sub>2</sub> comes from many commercial and industrial operations and is supplied for many uses besides beverages. (e.g., fire extinguishers, welding, food processing, etc.) CO<sub>2</sub> bottles can be contaminated by poor handling and storage. They can be contaminated by beer or soft drinks if a check valve malfunctions and the beer or soft drink flows back into an empty CO<sub>2</sub> bottle. A gas filter helps safeguard beer by removing unwanted impurities or contaminants from the gas. Filters must be replaced periodically per the manufacturer's instructions.

### Cooling

As with direct-draw systems, kegs reside in a walk-in cooler held at 34° to 38°F. But to keep beer cold throughout its journey from keg to faucet requires additional cooling components that surround the beer lines themselves. We find two common designs: air-cooled and glycol-cooled.

In a **forced-air long-draw system**, beer lines travel through a tube or chase kept cold by a continuously operating recirculation fan. The fan pushes cold air from a condensing unit inside the cooler into and through the ductwork. In both single-duct and double-duct systems, cold air travels a route from the cooler to and through the tap tower as well as a return route back to the cooler. Single-duct systems use a tube-in-tube design effective for runs of up to 15 feet. Runs of up to 25 feet can be created using double-duct systems where separate tubes



carry the outbound and return flows. These systems can be especially vulnerable to temperature fluctuations in the outside environment. All ductwork should be well insulated with at least 1/2" thick insulation. Careful assessment of the room temperature should be taken into consideration before installation. It is important to note that temperatures near the ceiling of an already hot basement or storage room where the ducts may run can be significantly higher than at ground-level.

It is also important to consider the extra cooling load to be placed on the keg cooler with such an installation. Many coolers are specifically designed to cool the exact dimensions of the cold box, and adding a forced air system may overload and compromise the entire cooling system.

**Glycol-cooled long-draw systems** service runs longer than 25 feet. Here, a separate chiller pumps a chilled mixture of water and food-grade liquid propylene glycol through cooling lines parallel to and in contact with the beer lines. These systems require well-insulated and carefully configured trunk line (see photo). Each beer line (usually barrier line) in a trunk touches a glycol line to keep the beer cold as it travels from keg to the faucet. Glycol chillers work well as long as they are maintained; see suggested maintenance points on page 59.

Glycol towers attach coolant lines parallel to the beer lines (typically stainless) and surround them tightly with insulation. This cooling method allows towers to be located remotely from the cold box, up to several hundred feet away.

In addition to the glycol chiller used to maintain temperature of the beer lines, some systems, like those using frosted or "ice" towers, use a separate glycol cooling system to chill the tap tower. ■



## section II

# draught operations

**d**raught systems from simple to complex can deliver high-quality beer—but only when properly operated and suitably maintained. Many who work with draught beer will never have the chance to buy or install the system components discussed in Section I, but all will pour beer from the faucet and nearly everyone will experience foaming or other problems at some time that can be traced to operating conditions. In Section II of this manual, we consider all the issues involved in operating a draught system and serving the customer a top-quality draught beer.

In Chapter 5, we focus on the heart of draught operation by looking at the dynamics of carbonation, pressure, and system resistance. By understanding these

concepts and their relationship with each other, you'll be much better equipped for successful draught system operation.

Chapter 6 covers practical issues related to the cooler and other “behind the scenes” aspects of beer service. Chapter 7 looks at glass cleaning and the proper way to pour a beer.

Chapter 8 concludes our discussion of operating issues by taking a close look at maintenance and cleaning. Whether you clean your system yourself or hire an outside service, you owe it to yourself to understand proper cleaning methods. Without this knowledge, you can't defend against a decline in beer quality at your establishment. ■

## chapter 5



# a matter of balance

**a**ll beer contains dissolved carbon dioxide (or CO<sub>2</sub>). Brewers control the amount of CO<sub>2</sub> in each beer to influence the overall character of the beer. For beer servers, its presence can be both a blessing and a curse.

Ideally, we deliver beer to the consumer's glass while maintaining its CO<sub>2</sub> content. When this happens, the beer pours "clear" without foaming and we create a pleasing head on the beer without waste. But too many draught systems fail at this goal. Foamy beer comes out of the faucet and servers overflow the glass trying to get a decent pour. Beer quality and retailer economics both suffer.

The ideal draught beer dispense system moves an incredibly fragile liquid from the safety of a stainless steel keg to the customer's glass without changing its properties, at a flow rate of about 1 gallon per minute, or 2 ounces per second. The design of the system

is critical to achieve proper flow rates and pouring characteristics. To put beautiful, high-quality beer in the glass and maximize consumer satisfaction as well as retailer profits, we must consider the components of balance and how they apply to draught systems. This chapter introduces the concepts, then looks at some practical examples.

### Components of Balance

To understand and manage draught system balance, we'll look at four measurements: beer temperature, applied pressure, resistance, and beer carbonation level.

In this manual we will be using degrees Fahrenheit (or °F) for all **temperature** measurements. Just remember that we want to know the temperature of the actual beer. Since it takes a keg of beer many hours to stabilize at the temperature of the cooler, the beer temperature can vary quite a bit from the setting of the thermostat in your cooler. (See page 44 for further details.)

We measure **applied pressure** in pounds per-square-inch-gauge abbreviated as “psig,” or often just “psi.” The pressure applied to any keg is shown by the gas regulator attached to it.

**Resistance** comes from draught system components like the beer line and changes in elevation as the beer flows from keg to glass. We measure resistance in pounds and account for two types: static and dynamic. For the purposes of this manual, and generally speaking in the trade, pounds of resistance are considered equivalent to pounds per square inch of pressure when balancing a draught beer system.

**Static resistance** comes from the effect of gravity, which slows the flow of beer being pushed to a level above the keg. Here’s one way to think about static pressure: if you have a U-tube filled with water, you can blow in one side and push the liquid up the other side of the tube. The weight of the liquid pushes back with hydrostatic (or “still-liquid”) pressure. Each foot of increased elevation adds 0.43 pounds of hydrostatic pressure to a draught beer system that must be overcome by dispense gas pressure. A figure of 0.5 pounds is often used in the trade for ease of calculation, and for purposes of discussion and examples in this manual, we follow this convention by using

0.5 pounds of pressure per foot of elevation. If the beer travels to a faucet above keg level, each foot of increased height will add approximately 0.5 pounds of resistance to the system. If the beer travels to a faucet below keg level, each foot of decreased elevation will subtract approximately 0.5 pounds of resistance from the system. The gravity factor remains the same regardless of tube length, bends, junctions, or other configuration issues. When the keg and faucet heads are at the same height, there is no static resistance and this factor has a value of zero. In the past, the elevation difference used to determine static resistance was often measured from the base of the kegs being dispensed to the faucet height. Because a full keg will contain about 2 1/2 feet of beer, we recommend measuring from the middle of the keg being dispensed to the faucet height. Likewise for large serving vessels: measure from the middle of the serving vessel fill height to the faucet height.

**Dynamic resistance** derives primarily from beer line, and also from some of the many components in a draught beer system (so-called “hardware resistance”). Items like couplers and faucets usually have negligible resistance values, although some might have a specified value. Faucet towers can range from 0 pounds to as high as 8 pounds of dynamic resistance; be sure to check with the manufacturer for exact tower resistance.

BEER TUBING			
Type	Size	Restriction	Volume
Vinyl	3/16" ID	3.00 lbs/ft	1/6 oz/ft
Vinyl	1/4" ID	0.85 lbs/ft	1/3 oz/ft
Vinyl	5/16" ID	0.40 lbs/ft	1/2 oz/ft
Vinyl	3/8" ID	0.20 lbs/ft	3/4 oz/ft
Vinyl	1/2" ID	0.025 lbs/ft	1-1/3 oz/ft
Barrier	1/4" ID	0.30 lbs/ft	1/3 oz/ft
Barrier	5/16" ID	0.10 lbs/ft	1/2 oz/ft
Barrier	3/8" ID	0.06 lbs/ft	3/4 oz/ft
Stainless	1/4" OD	1.20 lbs/ft	1/6 oz/ft
Stainless	5/16" OD	0.30 lbs/ft	1/3 oz/ft
Stainless	3/8" OD	0.12 lbs/ft	1/2 oz/ft

The combination of beer line tubing may include a jumper, trunk line, and choker, all of which can have different restriction values due to the varying diameters and smoothness of the interior walls. These values are tabulated based on a certain resistance for each foot the beer travels. We have mentioned beer lines made from vinyl, barrier tubing, and even stainless steel. Each type and diameter has a different resistance (stated as “restriction”) to beer flow as shown in the chart. (Note: This chart is provided as an example only. Please consult your equipment

manufacturer for exact values for your specific beer lines and system components.)

## Units of Carbonation

In the U.S. and some other countries, the industry measures beer carbonation in units of “volumes of CO<sub>2</sub>”. A typical value might be 2.5 volumes of CO<sub>2</sub>, meaning literally that 2.5 keg-volumes of uncompressed CO<sub>2</sub> have been dissolved into one keg of beer. Carbonation levels in typical beers run from 2.2 to 2.8 volumes of CO<sub>2</sub>, but values can range from as little as 1.2 to as high as 4.0 in specialty beers.

In Europe and other countries, the industry may measure carbonation in terms of “grams CO<sub>2</sub> per liter of beer”. A good rule of thumb is to multiply volumes of CO<sub>2</sub> by 2 to estimate grams per liter. So, a beer with 2.5 volumes of CO<sub>2</sub> would contain about 5 grams per liter of CO<sub>2</sub>. For more information on this calculation, see Appendix B.

Now that we understand the concepts of beer temperature, applied pressure, resistance, and carbonation, let’s look at how they interact in a draught system.

## Carbonation Dynamics

Beer carbonation responds to changes in storage and serving conditions. Let’s consider an average keg with a carbonation of 2.5 volumes of CO<sub>2</sub> and see what happens when conditions change.

Beer temperature and the CO<sub>2</sub> pressure applied through the coupler influence the amount of CO<sub>2</sub> dissolved in any keg of beer. At any temperature, a specific pressure must be applied to a keg to maintain the carbonation established by the brewery. If temperature or pressure varies, carbonation levels will change. Here’s an example.

Beer in a keg at 38°F needs a pressure of 11 psi to maintain 2.5 volumes of CO<sub>2</sub> as the beer is served. As long as the temperature and pressure remain constant, the beer maintains the same carbonation level.

		CO <sub>2</sub> pressure		
		9 psi	11 psi	13 psi
Temp	34 °F	2.5	2.7	2.9
	38 °F	2.3	2.5*	<b>2.7</b>
	42 °F	2.1	2.3	2.5

		CO <sub>2</sub> pressure		
		9 psi	11 psi	13 psi
Temp	34 °F	2.5	2.7	2.9
	38 °F	2.3	<b>2.5*</b>	2.7
	42 °F	2.1	2.3	2.5

\* Pressures rounded for purposes of illustration. Do not use these charts for system adjustment.

		CO <sub>2</sub> pressure		
		9 psi	11 psi	13 psi
Temp	34 °F	2.5	2.7	2.9
	38 °F	2.3	2.5*	2.7
	42 °F	2.1	<b>2.3</b>	2.5

Beer in a keg at 38°F needs a pressure of 11 psi to maintain 2.5 volumes of CO<sub>2</sub> as the beer is served. As long as the temperature and pressure remain constant, the beer maintains the same carbonation level.

If the temperature of the beer changes, so does the required internal keg pressure. Here we see that if the pressure remains at 11 psi but the temperature of the beer rises to 42°F, carbonation will begin to move from the beer to the headspace. Over a few days and as the keg empties, the overall carbonation in the beer drops to 2.3 volumes of CO<sub>2</sub>.

Alternately, if the temperature remains at 38°F, but the CO<sub>2</sub> pressure increases to 13 psi, then the carbonation level of the beer in the keg will increase as the beer slowly absorbs additional CO<sub>2</sub>.

The “ideal gauge pressure” for a beer is the pressure at which CO<sub>2</sub> is not diffusing from beer into the headspace and excess CO<sub>2</sub> is not absorbing in the beer. This value varies from account to account depending upon factors such as temperature, altitude, and carbonation

### Determination of CO<sub>2</sub> equilibrium pressure given volumes of CO<sub>2</sub> and temperature

Vol. CO <sub>2</sub>	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
Temp. °F	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi
33	5.0	6.0	6.9	7.9	8.8	9.8	10.7	11.7	12.6	13.6	14.5
34	5.2	6.2	7.2	8.1	9.1	10.1	11.1	12.0	13.0	14.0	15.0
35	5.6	6.6	7.6	8.6	9.7	10.7	11.7	12.7	13.7	14.8	15.8
36	6.1	7.1	8.2	9.2	10.2	11.3	12.3	13.4	14.4	15.5	16.5
37	6.6	7.6	8.7	9.8	10.8	11.9	12.9	14.0	15.1	16.1	17.2
38	7.0	8.1	9.2	10.3	11.3	12.4	13.5	14.5	15.6	16.7	17.8
39	7.6	8.7	9.8	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5
40	8.0	9.1	10.2	11.3	12.4	13.5	14.6	15.7	16.8	17.9	19.0
41	8.3	9.4	10.6	11.7	12.8	13.9	15.1	16.2	17.3	18.4	19.5
42	8.8	9.9	11.0	12.2	13.3	14.4	15.6	16.7	17.8	19.0	20.1

\* Chart assumes sea-level altitudes. Add 1 psi for every 2,000 feet above sea level.

level of the beer. Because beer carbonation can vary with the temperature of your cooler and the pressure applied to the keg, you must take care to maintain steady values suited to your system and beers.

Pressure gauges used on draught systems measure in pounds-per-square-inch gauge, or “psig”. This is the difference between the pressure in the keg and atmospheric pressure (14.7 psi at sea level). When dispensing beer at elevation, the carbonation level of the beer doesn’t change but the pressure displayed on the gauge will read low, by approximately 1 psi per every 2,000 feet. So a keg dispensed at 10,000 feet would need to have the gauge pressure increased by approximately 5 psig above the calculated dispense pressure at sea level. See pages 16-17 for more details on correcting for elevation.

You can determine ideal gauge pressure for pure CO<sub>2</sub> from the chart shown in the table above and in Appendix B. If you do not know the carbonation level in the beer, you can estimate it using the procedure found in Appendix B.

The key to maintaining a keg’s carbonation relies on fine-tuning four elements:

1. CO<sub>2</sub> percentage
2. Applied pressure
3. Keg temperature
4. A particular beer’s carbonation level

When all the elements are in balance, the beer will stay properly carbonated. For many systems using a single gas blend for regularly carbonated beers, the appropriate blend will be 70% CO<sub>2</sub>. For this reason, 70% CO<sub>2</sub> is the default setting for most gas blenders when no other is specified. To see the mathematical relationship between these factors as well as how to figure exact gas blends for various carbonation levels, see Appendix C.

A common issue in many draught systems is that many beers with different levels of carbonation are being poured on the same system. With the other three previously mentioned elements remaining the same, many beers can become flat. The solution lies in making adjustments to either of the two elements we can

		psi at 60% CO <sub>2</sub>				psi at 65% CO <sub>2</sub>				psi at 70% CO <sub>2</sub>	
		2.5 v/v	2.7 v/v			2.5 v/v	2.7 v/v			2.5 v/v	2.7 v/v
temp	40	27-33		temp	40	24-30	27-33	temp	40	21-26	24-29
°F	38	25-31	29-35	°F	38	22-28	26-31	°F	38	20-25	23-28
	37	25-30	28-34		37	22-27	25-30		37	19-24	22-27
	35	23-28	26-32		35	20-25	23-28		35	18-22	20-25

		psi at 75% CO <sub>2</sub>				psi at 80% CO <sub>2</sub>				psi at 85% CO <sub>2</sub>	
		2.5 v/v	2.7 v/v			2.5 v/v	2.7 v/v			2.5 v/v	2.7 v/v
temp	40	19-24	22-25	temp	40	17-21	19-24	temp	40	15-19	17-22
°F	38	17-22	20-25	°F	38	15-20	18-22	°F	38	14-18	16-20
	37	17-21	20-24		37	15-19	17-21		37	13-17	16-19
	35	16-20	18-22		35	14-18	16-20		35	12-16	14-18

\*Add 1 psi for every 2,000 feet of elevation to account for differences in atmospheric pressure.

readily adjust: CO<sub>2</sub> percentage, and applied pressure. Let's look at these individually.

### CO<sub>2</sub> Percentage Adjustment

The adjustment of CO<sub>2</sub> percentages for different beers has historically been difficult if not impossible. Gas blending panels usually have only one CO<sub>2</sub>-rich blend available, with dual blend panels typically accommodating nitrogenated beers with the second blend. Gas blending panels are now available that offer three blends: the nitro beer blend and two different CO<sub>2</sub>-rich blends for regularly carbonated beers. As it turns out, most regularly carbonated beers can be divided into two general groups of carbonation levels. These new panels allow the installer to customize a gas blend for each of these two ranges by following the chart below:

2.5 v/v Median		
Pressure	Storage Temp. 35-37°	Storage Temp. 38-40°
16-20 psi	75% - 80%	80% - 85%
20-25 psi	65%	70%

2.7 v/v Median		
Pressure	Storage Temp. 35-37°	Storage Temp. 38-40°
16-20 psi	80% - 85%	80% - 90%
20-25 psi	70%	75%

## Draught System Balance

When applied pressure equals resistance, a draught system will pour clear-flowing beer at the rate of 1 gallon per minute, or approximately 2 ounces per second.

### Applied Pressure Adjustment

Installers may choose to use a single gas blend for regularly carbonated beers and adjust the applied pressures on individual kegs to maintain proper carbonation. This is a helpful option in existing systems with a single CO<sub>2</sub>-rich gas blend or when a multi-blend gas blender is not available for use. When regularly carbonated beers are divided into two different groups, depending on their carbonation level, appropriate pressures for individual beers can be determined from the chart above.

Most systems have all lines restricted equally, so applying different pressures to different beers will result in certain beers flowing faster or slower than others in the same system. These flow rate variances are normally not an issue, still allowing for nearly optimal flow rates of 2 ounces per second as long as the



## Nitro Pour Pressure

Most nitrogenated beers are poured through a special faucet that, because of its added restriction, requires the beer to be dispensed between 30 – 40 psi. Even though the solubility of nitrogen is relatively low, this high dispense pressure does provide for some increased absorption of nitrogen, creating a creamy head when dispensed through the nitro faucet.

pressure variance between different beers is kept at or below 5 psi.

## System Balance

So far we've seen what happens to a beer's *carbonation* in the keg as the result of *applied pressure* and *temperature*. But of course beer must travel from the keg to the glass, and along the way it encounters the fourth measure we introduced, namely *resistance*. The beer line and changes in elevation impart resistance to the flow of beer from the keg to the faucet.

The pressure applied to the keg overcomes this resistance and drives the beer through the system and to the customer's glass. To achieve proper flow and beer quality, the pressure applied to the keg must equal the total resistance of the draught system.

We have already seen that the pressure applied to the keg needs to be matched to the carbonation level of the beer. This means we have two different factors to consider when deciding the pressure to apply to a keg. This creates a problem when the resistance of the system calls for more—or less—pressure than is needed to maintain the carbonation of the beer. To prevent conflicts, draught technicians design system resistance to match the pressure applied to the beer.

## Designing For Resistance

While the individual components in any draught system have a fixed resistance value, draught system designers select from a variety of choices to create systems with a target total resistance value. For instance, a 20-ft. run of 1/4" internal diameter vinyl beer line gives a total resistance of 17 psi while 5/16" barrier tubing of the same length only generates 2 pounds of resistance. If our target resistance value is 20 psi, the 1/4" vinyl system would need 1 foot of 3/16" choker line added at the tower end to achieve the total system target resistance, whereas the 5/16" barrier system would need 6 feet of 3/16" choker added at the tower end to reach the same target (see chart of beer tubing restriction values on page 36).

Thus, any draught system can be designed to operate under a range of applied pressure values. Whenever possible, the operating pressure will be set to maintain the carbonation of the beer being served.

Unfortunately, in some systems this doesn't work. Consider the resistance created by long beer lines and climbs of two or more floors. Even with the lowest resistance components, the applied pressures for these systems often exceed that needed to maintain beer carbonation. These systems must use mixed gas or pneumatic beer pumps to overcome the problem.

## Mixed Gas

As we have seen, beer readily absorbs carbon dioxide. Any change in CO<sub>2</sub> pressure on a beer results in a change in the carbonation of the beer. Nitrogen is different. Beer does not absorb nitrogen gas to any significant degree. This means we can apply nitrogen pressure to beer without changing the properties of the beer. Thus, in high resistance draught systems, we use a mixture of CO<sub>2</sub> and N<sub>2</sub> to achieve two objectives: 1) maintain proper beer carbonation and 2) overcome the system resistance to achieve a proper pour.

The exact mix of CO<sub>2</sub> and nitrogen depends on all the factors we have discussed: beer temperature and carbonation, system resistance, and the total applied pressure that's required. The details of these calculations are shown in Appendix C. There are also some excellent resources online to help determine the exact custom blend needed for your draught beer system (see the online wiki version of this manual for links). While some systems use a premixed blend, other installations may require a custom mix created from separate nitrogen and CO<sub>2</sub> tanks by an onsite gas blender.

## Dispense Goals

A balanced draught system delivers clear-pouring beer at the rate of 2 ounces per second. This means it takes about eight seconds to fill a pint glass and about one minute to pour 1 gallon of beer.

Some high-volume settings benefit from faster pours. If you try to achieve faster pours by increasing the gas pressure, you will create overcarbonated beer, foam at the taps, and slower pours. If you need faster pour flows, your draught technician can alter the system resistance to achieve this result. Gas pressure, once set for a particular beer, remains constant and should never be adjusted to alter the flow rate of the beer.

## Balancing Draught Systems

Having reviewed all the concepts behind draught system balance, let's examine three example systems to see how these variables are adjusted to create balanced draught systems in several different settings. ■

## Example 1: Direct-Draw System

- **Beer Conditions:**
  - Beer temperature: 38°F
  - Beer carbonation: 2.8 volumes of CO<sub>2</sub> per volume of beer
  - Dispense gas: 100% CO<sub>2</sub>
  - Gas pressure needed to maintain carbonation = 14.5 psig
- **Static Pressure:**
  - Vertical lift = 5 feet (Tap 5 feet above the center of the keg)
  - Static resistance from gravity = 5 feet x 0.5 pounds/foot = 2.5 pounds
- **Balance**
  - Applied pressure of 14.5 psi must be balanced by total system resistance
  - Since static resistance equals 2.5 psi, a total of 12 pounds of system resistance will be needed:  
Restriction = 14.5 – 2.5 = 12 pounds
  - To achieve this: 4 feet of 3/16" polyvinyl beer line (choker) @ 3 pounds per foot would give the right pressure balance of 12 pounds, but would be a shorter run than the 5 feet represented by elevation gain to the tap. So, use a combination of larger diameter vinyl, followed by a shorter length of choker:
    - 3.5 feet of 1/4" vinyl @ 0.85 pounds per foot = 3 pounds resistance
    - 3 feet of 3/16" vinyl @ 3.0 pounds per foot = 9 pounds resistance
    - 3 + 9 = 12 pounds of system resistance

## Example 2: Long-Draw, Closed-Remote System

This example assumes that the dispense gas blend mixture is already fixed, a vertical lift of 12 feet, and a beer trunk line total run of 120 feet. Find the operating pressure of the system, and then determine appropriate tubing size for the trunks, and length of restriction tubing.

- **Beer Conditions**

- Beer temperature: 35°F
- Beer carbonation: 2.6 volumes of CO<sub>2</sub> per volume of beer
- Dispense gas: 70% CO<sub>2</sub>/30% nitrogen blend from Appendix C,  
 $a = ((b+14.7)/c) - 14.7$

where a is the pressure, b is the ideal pressure of straight CO<sub>2</sub> for this situation (in this case, 10.7 psi, see chart in Appendix B), c is the proportion of CO<sub>2</sub> in the blended gas

$$a = ((10.7+14.7)/0.70) - 14.7$$

$$a = (25.4/0.70) - 14.7$$

$$a = 36.3 - 14.7$$

$$a = 21.6, \text{ or round to } 22 \text{ psi}$$

- Gas pressure needed to maintain carbonation = 22 psig

- **Static Pressure**

- Vertical lift = 12 feet (Tap 12 feet above the center of the keg)
- Static resistance from gravity = 12 ft. x 0.5 pounds/foot = 6.0 pounds

- **Balance**

- Applied dispense gas pressure of 22 psi must be balanced by total system resistance
- Since static resistance equals 6 pounds, the system will need a total of 16 pounds of dynamic resistance
- Restriction = 22 - 6 = 16 pounds
  - 120 ft. of 5/16" barrier @ 0.1 pounds per foot = 12 pounds
  - 1.3 ft. 3/16" vinyl choker = 4 pounds
  - 12 + 4 = 16 pounds

## Example 3: Forced-Air 10 Ft. Run

In this example, the beer cooler is directly over the bar. There is a 10-foot fall from the middle of the kegs to the faucet height, and the total run length is also exactly 10 feet.

- **Beer Conditions**
  - Beer temperature: 33°F
  - Beer carbonation: 2.8 volumes of CO<sub>2</sub> per volume of beer
  - Dispense gas: 100% CO<sub>2</sub>
  - Gas pressure needed to maintain carbonation = 11.7 psig (from chart in Appendix B)
- **Static Pressure**
  - Vertical fall = 10 feet (Faucet is 10 feet below the center of the keg)
  - Static resistance from gravity = 10 ft. x -0.5 pounds/foot = -5.0 pounds
- **Balance**
  - The applied dispense pressure of 11.7 psi, along with 5 pounds of static pressure, must be balanced by a total system resistance of 16.7 pounds
  - Restriction = 16.7 pounds
    - 10 ft. of 1/4" barrier @ 0.3 pounds per foot = 3 pounds
    - 4.6 ft. of 3/16" vinyl choker @ 3 pounds per foot = 13.7 pounds
    - = 3 pounds + 13.7 pounds = 16.7 pounds

## Direct Draw Draught System Balance

At 38°F

Carbonation (Volumes CO <sub>2</sub> )	2.3	2.4	2.5	2.6	2.7	2.8	2.9
psig Applied CO <sub>2</sub>	9.2	10.3	11.3	12.4	13.5	14.5	15.6
3/16" Vinyl beer line length	3'3"	3'5"	3'9"	4'2"	4'6"	4'10"	5'7"



## chapter 6

# preparation to pour

**W**hile many of the issues relating to draught quality concern system settings and activities that occur at the bar, some operating issues require attention behind the scenes as well. In this chapter, we'll look at keg handling and other behind-the-scenes preparations to serve beer that affect draught performance. The first sections address the important detail of keg chilling: Warm kegs cause more problems at the tap than nearly any other issue. Second, we'll cover some guidelines for linking kegs in series.

### **Cold Storage and Proper Chilling of Kegs before Serving**

To ensure fresh flavor and ease of dispense, draught beer should remain at or slightly below 38°F throughout distribution, warehousing, and delivery. Brewers and distributors use refrigerated storage for draught beer. In warm climates or long routes, they may also use insulating blankets or refrigerated delivery trucks to minimize temperature increases during shipping.

At retail, even a few degrees' increase above the ideal maximum of 38°F can create pouring problems,

especially excessive foaming. Ideally all draught beer delivered to retail will be stored cold until served.

Accounts that lack cold storage for their entire inventory of draught beer should allow adequate chilling time for recently refrigerated kegs in order to avoid dispense problems. In a similar vein, recently arrived kegs should be allowed adequate chilling time as they usually warm to some degree during delivery. In order to avoid dispense problems, every keg must be at or below 38°F while being served.

To help ensure that your kegs are properly chilled before serving, Chart 1 provides a guide to the approximate time needed to properly chill a keg to 38°F from a given starting temperature. Note that even kegs that "feel cold" (e.g., 44°F) may need to chill overnight in order to ensure proper dispense.

Chart 2 shows how quickly a keg will warm up when exposed to temperatures above 38°F. From this you can see that a keg will warm up during delivery or storage at ambient temperature from 38° to 44°F in only four or five hours. But looking back at Chart 1, we see that same keg will need to be in the cooler

**Chart 1**

Start Temp	Time to 38° F
50° F	25 hrs
48° F	23.5 hrs
46° F	21 hrs
44° F	18 hrs
40° F	7 hrs
38° F	0 hrs

**Chart 2**

Time	Temp
0 hrs	38° F
1 hrs	39° F
2 hrs	41° F
3 hrs	42° F
4 hrs	43° F
5 hrs	45° F
6 hrs	48° F

for a full 18 hours before reaching a proper serving temperature of 38°F again.

## Linking Kegs in Series

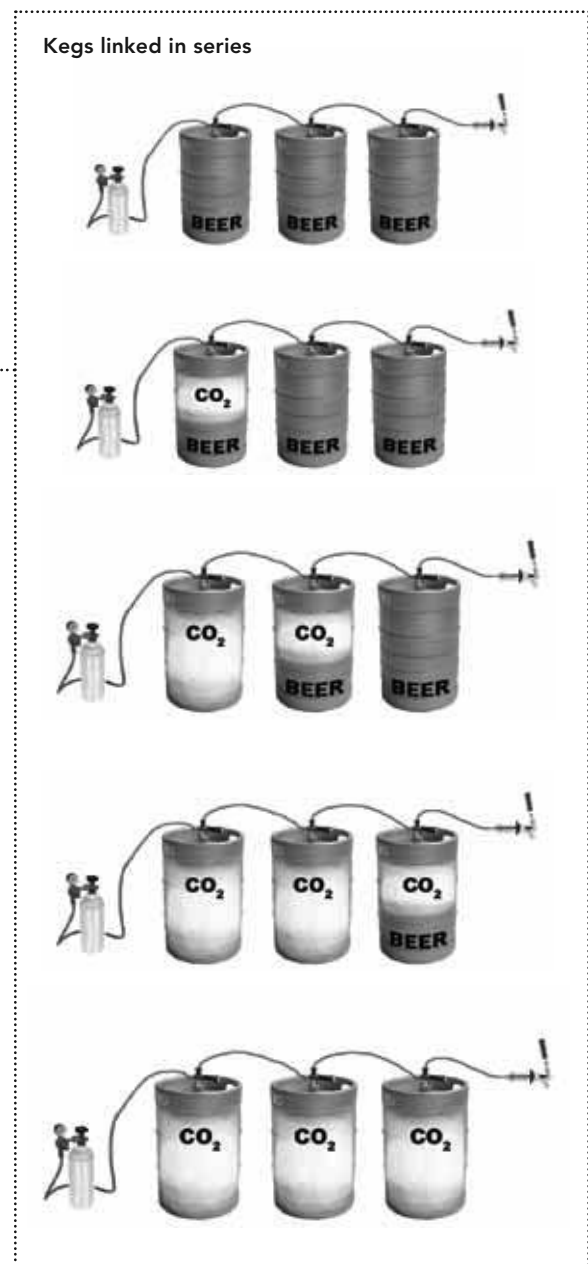
Busy accounts may connect kegs in a series or in a chain to meet peak capacity demands. Chaining two or three kegs of the same product together allows all of the chained kegs to be emptied before beer stops flowing.

The first keg in the series will be tapped with a normal coupler. The second (and subsequent) kegs in the series require that the Thomas valve be removed from the gas side of the coupler.

Tap the first keg with the normal coupler. Instead of sending the beer line from this first coupler to the bar faucet, connect it to the CO<sub>2</sub> inlet on the second keg's coupler. Subsequent kegs can be attached the same way.

When pressurized and pouring, beer flows from the first keg to the second and on to the third before it travels to the faucet. Once set, this arrangement will pour the contents of all the chained kegs before it runs empty.

A series arrangement should only be used in accounts that will "turn" or empty kegs rapidly. The account needs to completely empty the entire series on a regular basis. Failure to empty the series completely leaves old beer in the system. If a fresh keg is being rotated into a system that is not run dry, it is important to tap it in front of any empty or partial kegs in the system. This prevents foaming from beer entering a keg that is not already full. The diagrams below illustrate the progressive emptying of chained kegs. ■





## chapter 7

# serving draught beer

**P**roperly designed and appropriately operated, your draught system pours perfect draught beer from its faucets. But the consumer's experience can still be ruined by improper pouring, glass residue, and unsanitary practices. In this chapter, we review the serving practices required to deliver high quality draught beer.

To achieve the qualities the brewer intended, beer must be served following specific conditions and techniques. Let's review some of the critical conditions necessary for proper draught dispense.

- Beer stored between 34° - 38°F.
- Beer served between 38° - 44°F.
- To accomplish this, the glycol cooling the beer lines in a long-draw system should be set to 27° - 32°F.
- Balanced draught settings (pressure = resistance).
- Normal flow rate of 2 ounces per second.

### Glassware Cleaning

A perfectly poured beer requires a properly cleaned glass. As a starting point, glassware must be free of visible soil and marks. A beer-clean glass is also free of foam-killing residues and lingering aromatics such as sanitizer.

A freshly cleaned glass should be used for every pour. We recommend that accounts never refill a used glass. This practice may also violate local health codes.

Two systems deliver effective beer glass cleaning:

1. Manual cleaning in the three-tub sink, or
2. Dedicated automatic glass washers.

Each approach requires specific techniques and a certain degree of discipline. Let's look at what's involved with each one.

### Manual or Hand Cleaning in the Three-Tub Sink

1. *Clean sinks and work area prior to starting to remove any chemicals, oils, or grease from other cleaning activities.*



2. Empty residual liquid from the glass to a drain. Glasses should NOT be emptied into the cleaning water as it will dilute the cleaning solutions.



3. Clean the glass in hot water and suitable detergent. Detergent must not be fat- or oil-based. Detergents suitable for beer glass cleaning are available through restaurant and bar suppliers.

4. Scrub the glass with cleaning brushes to remove film, lipstick, and other residue. Rotate the glass on the brushes to scrub all interior and exterior surfaces. Be sure to clean the bottom of the glass.

5. Rinse glass bottom/butt down in cold water. Water for the rinse should not be stagnant but should be continually refreshed via an overflow tube. If time permits, a double dunk is recommended and preferred.

6. Sanitize in third sink filled with hot water and an appropriate sanitizer. Sanitizers typically contain chlorine so check the pH and chlorine content of the sanitizing bath periodically to maintain proper conditions. Water temperature should be at a minimum 90°F. Chlorine concentration should be 100 ppm or at the required local health department concentration.



2. Use correct detergent, sanitizer, and rinse agents in properly metered amounts.
3. Check concentrations once each day using kits, or follow detergent and sanitizer supplier recommendations.
4. Use water temperatures of 130° to 140°F. High temperature machines designed to operate at 180°F can be used without additional chemical sanitizers. Please check your health department for local requirements.
5. Maintain the machine to assure good water flow through the system including free flow through each nozzle and washer arm.
6. Regularly service the machine based on the manufacturer's or installer's guidelines.

### Handling Clean Glasses

Keep glassware clean and odor-free after washing:

1. Air-dry glassware. Drying glasses with a towel can leave lint and may transmit germs and odors.
2. Dry and store glasses in a stainless-steel wire basket to provide maximum air circulation. Similar deeply corrugated baskets or surfaces also work.
3. Do not dry or store glassware on a towel, rubber drain pad, or other smooth surface, as they can transfer odors to the glass and slow the drying process.
4. Store glassware in an area free of odors, smoke, grease, or dust.



### Automatic Glass Washing Machines

1. Dedicate this machine to cleaning bar and beer glassware only. Do not subject it to food or dairy product residue.



5. Store chilled glasses in a separate refrigerator away from food products such as meat, fish, cheese, or onions as they can impart an odor to the glasses.
6. Store beer glasses dry in a chiller. Never use a freezer. Chill glasses at 36° – 40°F.

### Testing for “Beer-Clean” Glass

Beer poured to a beer-clean glass forms a proper head and creates residual lacing as the beer is consumed. After cleaning, you can test your glasses for beer-clean status using three different techniques: sheeting, the salt test, and lacing. Let’s review each technique.

1. **Sheeting Test:** Dip the glass in water. If the glass is clean, water evenly coats the glass when lifted out of the water. If the glass still has an invisible film, water will break up into droplets on the inside surface.
2. **Salt Test:** Salt sprinkled on the interior of a wet glass will adhere evenly to the clean surface, but will not adhere to the parts that still contain a greasy film. Poorly cleaned glasses show an uneven distribution of salt.
3. **Lacing Test:** Fill the glass with beer. If the glass is clean, foam will adhere to the inside of the glass in parallel rings after each sip, forming a lacing pattern. If not properly cleaned, foam will adhere in a random pattern, or may not adhere at all.

### Glassware Temperature

- Serving between 38° to 44°F delivers the best taste experience for most beer styles. Domestic lager beer can be enjoyed at 38° to 40°F if served in a chilled glass. Beer served at near-frozen temperatures retains more CO<sub>2</sub> gas (resulting in a more filling experience for the consumer) and blinds the taste experience (taste buds are “numbed,” resulting in a bland taste experience) in comparison with beer served at recommended temperatures.
- Room temperature glasses are preferred for craft beer but may cause foaming on highly carbonated beer.
- Chilled glasses are preferred for domestic lager beer, but they should be DRY before chilling. Wet glassware should not be placed in a freezer or cooler as it may create a sheet of ice inside the glass.
- Frozen glasses will create foaming due to a sheet of ice being formed when the beer is introduced to the glass. Extremely cold glass surfaces will cause beer to foam due to a rapid release of CO<sub>2</sub> from the product.
- Water mist devices may be used to pre-wet and chill the glass interior prior to dispense. Glass interior should be mostly free of excess water before pouring.



Sheeting



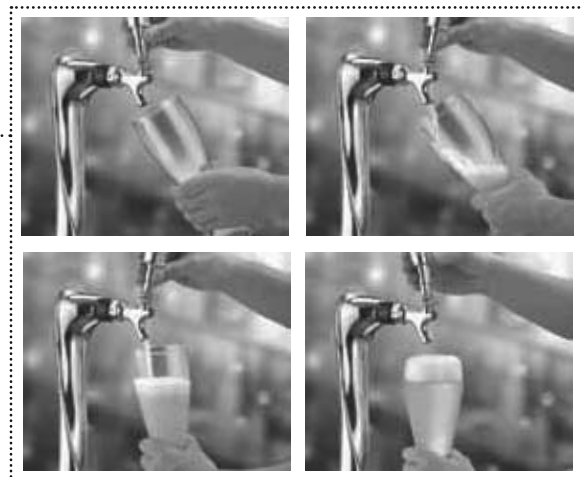
Salt



Lacing

## Pouring Draught Beer

Proper serving of draught beer is intended to have a “controlled” release of carbonation to give a better tasting and sensory experience. The evolution of CO<sub>2</sub> gas during pouring builds the foam head and releases desirable flavors and aromas.



### Technique

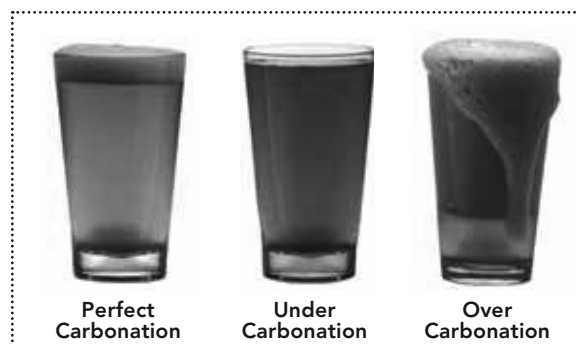
1. Hold glass at a 45° angle, open faucet fully.
2. Gradually tilt glass upright once beer has reached about the halfway point in the glass.
3. Pour beer straight down into the glass, working the glass to form a one-inch collar of foam (“head”). This is for visual appeal as well as carbonation release.
4. Close faucet quickly to avoid wasteful overflow.

### Pouring Hygiene

- In no instance should a faucet nozzle touch the inside of the glass.
  - Nozzles can cause glassware breakage; nozzles can transfer contamination from dried beer to glassware.
- In no instance should the faucet nozzle become immersed in the consumer’s beer.
  - Nozzles dipped in beer become a breeding ground for microorganisms.
- Importance of one-inch foam collar:
  - While retailers struggle with customers who demand their beer “filled to the rim,” brewers

prefer beer poured with about a one-inch collar of foam (“head”).

- A one-inch head maximizes retailer profit, as foam is 25% beer. Filling glass to the rim is really over-pouring.



- A proper head on a draught beer delivers the total sensory experience, including the following sensory benefits:
  - o Visual appeal of a good pour
  - o Aromatic volatiles in beer released
  - o Palate-cleansing effect of carbonation enhanced
- Textural and sensorial qualities of beer better presented to consumer

### Free-Flow Pouring

- Beer pours best from a fully open faucet.
- To control the faucet during operation, hold the handle firmly at the base.
- Partially open faucets cause inefficiency and poor quality, namely:
  - Turbulent flow
  - Excessive foaming
  - Waste (inefficiency)

### Pouring Growlers

Growlers are a great way to share the draught beer experience. They are a modern-day, clean way to bring beer home. Whether it is from a brewpub that doesn’t bottle or for a person who wants a sustainable package, the tradition was started long ago. In the late 1800s, customers would take home beer in a galvanized pail with a lid. Today, glass jugs with tight-sealing lids are used in place of the old pail. Those lids can be flip-top or screw-on.

Growlers are typically about 1/2 gallon in size and are filled off the faucet of your local establishment. This section will help guide you through a successful growler filling experience. It is important to note that the bottle should be rinsed immediately upon emptying to keep from infecting future refills.

A good procedure for filling is to rinse the growler out with cold water immediately before filling. This helps to cool down the glass that could have been sitting in a warm car or out in the sun. This cooling process helps to keep the beer from excessive foaming during the fill. A tube is then inserted into the faucet that reaches to the bottom of the bottle. A 3/8" i.d. x 1/2" o.d. works perfectly for standard faucets. The faucet handle is opened all the way and the growler fills from the bottom up. If the glass is cold enough, when foam starts to come out of the top, you can close the faucet, remove the tube from the growler, and seal. Typically the growler will need to be rinsed off on the outside. Seal the top with tape or heat-shrink seal. Put a tag or label indicating what product is inside and you're good to go. The filling tubes should be rinsed inside and out and put aside to dry.

Helpful hints:

- Laws vary from state to state, so check ahead before starting a program. Some states require that establishments can only fill growlers with their logo or that they have sold.
- Pre-rinse growler before filling with fresh water run through a cold plate to pre-chill the growler prior to filling.
- Keep a container of sanitizer for the fill tubes behind the bar.
- Keep extra seals for either style cap behind the bar in case a customer brings in a different type of growler.
- Use brown bottles instead of clear glass. Brown glass will protect beer from the harmful effects of light.

## Faucet Hygiene

We recommend quickly rinsing faucets with fresh water at the close of business each day. Studies have indicated that in retail locations that use this simple step,

the faucets and beer lines stay significantly cleaner. As an added benefit, the faucet won't become sticky as beer dries out, so the first pour the next day will be much easier since the handle will move readily.

Faucet plugs are available that insert in or cover the faucet opening when beer is not being poured for extended periods. This may help to keep the faucet cleaner and more sanitary.

**For notes on proper dispense hygiene when using a cask ale "beer engine," see Appendix D. ■**



## chapter 8



# system maintenance and cleaning

**i**n addition to alcohol and carbon dioxide, finished beer contains proteins, carbohydrates and hundreds of other organic compounds. Yeast and bacteria routinely enter draught systems where they feed on beer and attach to draught lines. Minerals also precipitate from beer, leaving deposits in lines and fixtures.

Within days of installing a brand new draught system, deposits begin to build up on the beer contact surfaces. Without proper cleaning, these deposits soon affect beer flavor and undermine the system's ability to pour quality beer.

### draught beer line soil types

Hop resin	sticky
Grain protein	gummy
Yeast & micro	resistant
Minerals	hard
Bio-film	homogenous mass

When undertaken using proper solutions and procedures, line cleaning prevents the buildup of organic material and mineral deposits while eliminating flavor-changing microbes. Thus, a well-designed and

diligently executed maintenance plan ensures trouble-free draught system operation and fresh, flavorful beer.

### Cleaning Guidelines

Many states require regular draught line cleaning, but all too often the methods used fall short of what is needed to actually maintain draught quality. In preparing this manual, our committee polled all sectors of the beer industry and called on our own many decades of cumulative experience to determine the necessary and sufficient conditions for proper draught maintenance. In this chapter, we recommend and detail the practices that have proven effective in sustaining draught quality.

Please note that all parts of the recommendations must be implemented. The proper cleaning solution strength won't be effective if the temperature is too cool or there is insufficient contact time with the lines. The lines themselves will remain vulnerable to rapid decline if faucets and couplers aren't hand-cleaned following the recommended procedures.

As a retailer, you may or may not clean your own draught lines, but you have a vested interest in mak-

## Summary of Draught System Cleaning and Service Recommendations

These guidelines reflect the key actions needed to maintain draught systems and pour trouble-free high-quality beer. Before performing these actions, please read the detailed recommendations found at [www.draughtquality.org](http://www.draughtquality.org) as they contain many details important to effective and successful cleaning.

### Perform draught line cleaning at a minimum every two weeks [14 days], as follows:

- Clearly posted documentation of line cleaning and servicing records is recommended in all keg coolers (visit [www.draughtquality.org/ff/CleaningLog.pdf](http://www.draughtquality.org/ff/CleaningLog.pdf) for a printable line cleaning log).
- Push beer from lines with cold water.
- Clean lines with caustic solution at 2% or greater concentration for routine cleaning of well-maintained lines, or at 3% for older or more problematic lines. Contact your chemical manufacturer to determine how much chemical is needed to achieve these recommended concentrations. If you use non-caustic-based cleaners such as acid-based or silicate-based cleaners, be sure to use the cleaning concentrations recommended by the manufacturer. For best results, maintain a solution temperature of 80° - 110°F during the cleaning process.
- Using an electric pump, caustic solution should be circulated through the lines at a minimum of 15 minutes at a velocity of up to 2 gallons per minute. If a static or pressure pot is used (though not recommended), the solution needs to be left standing in the lines for no less than 20 minutes before purging with clean water.
- Disassemble, service, and hand-clean faucets; hand-clean couplers.
- After cleaning, flush lines with cold water until pH matches that of tap water and no visible debris is being carried from the lines.

### Acid Cleaning quarterly [every three months], as follows:

- Disassemble, service, and hand-clean all FOB-stop devices (a.k.a. beer savers, foam detectors).
- Disassemble, service, and hand-clean all couplers.
- Perform acid cleaning of draught lines as follows:
  - Push beer or caustic cleaner from lines with cold water.
  - Clean lines with an acid line cleaner mixed to manufacturer's guidelines. Maintain a solution temperature of 80°-110°F.
  - Circulate the acid solution through the lines for 15 minutes at a velocity of up to 2 gallons per minute for electric pump cleaning, or let stand in the lines for no less than 20 minutes for static cleaning,
  - After acid cleaning, flush lines with cold water until pH matches that of tap water and no visible debris is being carried from the lines.

ing sure the cleaning is done properly. Clean lines make for quality draught beer that looks good, tastes great, and pours without waste.

Take the time to review the guidelines in this manual and monitor your draught line cleaners—no matter who they are—to ensure that your system receives the service it needs to serve you and your customers well. Simple checks like maintaining cleaning logs, using a straw to scrape the inside of a faucet, and checking keg couplers for visible buildup will help to ensure your beer lines are being properly maintained and serviced.

## Common Issues

Later in this chapter, we cover the details of cleaning solutions and procedures, but first let's review some related issues. We'll start with an important look at safety, then briefly discuss design considerations and wrap up with the long-term maintenance issue of line replacement.

## Cleaning Safety

Line cleaning involves working with hazardous chemicals. The following precautions should be taken:

- Cleaning personnel should be well trained in handling hazardous chemicals.
- Personal protection equipment including rubber gloves and eye protection should be used whenever handling line cleaning chemicals.
- Cleaning solution suppliers offer Material Safety Data Sheets (MSDS) on their products. Cleaning personnel should have these sheets and follow their procedures while handling line cleaning chemicals.
- When diluting chemical concentrate, **always add chemical to water** and never add water to the chemical. Adding water to concentrated caustic chemical can cause a rapid increase in temperature, possible leading to violent and dangerous spattering or eruption of the chemical.

## System Design and Cleanliness

Draught system designs should always strive for the shortest possible draw length to help reduce operating challenges and line cleaning costs. Foaming beer and other pouring problems waste beer in greater volumes as draw length increases. Line cleaning wastes beer equal to the volume of the beer lines themselves. Longer runs also place greater burdens on mechanical components, increasing repair and replacement costs.

Be sure to check with the manufacturers of the various components in any draught beer system to ensure that all components (line material, fittings, faucets, couplers, pneumatic pumps, fobs, etc.) are compatible with the cleaning methods and procedures you plan to use. The acceptable range of variables such as cleaning solution concentration, temperature, and pressure can vary by component and manufacturer.

Large venues like stadiums, arenas, and casinos often combine very long draught runs with long periods of system inactivity that further complicate cleaning and maintenance. Additional maintenance costs eventually outweigh any perceived benefits of a longer system.

## A Few Words About Mechanical Cleaning

Mechanical cleaning methods use sponges to physically scrub the interior of beer lines. Because couplers, faucets, beer pumps, and FOBs need to be cleaned every two weeks, mechanical cleaning at an interval longer than every two weeks is not recommended. There are advantages and disadvantages to mechanical cleaning. Potential advantages include potentially more thorough cleaning relative to chemical cleaning alone, and time savings for draught beer cleaning service providers. Potential disadvantages include possible abrasion of the smooth beer line interior over time via scrubbing of the interior of the beer line by the sponge, and fittings or beer line that are too small in

diameter, resulting in possible stuck sponges. Mechanical cleaning should only be used in draught systems that have been specifically designed to be cleaned in this way.

### Other Line Cleaning Methods

Devices that purport to electrically or sonically clean draught lines are not a suitable substitute for chemical line cleaning. Although some sonic cleaners may inhibit bacteria and yeast growth, they have little or no cleaning effect on draught hardware and fittings.

### Line Replacement and Material

- All vinyl jumpers and vinyl direct draw lines should be replaced every year.
- All long-draw trunk line should be replaced in the following instances:
  - When the system is 10 years or older.
  - When flavor changes are imparted in a beer's draught line from an adjacent draught line.
  - When any line chronically induces flavor changes in beer.
- Draught lines may need to be replaced after pouring root beer, fruit-flavored beers, margaritas, or ciders. Such beverages may permanently contaminate a draught line and possibly adjacent draught lines in the same bundle. Such contamination precludes future use of that draught line for beer.
- In the case where a coupler's gas backflow valve (Thomas valve) is or ever has been missing, the gas line may have been compromised and should be replaced.
- Ensure the material used in the manufacture of the draught beer lines is compatible with the chemicals, dilution rates, and temperatures outlined on the following pages (also see "Beer Line" in Chapter 1).

### Detailed Recommendations

The following sections detail more specific recommendations on draught line cleaning. We begin with the basic issue of tasks and their frequency, then move into the more involved questions of cleaning

solutions and procedures. The final pages of this chapter detail the procedures for electric pump and pressure pot cleaning.

### Cleaning Frequency and Tasks

- Every two weeks (14 days)
  - Draught lines should be cleaned with a caustic line-cleaning chemical following the procedures outlined in this chapter.
  - All faucets should be completely disassembled and cleaned.
  - All keg couplers or tapping devices should be scrubbed clean.
  - All FOB-stop devices (a.k.a. beer savers, foam detectors) should be cleaned in line, and cleaning solution vented out of the top.
- Quarterly (every three months)
  - Draught beer lines should be de-stoned with an acid line cleaning chemical or a strong chelator that is added to or part of the alkaline chemical formulation. (The DBQ working group is working with brewing industry researchers to complete further studies on line-cleaning chemistry, including additives such as EDTA.)
  - All FOB-stop devices (a.k.a. beer savers, foam detectors) should be completely disassembled and hand-detailed (cleaned).
  - All couplers should be completely disassembled and detailed.

### Cleaning Solutions and Their Usage

#### *Caustic-Based Cleaning Chemistry*

- Caustic chemicals remove organic material from the interior of the draught line, hardware, and fittings. The removal of this buildup prevents growth of beer-spoiling bacteria such as lactobacillus, pediococcus, and pectinatus.
- Use a caustic cleaner specifically designed for draught line cleaning that uses either sodium hydroxide, potassium hydroxide, or a combination of both.
- Routine use of caustic line-cleaning chemical

products that are “built” with EDTA or other chelating agents may help remove calcium oxalate (beer stone) from draught lines. Brewery testing has indicated that these additives can provide significant cleaning benefit.

- Never use solutions that contain any amount of chlorine for line cleaning. Testing indicates that properly formulated caustic-based cleaners without chlorine can be just as effective at cleaning draught beer lines. Chlorine is not compatible with some beer line materials, and residual chlorine can cause flavor changes in draught beer.
- Based on brewery and independent lab testing, we recommend mixing caustic-based line cleaning solutions to a working strength of at least 2% caustic (as sodium hydroxide). A 3% caustic solution is more appropriate for problem systems, heavily soiled systems, systems with older lines, or for any line that imparts a flavor change to the beer served from it. Contact your chemical manufacturer to determine how much chemical is needed to achieve these recommended concentrations.
- We recommend the use of portable titration kits to confirm the working caustic strength of beer line-cleaning solutions.
- Mix caustic solution with water warmed to a temperature between 80° - 110°F.
- Caustic cleaner must remain in contact with the draught line for at least:
  - 15 minutes when solution is being recirculated, and
  - 20 minutes for static or pressure pot cleaning.

#### *Acid Chemical*

- Acid line cleaner removes inorganic materials such as calcium oxalate (beer stone) and calcium carbonate (water stone) from the interior of the draught line, hardware, and fittings.
- Routine use of caustic cleaning solutions with EDTA or other chelating agent additives may reduce calcium oxalate buildup in draught lines

and may decrease the need to clean regularly with an acid-based cleaner. Acid-based line cleaners suitable for draught line cleaning contain solutions of phosphoric acid.

- Some acid-based cleaners use acids that can harm your draught equipment:
  - Hydrochloric acid corrodes stainless steel and should not be used for cleaning draught lines.
  - Nitric acid is not compatible with nylon products, including some commonly used draught line tubing, and should not be used for cleaning draught lines.
- Mix acid line cleaner to the solution strength recommended by the manufacturer.
- Mix acid line cleaner with water warmed to a temperature between 80° -110°F.
- Acid solution must remain in contact with the draught line for at least:
  - 15 minutes when solution is being recirculated, or
  - 20 minutes for static or pressure pot cleaning.

#### *Water Rinsing*

- Always flush draught lines with fresh water before pumping chemical into the line.
- Always flush draught lines with water **after** using any chemical solution (caustic and acid).
- Continue water flushing until:
  - No solid matter appears in the rinse water.
  - No chemical residue remains in the draught line.
- Confirm chemical removal by testing the solution with pH strips or a pH meter.
  - Before beginning the rinse, draw a reference sample of tap water and test its pH.
  - During rinsing, test the rinse water exiting the draught system periodically.
  - When the pH of the rinse water matches that of the tap water, the chemical is fully flushed out.
- **Chemical solution must never be flushed from draught lines with beer.**



## Cleaning Methods and Procedures

Because every draught beer system is different, there is no definitive procedure for cleaning them. There are, however, certain principles that apply to cleaning every system. To be effective, cleaning solutions need to reach every inch of beer line and every nook and cranny of the connectors and hardware. You can hand clean some items like couplers and faucets, but most of the system must be reached by fluid flowing through the beer lines. The industry currently uses two cleaning procedures for beer lines: recirculation by electric pump, and static or pressure pot cleaning.

Electric recirculating pump cleaning is recommended as the preferred method for nearly all systems. Recirculation pump cleaning uses the combination of chemical cleaning and mechanical action to effectively clean a draught system, by increasing the normal flow rate through the beer lines during the cleaning process.

While static or pressure pot cleaning is an alternative, it is significantly less effective and is not a recommended method for cleaning. This procedure requires additional time to ensure that the cleaning solutions have the right contact time in line, to make up for the lack of mechanical force.

*Key considerations in setting up an electric pump cleaning:*

- The chemical flow should be the reverse of the beer flow wherever possible.
- Ideal chemical flow rate achieves twice the flow rate of the beer. In standard systems, beer flows at 1 gallon per minute (gpm), and ideal chemical flow rate is 2 gpm. 2 gpm may not be attainable for all systems. In these cases, a minimum of 1 gpm should be achieved.
  - The flow rate can be controlled by:
    - o Minimizing the number of draught lines cleaned at one time.
    - o Increasing the size of the pump used.

- The flow rate can be tested in a 15-second test. Multiply the volume of liquid dispensed by 4 to determine the ounces or gallons per minute (1 gallon = 128 ounces).
- The pressure on the draught lines during recirculation should never exceed 60 psi.
- Under these conditions, chemical solution should recirculate for a minimum of 15 minutes.

Static or pressure pot cleaning offers an alternative method to clean runs of less than 15 feet. This requires 20 minutes of contact time with the cleaning solutions to make up for the lack of circulation.

The remainder of this chapter covers use of these cleaning methods, starting with setup and proceeding to the detailed steps for each procedure.

### *Before You Start*

Regardless of your cleaning methods, some system designs require specific attention before you begin cleaning. Here's a list of items to check and consider.

- In pneumatic beer pump systems:
  - Turn off the gas supply to the pumps.
  - On the line(s) to be backflushed, set the pump valve or flow diverter orientation to "Backflush" so that cleaning solution may flow through the pump body in the appropriate direction as needed. Pumps that lack a "backflush" option may be damaged by cleaning and should be cleaned using a different method.
- All legs in "split lines" (lines that are "teed" in the cooler or under the bar to feed more than one faucet from a single keg) must be cleaned as completely separate draught line.

### *Recirculation-Electric Pump Cleaning Step-By-Step Procedure:*

1. Begin by connecting two keg couplers with a cleaning adapter or cleaning cup. Cleaning adapters are available to accommodate many different combinations of coupler types, with the most

common being "D" type to "D" type as shown. Do not engage the couplers, or cleaning solution may travel up the gas line. The shaft on each side of the adapter raises the check ball within the coupler (see diagram on page 10) to allow cleaning solution to flow in either direction.

- If cleaning four lines, connect a second set of lines with another cleaning coupler, creating a second "loop." Cleaning more than four lines at once is not recommended, as it will be difficult to achieve the proper chemical flow rate.
- To clean the lines and couplers used for series kegs, connect the couplers attached to the gas lines and place series caps with check ball lifters on all other couplers.



2. On the corresponding lines at the bar, remove both faucets from their shanks.
  - When cleaning two lines, attach the "Out" hose from the pump to one shank and a drain hose or spare faucet to the other shank.
  - When cleaning four lines, attach the "Out" hose from the pump to one shank, connect the other shank in the loop to a shank in the second loop with a "jumper" hose fitted with two cleaning adapters (one on each end), and attach a drain hose or spare faucet to the remaining shank in the second loop.
  - When cleaning four lines, ensure that the drain hose and "Out" hose from the pump are not on the same coupler "loop."
3. Fill a bucket ("Water Bucket") with warm water and place the "In" hose into the water.
  - Turn pump on and flush beer into a second bucket ("Chemical Bucket") until the line runs clear with water.
  - Shut pump off and discard the flushed beer.
4. Turn pump back on, allowing warm water to run into the clean Chemical Bucket.
  - Measure the flow rate of the liquid by filling a beer pitcher or some container with a known volume. Flow rate should be up to 2 gallons (256 oz.) per minute
    - If cleaning is configured for four lines and flow rate is too slow, remove the jumpers and clean each pair of lines separately.
  - Allow bucket to fill with just enough water to

cover the inlet hose of the pump.

- Add the appropriate amount of line cleaning chemical to achieve 2-3% caustic in solution based on age and condition of beer line.
5. Remove the "In" hose from the Water Bucket and place into the Chemical Bucket.
    - There should now be a closed loop.
    - Water should be draining into the same bucket that the pump is pulling from.
  6. Allow solution to recirculate for a minimum of 15 minutes.
    - While waiting, clean your faucets.
    - Fill Water Bucket with cold water.
  7. Begin your rinse by removing the "In" hose from Chemical Bucket and placing it into the Water Bucket (filled with cold water).
  8. Continue pumping cold water from the Water Bucket into the Chemical Bucket (shutting off pump and dumping Chemical Bucket as needed) until all chemical has been pushed out of the draught lines and there is no solid matter in the rinse water.
  9. Finish up by shutting off the pump, detaching the cleaning coupler, and replacing the faucets.

#### *When Finished*

- Be sure to return all system components to their original functional settings; e.g., turn on gas supply to pneumatic beer pumps, reset FOBs and pneumatic pump flow diverters, etc.

#### *Static – Pressure Pot Step-By-Step Procedure:*

1. Fill the cleaning canister with clean water.
2. Untap the keg and tap the cleaning canister. Engage the tapping device.
  - When cleaning series kegs, connect the tapping devices attached to the gas lines and place series caps on all other tapping devices.
3. Open faucet until the beer is flushed out and clear water is pouring.
4. Untap the canister and fill the canister with cleaning chemical mixed to the appropriate strength to achieve 2-3% caustic in solution based on age and condition of beer line.

5. Tap the canister again. Please note: When applying CO<sub>2</sub> to a pressure pot containing a caustic solution, the CO<sub>2</sub> will weaken or neutralize the caustic solution. It is best not to agitate or let it stand in the same container for an extended period. For the same reason, the use of pressure pots that feature a "spitting" action, whereby CO<sub>2</sub> is injected directly into the outflow of solution, is not recommended.
6. Open the faucet until the water is flushed out and chemical solution is pouring from the faucet.
7. Shut off the faucet and untap the canister.
  - If the system is driven with pneumatic beer pumps, shut off the gas supply to the pumps to turn them off.
8. Remove the faucet and clean.
9. Replace faucet and retap the canister.
10. Run cleaning solution again to fully repack the contents of the draught line.
11. Allow cleaning solution and beer line to be in contact for no less than 20 minutes.
12. Untap canister, empty, and rinse.
13. Fill the canister with clean, cold water and retap.
14. Open the faucet and rinse until all chemical has been flushed out and there is no solid matter in the rinse water.
15. Finish by untapping the canister, retapping the keg and pouring beer until it dispenses clear.



#### *When Finished*

- Be sure to return all system components to their original functional settings; e.g., reset FOBs, reset pneumatic beer pump cleaning diverters to dispense setting and turn on pump gas supply, etc.

## **Glycol Chiller Maintenance**

Glycol chillers are key components to long draw dispense systems. Chilled glycol helps to maintain the temperature of draught beer in the beer lines between the keg and the faucet. Glycol chillers are much less

expensive to maintain than they are to replace; regular maintenance will increase both their service life and dependability. Here are some recommended maintenance practices; be sure to check with your manufacturer for items and procedures specific to your chillers.

- Glycol bath: Keep the cover of the glycol bath closed to prevent water vapor from diluting the strength of the glycol.
- Glycol bath temperature: Check every two weeks, making sure the bath temperature is within the range specified by the manufacturer. Many chillers have temperature gauges that are easily visible from the outside.
- Check motors monthly for smooth-sounding operation and no signs of overheating.
- Check pumps monthly; check connections and insulation for leaks or missing insulation, and for smooth-sounding operation.
- Inspect condenser monthly for dirt and airflow obstructions and clean as necessary. Remove and clean grills to expose the condenser fins. Remove all contaminants from the fin surface by using a stiff bristle brush, vacuum cleaner, or compressed gas discharged from the fan side of the condenser.
- Visually inspect trunk lines every six months for signs of ice buildup, insulation damage and glycol leakage.
- Glycol strength: Check viscosity and condition of glycol-water cooling mixture every six months. Test freezing point every 18 months with a refractometer and adjust or replace glycol mixture as needed. Typical ranges are 20-25% glycol; be sure the glycol concentration follows manufacturer recommendations. ■



## chapter 9

# troubleshooting

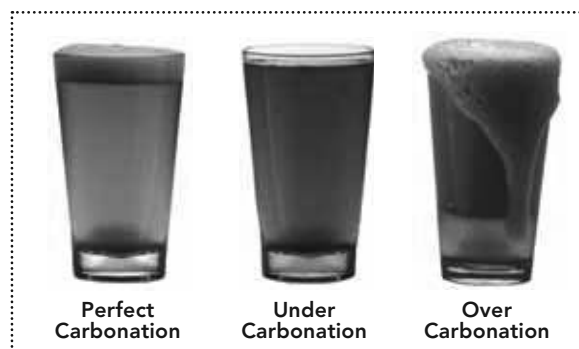
**P**erfectly poured draught beer is the result of proper temperature, gas pressure and mixture, and a well-maintained draught beer system. It's easy to take all the variables for granted when beer is pouring well. But improperly pouring beer can be very frustrating, and can result in loss of sales. This chapter is intended to provide useful troubleshooting steps anyone can follow to solve draught beer dispense problems.

The single most common cause of problems encountered in draught beer dispense systems is temperature control. The first step in solving any dispensing problem is to confirm that the temperature of the keg and the cooler are where they are supposed to

be. In air-cooled and glycol-cooled systems, the next step is to check the temperature of the beer being delivered to the faucet, confirming that the air and glycol systems used to maintain proper beer line temperature are working properly.

The troubleshooting steps that follow are organized by the type of draught beer system and how the systems are cooled, using air or glycol. Direct-draw systems and long-draw systems cooled by air or glycol each have unique features that are addressed in the troubleshooting steps.

Other steps including gas pressure and supply, beer supply, and mechanical issues are also discussed.



## DIRECT DRAW SYSTEMS

Problem	Possible Cause	Possible Solution
<b>Beer Foaming</b>	Temperature too warm (should be 38° F)	Adjust temperature control or call qualified service person
	Temperature too cold/frozen beer in lines (should be 38° F)	Adjust temperature control or call qualified service person
	Kinked beer line	Change beer line
	Wrong diameter or length beer line (should be 4 to 5 ft. of 3/16" vinyl tubing or possibly even longer)	Change beer line
	Applied pressure too high (should be 12 to 14 psi for most beers)	Adjust CO <sub>2</sub> regulator to brewer's specification
	Applied pressure too low (should be 12 to 14 psi for most beers)	Adjust CO <sub>2</sub> regulator to brewer's specification
	Coupler washers bad	Replace coupler washers
	Faucet washer bad	Replace faucet washers
	System dirty	Clean system or call customer's line cleaning service
	CO <sub>2</sub> leaks or out of CO <sub>2</sub>	Check fittings, clamps, shut-offs and regulators, replace as necessary
	Beer foaming in jumper – keg valve seal torn or ripped	If seal is ripped/torn, gas enters the liquid flow stream causing foaming. Replace keg and report defective keg to distributor
	Beer foaming in jumper - physical obstructions at coupler-valve junction	Remove any physical obstructions or debris (e.g. a piece of a dust cover) that could allow gas to enter the liquid flow
	Beer foaming at faucet – clogged vent hole(s)	Disassemble and clean faucet, or call line cleaning service
<b>No Beer at Faucet</b>	Empty CO <sub>2</sub> bottle	Replace with full CO <sub>2</sub> bottle
	Regulator shutoff closed	Open shutoff
	CO <sub>2</sub> bottle main valve turned off	Turn on CO <sub>2</sub> bottle main valve
	Keg empty	Replace with full keg
	Coupler not engaged	Tap keg properly and engage coupler
	Check ball in coupler stuck	Free check ball
	Line/faucet dirty	Clean line/faucet

For air-cooled systems, the maximum recommended distance for a double-duct system is 25 feet (tube side by side) and for a single-duct system is 15 feet (tube within a tube).

<b>AIR COOLED SYSTEMS</b>		
<b>Problem</b>	<b>Possible Cause</b>	<b>Possible Solution</b>
<b>Beer Foaming</b>	Check temperature at faucet - too warm (should be 38° F)	Blower fan air flow obstructed Adjust temperature control or call qualified service person System designed improperly: too long, wrong size fan, etc.
	Check temperature at faucet too cold (should be 38° F)	Adjust temperature control or call qualified service person
	Kinked beer line	Change beer line
	Wrong size beer line	Change beer line
	Applied pressure too high (should be 12 to 14 psi for most beers)	Adjust CO <sub>2</sub> regulator to brewer's specification
	Applied pressure too low (should be 12 to 14 psi for most beers)	Adjust CO <sub>2</sub> regulator to brewer's specification
	Wrong gas (mixed gas blenders recommended)	Change to mixed gas blender, use target pressure
	Coupler washers bad	Replace coupler washers
	Faucet washer bad	Replace faucet washers
	System dirty	Clean system or call customer's line cleaning service
	Beer foaming in jumper – keg valve seal torn or ripped	If seal is ripped/torn, gas enters the liquid flow stream, causing foaming. Replace keg and report defective keg to distributor
	Beer foaming in jumper - physical obstructions at coupler-valve junction	Remove any physical obstructions or debris (e.g. a piece of a dust cover) that could allow gas to enter the liquid flow
	Beer foaming at faucet – clogged vent hole(s)	Disassemble and clean faucet, or call line cleaning service
<b>No Beer at Faucet</b>	Empty CO <sub>2</sub> bottle, N <sub>2</sub> bottle, or mixed gas bottle	Replace with appropriate full gas bottle
	Regulator shutoff closed	Open shutoff
	Gas bottle main valve turned off	Turn on gas bottle main valve
	Keg empty	Replace with full keg
	Coupler not engaged	Tap keg properly and engage coupler
	Check ball in coupler stuck	Free check ball
	Line/faucet dirty	Clean line/faucet

A glycol system is designed to maintain liquid beer temperature from the cooler to the point of dispense.

<b>GLYCOL CHILLED SYSTEMS</b>		
<b>Problem</b>	<b>Possible Cause</b>	<b>Possible Solution</b>
<b>Beer Foaming</b>	Check temperature at faucet - too warm (should be 38° F)	Check glycol chillers for proper operation; adjust glycol bath temperature if too warm (most systems are designed to operate between 28° and 34° F, check unit's manufacturer specs) Adjust temperature control or call qualified service person
	Check temperature at faucet - too cold (should be 38° F)	Check glycol chillers for proper operation; adjust glycol bath temperature if too cold (most systems are designed to operate between 28° and 34° F, check unit's manufacturer specs) Adjust temperature control or call qualified service person
	Wrong gas (glycol systems usually require a mixed gas blender)	Change to mixed gas blender, use target pressure
	Glycol pump functioning (check return line)	Call qualified serviceman to adjust glycol chiller temperature or operation
	Gas regulators incorrectly set	Contact installer
	Applied pressure too low (should be 12 to 14 psi for most beers)	Adjust CO <sub>2</sub> regulator to brewer's specification
	Coupler washers bad	Replace coupler washers
	Faucet washer bad	Replace faucet washers
	System dirty	Clean system or call customer's line cleaning service
	Power pack – check condenser, glycol concentration	Call qualified serviceman to clean clogged condenser fins, check glycol strength, service glycol chiller
	Beer foaming in jumper – keg valve seal torn or ripped	If seal is ripped/torn, gas enters the liquid flow stream causing foaming. Replace keg and report defective keg to distributor.
	Beer foaming in jumper - physical obstructions at coupler-valve junction	Remove any physical obstructions or debris (e.g. a piece of a dust cover) that could allow gas to enter the liquid flow
	Beer foaming at faucet – clogged vent hole(s)	Disassemble and clean faucet, or call line cleaning service
<b>No Beer at Faucet</b>	Empty CO <sub>2</sub> source, N <sub>2</sub> source, or mixed gas bottle	Replace with appropriate full gas bottle, refill bulk CO <sub>2</sub> or N <sub>2</sub> receiver, check nitrogen generator
	Regulator shutoff closed	Open shutoff
	Gas bottle or bulk tank main valve turned off	Turn on gas bottle or tank main valve
	Keg empty	Replace with full keg
	Coupler not engaged	Tap keg properly and engage coupler
	Check ball in coupler stuck	Free check ball
	Line/faucet dirty	Clean line/faucet
	FOB detector	Reset FOB detector
Pneumatic beer pumps	Check gas supply to pumps; check pump diverter setting	



## Off Flavors in Draught Beer

The purpose of this manual is to explain how to maintain the brewery-intended flavor of draught beer products. When fresh and properly dispensed, draught beer tastes the way the brewer intended—clean, flavorful, and enjoyable. Draught beer is susceptible to damage from a host of factors, such as age, heat, and air. But the number one factor affecting the quality of draught beer flavor and aroma is poor hygiene. Improper cleaning of beer system lines and components from the coupler in the cooler to the faucet at the bar can lead to significant changes in beer flavor, all of them unwelcome. Over time, poor beer line hygiene will inevitably result in loss of sales due to customer dissatisfaction, and to replac-

ing beer lines at great expense. Staying ahead of these potentially costly outcomes is key to serving great tasting draught beer.

The chart on page 65 lists the most common off flavors that occur due to post-brewery unhygienic conditions and the mishandling of draught products. Beer-spoiling bacteria will ruin a beer's flavor and aroma, and will inevitably lead to lost repeat business and potential sales. While these microorganisms are not health risks, they will cause bacterial infections in draught systems that are often difficult, if not impossible, to completely remove. By following the guidelines outlined in this manual, the occurrence of these off flavors can be prevented. ■

OFF FLAVOR NAME	FLAVOR DESCRIPTION	BACTERIA	LIKELY CAUSES	HOW TO PREVENT AND RESOLVE
<b>Diacetyl</b>	Buttery, Buttered popcorn, Butterscotch, Caramel, can have a slick or milky mouthfeel at high levels	Anaerobic Bacteria* Pediococcus (most likely), Lactobacillus (less likely)	Pediococcus and Lactobacillus occur from unhygienic conditions in draught beer systems. Diacetyl is the most common off flavor associated with dirty draught systems. These bacteria are most likely to develop when: <ul style="list-style-type: none"> <li>• The cleaning frequency is allowed to span beyond a two-week cycle</li> <li>• Regular use of an electric recirculating line cleaning pump is not in use</li> <li>• Associated draught equipment is not properly disassembled, serviced, and hand-cleaned on the recommended intervals</li> <li>• Improper chemicals or low chemical concentrations are used</li> <li>• Beer lines are older than their recommended age</li> <li>• Kegs in series are not completely emptied on a weekly basis</li> <li>• Ineffective line cleaning procedures are used</li> </ul>	Removing a bacterial infection from a beer line can be very difficult, if not impossible to completely remove. Even after a cleaning, these bacteria may remain in the beer line and keg at initially undetectable levels. However, in a short time, these anaerobic bacteria will resurface as an overpowering infection. The goal is to completely rid the system of any traces of bacteria so the off-flavors never return.  Prior to cleaning, begin by replacing infected hardware and beer lines wherever possible, and always replace any kegs that have been tapped into an infected system. Follow the step-by-step pump cleaning procedures in Chapter 8, rotating between caustic and acid cycles to maximize your chances of removal.
<b>Lactic Acid</b>	Sour, Sour Milk, Acidic (note- the bacterial load would have to be very large to pick up this flavor)	Anaerobic Bacteria* Lactobacillus (most likely), Pediococcus (less likely)	Acetobactor will often begin its growth in dirty drains, spill trays, bar tops, or used bar rags and will eventually spread to the beer dispense faucet.  Serving staff submerging a faucet into a beer will increase the growth-rate of these bacteria.  The leading cause of acetobactor comes from faucets not being completely disassembled and hand-detailed on a two-week cycle.	Serving staff should be thoroughly trained on proper serving techniques (Chapter 7).  Beer faucets should be completely disassembled and hand-detailed using caustic chemicals every two weeks.  Stainless steel is the best material for faucets to prevent bacterial buildup.  Monitor brewery-recommended best-consumed-by-dates and temperature specifications.  Ensure any kegs in series have been completely emptied (series kegs should be completely emptied and replaced once per week).  Never use compressed air in direct contact with draught beer.  Use barrier and stainless steel tubing whenever possible.
<b>Acetic Acid</b>	Sour, Vinegar	Aerobic Bacteria* Acetobactor	Oxidation comes from time, temperature, or direct exposure to oxygen. All beers have an expiration date. This is the date by when a brewery feels the beer has taken on significant oxidative properties, and that the beer no longer represents the brewery-intended flavor.  This expiration date can easily be shortened with the addition of warm temperatures. Draught beer should be kept cold (below 50° F) at all times to maximize its freshness. The longer a beer is kept warm and/or the higher the temperature, the faster the beer will oxidize. If a beer ever rises above 80° F, for any amount of time, the beer is likely ruined.  In draught beers, oxidation can happen with the use of an air compressor. If an air compressor is used to dispense draught beer, oxygen will be forced into the keg, and can oxidize a beer within 24 hours (Chapter 1).  Porous beer tubing material will allow oxygen to leach through to the beer after extended pouring delays (Chapter 4).	
<b>Oxidation</b>	Papery, Cardboard, Fruity, Bready, Vinous, Vegetal (These are only a few descriptors as oxidation is a very broad term and different ingredients will take on different oxidative properties)	N/A. Oxidation in beer is a reaction that occurs when a beer is exposed to oxygen molecules.		

## appendix a

# ISBT guidelines for beverage grade carbon dioxide

Purity . . . . .	99.9% min*
Moisture . . . . .	20 ppm max
Oxygen . . . . .	30 ppm max
Carbon monoxide . . . . .	10 ppm max
Ammonia . . . . .	2.5 ppm max
Nitric oxide/nitrogen dioxide . . . . .	2.5 ppm max each
Nonvolatile residue . . . . .	10 ppm (wt) max
Nonvolatile organic residue . . . . .	.5 ppm (wt) max
Phosphine . . . . .	0.3 ppm max
Total volatile hydrocarbons . . . . .	50 ppm max
Acetaldehyde . . . . .	0.2 ppm max
Aromatic hydrocarbon . . . . .	20 ppb max
Total sulfur content . . . . .	0.1 ppm max
Sulfur dioxide . . . . .	1 ppm max
Odor of solid CO <sub>2</sub> . . . . .	No foreign odor
Appearance in water . . . . .	No color or turbidity
Odor and taste in water . . . . .	No foreign taste or odor

*All specification based on volume (v/v) unless otherwise noted.*

# CO<sub>2</sub> gauge pressure, temperature and carbonation level reference chart

**Table 1. Determination of CO<sub>2</sub> equilibrium pressure given volumes of CO<sub>2</sub> and temperature**

Vol. CO <sub>2</sub>	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
Temp. °F	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi
33	5.0	6.0	6.9	7.9	8.8	9.8	10.7	11.7	12.6	13.6	14.5
34	5.2	6.2	7.2	8.1	9.1	10.1	11.1	12.0	13.0	14.0	15.0
35	5.6	6.6	7.6	8.6	9.7	10.7	11.7	12.7	13.7	14.8	15.8
36	6.1	7.1	8.2	9.2	10.2	11.3	12.3	13.4	14.4	15.5	16.5
37	6.6	7.6	8.7	9.8	10.8	11.9	12.9	14.0	15.1	16.1	17.2
38	7.0	8.1	9.2	10.3	11.3	12.4	13.5	14.5	15.6	16.7	17.8
39	7.6	8.7	9.8	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5
40	8.0	9.1	10.2	11.3	12.4	13.5	14.6	15.7	16.8	17.9	19.0
41	8.3	9.4	10.6	11.7	12.8	13.9	15.1	16.2	17.3	18.4	19.5
42	8.8	9.9	11.0	12.2	13.3	14.4	15.6	16.7	17.8	19.0	20.1

Based on Data from "Methods of Analysis," American Society of Brewing Chemists, 5th Edition - 1949

- The values in this table assume sea-level altitude, beer specific gravity of 1.015, and beer alcohol content at 3.8% abw or 4.8% abv. Values shown are in psig, or gauge pressure.
- It's important to remember that carbonation is proportional to absolute pressure, not gauge pressure. Atmospheric pressure drops as elevation goes up. Therefore, the gauge pressure needed to achieve proper carbonation at elevations above sea level must be increased. Add 1 psi for every 2,000 feet above sea level. For example, a retailer at sea level would use 11.3 psi gauge pressure to maintain 2.5 volumes of CO<sub>2</sub> in beer served at 38° F. That same retailer would need 13.3 psi gauge pressure at 4,000 feet elevation to maintain 2.5 volumes of CO<sub>2</sub>.

## Figuring ideal gauge pressure of straight CO<sub>2</sub> when carbonation level is not known:

1. Set the regulator pressure to 5 psi.
2. Tap a fresh keg. **Make sure the keg has been in the cooler long enough to be at the cooler temperature.**
3. Pour a small amount of beer through the faucet.
4. Observe the beer in the draught line directly above the keg coupler (with a flashlight if necessary), inspecting for bubbles rising up from the beer in the keg.
5. If bubbles are present, raise the regulator pressure 1 psi.
6. Repeat steps 3 - 5 until no bubbles are present.
7. Check the keg temperature 24 hours after setting the initial gauge pressure to assure temperature stability, and to reset the gauge pressure as needed due to a change in keg temperature.

This is the lowest pressure at which the gas in the beer is not escaping. This is your ideal gauge pressure.

## Converting Volumes of CO<sub>2</sub> to Grams per Liter of CO<sub>2</sub>:

In the U.S., carbonation is expressed in units of "volumes of CO<sub>2</sub>". What this means is that one keg of beer carbonated to 2.5 volumes of CO<sub>2</sub> contains 2.5 kegs worth of CO<sub>2</sub> compressed and dissolved into the beer. In other countries, carbonation is often expressed in units of grams per liter. To convert between volumes of CO<sub>2</sub> and grams per liter, the quick and easy answer is 2 g/L equals 1 v/v.

However, "2" is not exactly correct. Several alternative values and a method to calculate the value are listed below.

A first approximation can be found by assuming that CO<sub>2</sub> has a molar mass of 44 grams per mol and that one mol of gas at STP conditions (0°C, 1 ATM) occupies a volume of 22.4 liters. Converting from g/L to v/v is then,

$$\frac{1 \text{ g CO}_2}{1 \text{ L Beer}} * \frac{1 \text{ mol CO}_2}{44 \text{ g CO}_2} * \frac{22.4 \text{ L}}{1 \text{ mol CO}_2} * \frac{22.4}{44} = 0.509$$

Inverting this value gives us the conversion factor for converting from v/v to g/l.

$$\frac{1}{0.509} = 1.965$$

For a slightly more accurate answer we can use the value of 44.01 g/mol for CO<sub>2</sub> and 22.426 L/mol for the STP volume of the gas. We can also take account of the fact that CO<sub>2</sub> does not behave strictly in accordance with the Ideal Gas Law and has a compressibility factor (Z) of 0.99952 under the stated conditions. Using these values we get 1.966 instead of 1.965. Not much improvement there, but perhaps a better sense of accuracy.

Another tool is the NIST Standard Reference Database 23, Ver 9.0, 2010. This database gives a value for the density of CO<sub>2</sub> at STP conditions of 1.9768 g/L. This may be accepted as the most accurate value and it is the one to use if doing an exact analysis.

So, for quick conversions that most people can do in their head, "2" is an acceptable answer. In cases where one wants to have more accuracy, they can use 1.9768 or whatever rounded-off value they feel comfortable with. ■

# carbonation, blended gas, gas laws & partial pressures

### Carbonation

In general, the amount of carbonation in beer depends primarily on the pressure of CO<sub>2</sub> applied to the keg of beer being dispensed, and the temperature of the beer. In reality, many other factors can also affect carbonation levels including blended gas proportion of CO<sub>2</sub>, alcohol content, and specific gravity. Knowing a bit about these factors can help you finetune your draught dispense system to achieve the perfect pour for every brand dispensed.

**Temperature:** In general, gas is less soluble in liquid as the temperature rises. This seems obvious—a nice cold keg of beer dispenses easily, while that same keg of beer dispenses as foam if it gets warm.

**Proportion of CO<sub>2</sub> in blended gas:** This is directly related to the pressure of the CO<sub>2</sub> in the headspace over the beer within the keg. Two different gas laws (Dalton's Law of Partial Pressures and Henry's Law) can help us make sense of what's going on. This is most easily described by example, along with a little math. Consider a situation in which a keg of beer is dispensed using gas at 20 psi. If pure CO<sub>2</sub> is used to dispense

beer, then all of the pressure on that keg is due to CO<sub>2</sub>. But what if the gas being used is a blend of 75% CO<sub>2</sub> / 25% N<sub>2</sub>? In this case, Dalton's Law can help us figure out what's going on. Dalton's Law of partial pressures says that *the total pressure exerted by a gaseous mixture is equal to the sum of the partial pressures of each individual component in a gas mixture*. This means the partial pressure of CO<sub>2</sub> is equal to the proportion of CO<sub>2</sub> in the gas, in this case 75%, times the total absolute pressure of the blended gas, or 34.7 psia (20 psig + 14.7 psi atmospheric pressure = 34.7 psia). In this case, the partial pressure of CO<sub>2</sub> is:

$$75\% \times 34.7 \text{ psia} = 26.0 \text{ psia}$$

$$26.0 \text{ psia} - 14.7 \text{ psi atmospheric} = 11.3 \text{ psi gauge.}$$

So, in this example using blended gas, the carbonation of the beer will be proportional to 11.3 psi of CO<sub>2</sub>, NOT 20 psi CO<sub>2</sub>. It's important to note this calculation must be done in absolute pressure, then converted to gauge pressure (if you used gauge pressure of 20 psi rather than 34.7 psia, 75% of that value would result in 15 psi as the partial pressure of CO<sub>2</sub> in this scenario, which is not correct.) Consulting the carbonation

chart on page 67 and assuming a temperature of 38 °F and 11.3 psi CO<sub>2</sub> pressure, the carbonation level in this example would be 2.5 volumes (rather than 2.8-2.9 volumes, which would be the 15 psi result if you had incorrectly used gauge pressure).

**Alcohol Content:** Most of the liquid in beer is water. The standard carbonation table assumes a beer containing 4.8% abv, meaning that about 95% of the liquid is water. As it turns out, CO<sub>2</sub> is quite a bit less soluble in ethanol than it is in water—this has to do with the basic physical properties of these substances. So what happens in beer that contains higher alcohol levels? Generally speaking, **the carbonation level in a beer will decrease from the standard values shown as the alcohol content increases** above 4.8% abv. This factor is secondary to temperature and pressure, but is noticeable in many brands of beer with higher alcohol content.

Consider a beer being served at 38° F with pure CO<sub>2</sub> at 13 psi. If the beer contains 4.8% abv, the resulting carbonation level will be 2.66 volumes of CO<sub>2</sub>. Now consider a beer much higher in alcohol, for example a barley wine containing 11 % abv. The carbonation level of that beer will be about 2.51 volumes. This is not a huge change, but it is noticeable at retail, and may explain to some degree the slow decrease in head foam sometimes observed over time in high alcohol beers served at retail. In this same instance, increasing the pressure from 13 psi to 14.5 psi will maintain the 2.66 volumes of carbonation desired by the brewer. Visit the Draught Quality wiki for links to online calculators you can use to determine the effects of alcohol content on carbonation.

**Specific Gravity:** The standard carbonation table shown in Appendix B assumes that a beer has a specific gravity of 1.015. Specific gravity is a measure of the density of beer compared to water, and is often expressed as SG. A beer with SG of 1.015 is 1.5% more dense than water. Beer contains mostly water

and alcohol, along with a certain amount of dissolved solids such as carbohydrates and proteins that provide mouthfeel, body, color, and flavor. CO<sub>2</sub> is soluble in the liquid in beer, NOT in the solids in beer. So, the more solids there are in a beer, the less CO<sub>2</sub> can dissolve in the beer.

If the specific gravity of a beer is above the reference value of 1.015, it will contain very slightly less carbonation than the value shown in the table. Likewise, if the specific gravity of a beer is below the reference value of 1.015, it will contain very slightly more carbonation than the value shown in the table. The effect of SG on carbonation is very small, and for practical purposes is difficult to determine with accuracy or to observe or do anything about in a retail setting. Suffice to say that a beer with SG of 1.030 would contain approximately 0.05 fewer volumes of CO<sub>2</sub> than a beer with SG of 1.015 at the same temperature and pressure.

## Blended Gas Dispense Examples

Henry's Law states: *"At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid."* This turns out to be really useful when dispensing beer in systems where more than 12-15 psi of dispense pressure is needed to move beer to the taps, such as long-draw systems.

The partial pressure of a gas within a blend can be calculated by multiplying the total pressure of the gas blend (in psia, not psig) times the proportion of that gas in the blend. Let's consider a couple of scenarios in which draught beer is 1) dispensed using blended gas at 70% CO<sub>2</sub>/30% N<sub>2</sub>, and 2) dispensed using straight CO<sub>2</sub>. In both scenarios, let's assume the dispense temperature is the same at 39°F, and that the system has been designed and balanced to dispense beer at an operating pressure of 20 psig, or, 20 + 14.7 = 34.7 psia.

### Scenario 1:

#### *Dispensing with blended gas at 70% CO<sub>2</sub>/30% N<sub>2</sub>*

The carbonation in the beer will depend on the partial pressure of CO<sub>2</sub>, which equals 34 psia (the total dispense pressure) x 70% (proportion of CO<sub>2</sub> in the blend) = 23.8 psia. At sea level, atmospheric pressure is 14.7 psi; 23.8 psia – 14.7 = 9.1 psig. A partial pressure of 9.1 psi for CO<sub>2</sub> at 38°F would result in about 2.3 volumes of carbonation in beer. For most brands of beer, this carbonation rate is a bit lower than typical values of 2.5 – 2.7 volumes.

### Scenario 2:

#### *Dispensing with straight CO<sub>2</sub>*

The carbonation in the beer will depend on the partial pressure of CO<sub>2</sub>, which equals 34.7 psia (the total dispense pressure) x 100% (proportion of CO<sub>2</sub> in the blend) = 34.7 psia. At sea level, atmospheric pressure is 14.7 PSI; 34.7 psia – 14.7 = 20 psig. A partial pressure of 20 psi for CO<sub>2</sub> at 38°F would result in about 3.3 volumes of carbonation in beer. For most brands of beer, this carbonation rate is a bit higher than typical values of 2.5 – 2.7 volumes.

From these examples, we can see that at the operating parameters of the system in question, straight CO<sub>2</sub> would result in carbonation levels that are too high. The blend we chose, at 70% CO<sub>2</sub>, would result in carbonation levels that are a bit too low. So, is there a way to use Henry's Law to figure out the exact blend for our draught beer system? And, looking at this another way, is there a way to use this math to figure out the ideal pressure to use, given a certain blend of gas?

As it turns out, there are tools available online to do both of these tasks with a great degree of accuracy. There are also some relatively straightforward calculations that do the same things very quickly, shown here. The following equation is very useful for con-

verting back and forth between gauge pressure and absolute pressure, and proportion of CO<sub>2</sub> in a blend:

$$c = \frac{b + 14.7}{a + 14.7}, \text{ where}$$

a = gauge pressure of the blended gas;

b = ideal gauge pressure of straight CO<sub>2</sub> (from the carbonation table in Appendix B);

c = % of CO<sub>2</sub> in the blend

## Determining the ideal blend of CO<sub>2</sub>/ N<sub>2</sub> mixed gas for a given draught beer dispense system.

Let's get back to our example above, in which a draught beer dispense system was designed to operate at 39°F, and at 20 psig. Let's also assume that the beers being poured contain 2.5 volumes of CO<sub>2</sub>.

From the carbonation table, we see that a beer at 2.5 volumes of CO<sub>2</sub> at 39°F has an equilibrium pressure of 11.9 psi of CO<sub>2</sub>.

So now we know that a = 20 psi, and b = 11.9 psi.

$$c = \frac{11.9+14.7}{20+14.7} = \frac{26.6}{34.7} = .767 \text{ or } 77\% \text{ CO}_2 \text{ rounding up}$$

What if we wanted to also dispense beers with 2.7 volumes of CO<sub>2</sub> in this same retail establishment? From the carbonation table, we see that a beer at 2.7 volumes of CO<sub>2</sub> at 39°F has an equilibrium pressure of 14.1 psi of CO<sub>2</sub>. In this case, a = 20 psi, and b = 14.1 psi.

$$c = \frac{14.1+14.7}{20+14.7} = \frac{28.8}{34.7} = .830 \text{ or } 83\% \text{ CO}_2$$

In this case, a gas blender with more than one blend of mixed gas would be very helpful. You would use the 77% CO<sub>2</sub> to dispense the beers with 2.5 volumes of carbonation, and the 83% blend to dispense the beers with 2.7 volumes of carbonation.



## Determining the correct pressure for a given blend of CO<sub>2</sub> / N<sub>2</sub> mixed gas

What if in the above example, we only had access to one blend of gas? Could we adjust the pressure a bit to achieve more than one level of carbonation, and still dispense beer in the same draught beer system? Well, maybe. This is very similar to the procedure outlined on Page 38 of this manual. Let's get back to our example above, in which a draught beer dispense system was designed to operate at 39° F and at 20 psig. We want to dispense beers containing both 2.5 and 2.7 volumes of CO<sub>2</sub>.

From the above example, we know that the 77% CO<sub>2</sub> blend is correct for the 2.5 volume beers. What pressure would we have to use to correctly dispense beers with 2.7 volumes of CO<sub>2</sub> using this 77% blend?

Looking back at our equation:

$$c = \frac{b + 14.7}{a + 14.7}, \text{ where}$$

a = gauge pressure of the blended gas; in this case, a is our unknown

b = ideal gauge pressure of straight CO<sub>2</sub> (from the carbonation table in Appendix B); in this case, b = 14.1

c = % of CO<sub>2</sub> in the blend; in this case, c = 0.77

$$a = (b + 14.7)/c - 14.7$$

$$a = 28.8/.77 - 14.7$$

$$a = 37.4 - 14.7$$

$$a = 22.7 \text{ psi}$$

So in theory if we increase the dispense pressure from 20 psi up to 22.7 psi on those kegs of beer with 2.7 volumes of CO<sub>2</sub>, we could use the same 77% CO<sub>2</sub> blend to dispense them and maintain proper carbonation. This may or may not work in reality—the beer might pour too fast at the bar, creating turbulence within the glassware. Or it might result in an acceptable pour with the right amount of carbonation. Experimentation at the bar would reveal if the pressure increase worked, or if an additional blend were needed to pour these beers. ■

# notes on serving cask ale

### Cask Ale

Cask ale, sometimes called “cask conditioned beer” or “real ale,” is draught beer dispensed and served in a traditional method. Cask ale is usually served at warmer temperatures than regularly carbonated draught beer, and without applied pressure. The result is a beer with different presentation, flavor, and aroma, wholly unique from the same beer filtered, force carbonated, and dispensed with CO<sub>2</sub> or mixed gas top pressure.

In this manual, we’ll focus on a few particulars of dispensing cask ale that represent basic knowledge and best practices. The care and handling of cask ale is an art unto itself, sometimes referred to as “cellarman-ship,” the details of which are well beyond the scope of this manual. Please refer to the online version of this manual for supplier and knowledge links.

### Temperature

Cask ale is typically conditioned and dispensed at 45°-55°F, unlike the colder 36°-40°F range for regularly carbonated draught beer. This temperature is warm enough to allow the beer within the cask to develop its own natural carbonation. This temperature also

means that CO<sub>2</sub> is not as soluble in the beer, so it contains far less carbonation. (See below).

### Carbonation

Because cask ale is handled at warmer temperatures, and since CO<sub>2</sub> is less soluble at warmer temperatures, cask ale contains much lower levels of carbonation than regular draught beer. Cask beer typically contains from 0.9-1.2 volumes of CO<sub>2</sub>, far less than the 2.5 to 2.7 volumes typical of carbonated draught beer.

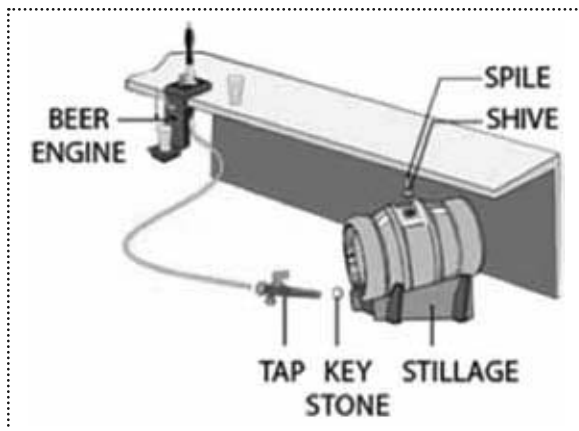
The carbonation in cask ale arises from natural secondary fermentation within the cask, rather than from force carbonation at the brewery. The relatively warmer cellaring temperatures allow this fermentation to occur after the cask leaves the brewery.

### Dispensing Cask Ale

Cask ale is normally dispensed from a cask located relatively close to the bar, or even on the bar or back bar. Most modern casks are metal, although a few wooden varieties are sometimes still found. Most casks contain two openings that are filled with wooden or plastic plugs called shives (for letting gas in)

and keystones (for tapping and removing beer). The cask is placed on its side with the shive up and the keystone down. Cask ale is dispensed without top pressure, meaning that it either pours from the cask through a faucet-like tap directly into the glass using gravity, or the beer is pumped a short distance using a pump called a beer engine.

Gas is allowed to enter the cask being emptied in order to prevent a vacuum from forming. Busy bars that empty a cask in one to three days will sometimes allow air to enter the cask, while other locations will use CO<sub>2</sub> at atmospheric pressure to fill the headspace. CO<sub>2</sub> is preferable in terms of preserving the beer; there may be some disagreement about whether this practice is “proper” or traditional, but this manual is not the forum for that discussion.



Cask ale dispensed directly from a cask using a gravity dispense tap will usually have very low amounts of foam in the glass. Cask ale dispensed from a beer engine will often be poured through a fitting called a sparkler that serves to create foam from the very low level of carbonation present.



## Beer Engines

Beer engines dispense cask beer. Pulling the handle actuates a piston or chamber of the engine and pumps beer from the cask to the customer's glass. Beer engines can be clamp-on or built into a bar. Some breweries that make cask ales will require a sparkler (perforated disk) that attaches to the end of the pouring spout.



## Cask Ale Pouring, Hygiene, and Best Practices

Pouring cask ale from a swan neck beer engine faucet is the only instance when the faucet should come into contact with the inside of a beer glass. Due to the unique nature of this beer dispense system, a list of guidelines must be followed to ensure proper sanitation and high product quality.

1. At the start of the day, discard the first pull of beer as this empties the beer engine cylinder of beer that has been sitting overnight.
2. Always use a clean glass for every serving of cask ale dispensed from a beer engine. This is the case when pouring any draught beer, but even

more so with cask ale due to the potential to transfer germs from one glass to another.

3. The closing bartender should do one final clean of the cask faucet, drip tray, and the surface of the entire cask pump when the bar closes. This cleaning should be done with restaurant/bar sanitizer approved by your local and state health code. If the cask faucet uses a sparkler, the sparkler should be removed and soaked overnight in the same sanitizer at a soaking concentration listed by the manufacturer.
4. The opening bartender should wipe the cask faucet with a clean towel wetted with fresh water before the first cask beer is pulled to ensure any residual sanitizer from the previous night is removed. If the cask pump is fitted with a sparkler, thoroughly rinse the sparkler under fresh water before attaching it to the cask faucet.

#### **Notes On Cask System Hygiene**

5. Run clean, warm water through the beer line and beer engine between every cask.
6. Perform regular beer line cleaning every 14 days, just like regular draught beer lines. Be sure to check with the manufacturer of the beer engine to ensure the cleaning solution concentration is compatible with the piston, so as not to damage it.

7. Cleanliness is paramount in the handling of cask ale. Unlike kegged draught beer, items are being inserted into beer such as taps, spiles, ale extractors, etc. These all give an opportunity for bacteria to be introduced.

#### **Importance of one-inch collar of foam:**

- Well-prepared cask ale will easily allow for 1-inch of head or more if a sparkler is fitted on the end of the faucet. Without the sparkler device, a full 1-inch collar of foam may be difficult to achieve. The bar or restaurant manager should consult the brewer to discuss how their particular beer is intended to be served.

The purpose of a proper head on any cask ale is the same as a draught beer; the head helps to deliver the total sensory experience, including the following sensory benefits:

- Visual appeal of a good pour
- Aromatic volatiles in a beer are released
- Palate-cleansing effect of carbonation is enhanced
- Textural and sensorial qualities of beer are better presented to consumer. ■

# appendix e

## tools of the trade

Quality draught beer requires the technician to be equipped with the proper tools assuring professional installation and service. Valuable tips and lists of suggested tools and equipment for draught beer service professionals follow:

### Tool Tips

- Put safety first and always wear eye protection
- Buy the best tools you can afford, as they will last a lifetime
- Always use the right tool for the job
- Keep your tools clean, sharp, calibrated, and organized

### Beer Hand Tools

1. Side Cutters & O-Clamp Crimpers
2. Spanner / Faucet Wrench
3. Tube Gauge
4. Faucet Brushes - 3/8" & Mini Wire Brush
5. Box and Open End Wrench Set, Particularly 9/16"
6. Tower Wrench- 1" & 1-1/6"
7. Multi Screwdriver
8. Large 12" Flat Blade Screwdriver
9. 10" Crescent Wrench
10. Small & Large Channel Lock
11. Needle Nose Pliers
12. Side Cutter Pliers
13. Small Pipe Wrench
14. Vise Grip
15. 3/8" Drive Socket Set
16. Awl or Center Punch
17. Hammer
18. Rubber Mallet
19. Small Pry Bar
20. Bolt Cutter

21. 12' & 100' Tape Measure
22. Combination Square
23. Pinch Off Pliers - Vise Grip Brand
24. Allen Wrench Set
25. Torpedo Level
26. Chalk Line & Chalk
27. Pencils / Markers
28. Stud Finder
29. Rope & String
30. Rope Puller Come Along
31. Heavy Duty Fish Tape/Chain Hoist
32. Hack Saw
33. Small Utility Hand Saw
34. Scissors
35. Tin Shears
36. Razor Knife & Blades
37. Hose Cutters
38. Knife
39. Pipe Cutter
40. Sharpie Pen
41. Pull lube (Poly G)

**Miscellaneous**

42. Tool Box / Bag
43. Parts Organizers
44. Graduated Cylinder
45. Soldering Torch, Gas, Sand Paper & Flux
46. Quick-Grip Clamps
47. Sponge/ Bucket
48. Small Vacuum
49. Extension Cords
50. 3-Way Plug
51. Step Ladder
52. Work Lights
53. Flashlight
54. Headlamp
55. Voltmeter
56. First Aid Kit
57. Safety Glasses
58. Lifting Belt
59. Hard Hat
60. Moving Blankets
61. Gloves - Work & Latex
62. Box of Rags
63. 5 Gallon Buckets
64. Cargo Straps
65. Tool Belt
66. Hand Truck
67. Walkie Talkies
68. Cell Phone
69. Labels or Labeler

**Tooling**

70. Drill Bit Set - Cobalt Steel Bits with 135° Points
71. 12 1/4" Drill Bit
72. Hole Saw Extender
73. Hole Saws - Many Sizes
74. Cutting Oil
75. Coring Bits For Stone / Concrete

**Power Tools**

76. 1/2" Hammer drill motor
77. Hole Saw
78. Reciprocating Saw
79. Dremel Tool
80. Angle Grinder
81. Circular Saw
82. Impact Driver
83. Angle Drill

**Specialty Tools**

84. Cobalt Steel Bits
85. Refractometer – Glycol Checker
86. ATP Meter
87. Pressure Tester
88. Thermometer - Two Types  
(Recording thermometer)
89. Beer Gas Analyzer
90. Cleaning Kit – Recirculating Pump, Line  
Cleaner, Cleaning Pot, Titration Kit, Fittings
91. CO<sub>2</sub> Bottle with Regulators & Adapters for  
Various Tubing Connections

# draught beer glossary

**Acid Cleaner** – Although several blends of acid cleaners are recommended to assist in beer stone and water stone removal, some acids react with system components. Phosphoric acid-based blends are the only ones safe on all materials.

**Balance** – Ensuring that the applied pressure matches the system requirements so that the beer dispenses at the optimum rate of about 2 ounces per second or 1 gallon per minute while maintaining brewery-specified carbonation level.

**Barrier Tubing** – Plastic tubing with a lining of nylon or PET that provides a gas barrier to better protect the beer from oxidation.

**Beer Pump** – A mechanical pump that is generally driven by compressed air or CO<sub>2</sub> that can move beer great distances without changing the dissolved gases.

**Beer Stone**- Calcium Oxalate – A mineral deposit that forms slowly on a surface from beer and is very difficult to remove.

**Caustic or Caustic Soda or NaOH** – Sodium hydroxide – a high pH chemical commonly used in blending draught line cleaning solutions that will react with organic deposits in the draught beer line. Very effective, but also very dangerous. Commonly used in oven cleaners.

**Caustic Potash or KOH or Potassium Hydroxide** - Similar to sodium hydroxide, but offers slightly different chemical properties in a blended cleaning solution.

**CO<sub>2</sub>** – Carbon dioxide, a natural product of fermentation and the gas used to push beer in draught beer systems. CO<sub>2</sub> leaks in the gas system are dangerous because high concentrations of CO<sub>2</sub> will displace air and cause asphyxiation.

**CO<sub>2</sub> Volumes** – The concentration of CO<sub>2</sub> in beer expressed as volumes of gas at standard conditions per volume of beer.

**Coil Box** – A cooling system to bring beer to serving temperature at the point of dispense consisting of a coil of stainless steel immersed in ice water. Often used at picnics or events where normal keg temperature cannot be maintained.

**Cold Plate** – A cooling system to bring beer to serving temperature at the point of dispense consisting of a stainless steel coil embedded in an aluminum plate in contact with the ice. Cooling is the result of melting the ice rather than just heat transfer, so water must be drained away from the cold plate. Often used at picnics or events where normal keg temperature cannot be maintained.

**Coupler** – The connector to the keg.

**Dewar** – An insulated, pressurized container for liquified gas such as CO<sub>2</sub>.

**Direct Draw** – A draught beer system that has a short jumper connection from the keg to the faucet.

**EDTA** – Ethylene Diamine Tetracetic Acid – A cleaning solution additive that can dissolve calcium mineral deposits in draught beer systems.

**Faucet** – The dispensing end of the draught beer system that controls the flow of beer.

**Flash Chillers** – Mechanical cooling systems to bring beer to serving temperature at the point of dispense. Often used with flash-pasteurized kegs that can be stored at room temperature.

**FOB** – Foam on Beer detector. A device that stops the flow of beer when the keg is empty before the beer line is filled with foam.

**Glycol or Propylene Glycol** – A food-grade refrigerant that is recirculated through insulated tubing bundles to maintain beer temperature.

**ISBT** – International Society of Beverage Technologists, who created a quality standard for CO<sub>2</sub> for beverage use.

**Jockey Box** – A cooler with a coiling coil or cold plate and faucets to chill the beer at the point of dispense.

**John Guest Fittings** – A specific brand of quick connect for stiff plastic tubing.

**Jumper Tubing** – The flexible piece of vinyl tubing used between the keg and draught beer system that should be replaced annually.

**Lift** – The change in height from the keg to the faucet that is a component of system balance.

**Line** – Tubing that makes up the draught beer flow path.

**Long Draw** – A draught beer system over 50 feet long that uses barrier tubing in a refrigerated bundle that typically requires a mixed gas to avoid overcarbonation.

**Nitrogen Generator** – A system designed to separate nitrogen from compressed air, typically by membrane. Nitrogen used for beer dispense in a mixed gas application must be >99% pure.

**NSF** – National Sanitation Foundation: An organization that certifies food service equipment for performance and cleanability.

**Party Pump or Picnic Pump** - A hand pump that uses compressed air to dispense beer. This type of pump should only be used when the entire keg will be dispensed at one time, because oxygen will damage the beer.

**PE – Polyethylene** – Stiffer tubing used in older refrigerated bundles (this oxygen-permeable material contributed to oxidation of the beer remaining in the lines and is now only recommended for use as glycol tubing).

**Pot** – Pressure Pot, Cleaning Pot – A canister for cleaning solution or rinse water that is connected to a pressure source pushing the solution through the lines like beer. Does not give sufficient velocity for (mechanical) cleaning, so this should only be used on short lines with longer chemical exposure.

**PSI** – Pounds per square inch. A unit of measure of gas pressure.



**PSIA** – Pounds per square inch, absolute. A measure of gas pressure against a perfect vacuum so it includes the atmospheric pressure of 14.7 psi at sea level.

**PSIG** – Pounds per square inch, gauge. A measure of gas pressure against the atmospheric pressure, typically seen on gas regulator gauges. Since atmospheric pressure varies with altitude, the gauge pressure must be adjusted with altitude.

**PVC** – Polyvinyl Chloride – Flexible jumper tubing.

**Regulator** – A gas control valve that delivers a set gas pressure regardless of tank pressure. There may be a primary regulator on the gas source and a secondary regulator at the gas connection for each keg.

**Resistance (or System/Component/Line Resistance)** – A measure of the pressure drop across a component or over a length of tubing at the optimum beer flow rate.

**Sanitizer** – An EPA-registered product that is designed to kill microorganisms.

**Sankey** – The modern style of keg coupler. It is available in several versions to fit specific styles of keg valves produced in Europe and the U.S.

**Sequestrants** – Chemicals that hold metal ions in solution and prevent mineral deposits.

**Series Kegs** – Hooking multiple kegs together so the beer from the first flows through the second and then into the next so that the kegs can be changed less frequently.

**Shank** – The connecting piece that goes through the cold box wall or tower and connects the tubing and tail piece to the tap. It also can help provide system pressure reduction.

**Short Draw** – A draught system under 50 feet long that can be run on straight CO<sub>2</sub> or mixed gas, and can use air-cooled or refrigerated lines.

**Surfactants** – Compounds used in blended draught beer line cleaners that lower surface tension to enhance surface wetting, break the bond between deposits and the tubing surface, and suspend soils in cleaning solution so they can be removed.

**Tail Pieces** – The connectors that allow a piece of tubing to be attached to a piece of equipment.

**Tap** – The connector from the draught system to the keg (more properly referred to as a coupler).

**Tavern Head** – The connector from the draught system to the keg (more properly referred to as a coupler).

**Tower** – The mount on the bar that holds the faucets and is cooled to maintain beer temperature up to the point of dispense.

**Water Conditioners** – A component of a blended cleaner that is intended to carry away soils.

**Water Stone** – Calcium Carbonate – A mineral deposit that forms from water and can be removed with acid. ■

# www.draughtquality.org

Brewers Association  
736 Pearl Street  
Boulder, CO 80302  
303.447.0816 • 888.822.6273  
draughtquality.org  
info@brewersassociation.org

\$6.95 U.S.

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[www.BrewersAssociation.org](http://www.BrewersAssociation.org)

