

KEGGING YOUR HOMEBREW

Warning

Working with carbon dioxide is potentially very dangerous. CO₂ cylinders are under very high pressure. If the valve were to break off of the cylinder, it would become an unguided missile, possibly causing injury or death. For this reason it is important that you immobilize CO₂ cylinders by securing them with chains, bungee cords, etc.

Additionally, a CO₂ gas leak in an enclosed area could displace oxygen and cause asphyxiation. Always test gas handling systems for leaks.

The CO₂ cylinder

A filled CO₂ cylinder contains carbon dioxide in a liquid state. This liquid CO₂ exerts vapor pressure, filling the head space of the cylinder with gaseous CO₂. At room temperature, the vapor pressure of carbon dioxide is about 800 pounds per square inch (PSI). If you put your CO₂ cylinder in the refrigerator, you may notice the vapor pressure drop as low as 400 PSI.

As you draw CO₂ gas from the cylinder's head space, the liquid CO₂ evaporates to maintain a constant vapor pressure. If you monitor the pressure inside the CO₂ cylinder, you will notice that the pressure remains constant even as you draw off CO₂. The pressure in the cylinder will not drop until the liquid CO₂ is depleted, at which point the pressure will drop rapidly.

Because of this phenomenon, the best way to measure CO₂ usage is to weigh the cylinder, and subtract the cylinder's tare weight, or the weight of the empty cylinder. The tare weight is usually stamped into the cylinder and is prefixed by the letters "TW". An experienced brewer will know when the cylinder needs more gas just by lifting the cylinder and assessing its weight.

A shutoff valve is located at the top of the cylinder. Keep this valve closed until you attach a regulator to the cylinder. To open this valve, you need only crack it open 1/2 turn.

The Keg

A Cornelius-style keg is a cylindrical tank made of stainless steel. On the top of the keg are two male posts for attaching quick disconnect couplings, which allow you to quickly and easily attach fluid lines, such as gas or beverage tubing.

Underneath the post labeled "IN" is a very small gas down tube which is used to deliver CO₂ gas into the head-space of the keg. When filling a keg, you should make sure that this down tube is never immersed in liquid, or else liquid could get forced into the gas hose.

The post labeled "OUT" is attached to a much longer liquid down tube, which extends to the bottom of the keg. This tube remains immersed in liquid until all the liquid has been dispensed from the keg.

When cleaning or siphoning beer into the keg, access to the inside is provided via the oval lid. A rubber o-ring provides a positive seal between the lid and tank. The lid contains a pressure relief valve, which can be manually opened to vent excess CO₂ pressure from the keg. This pressure relief valve also serves as an emergency overpressure valve, automatically venting CO₂ if the pressure exceeds the maximum safe pressure of 130 PSI.

The Regulator

As you might expect, CO₂ pressures in your keg system are regulated by a CO₂ regulator, pictured in Figure 1. The regulator is attached to the high-pressure CO₂ cylinder by the cylinder coupling nut. The regulator is attached to the keg through a low-pressure port; our regulators have a shutoff valve installed in this port, which allows the brewer to conveniently, quickly, and absolutely shut off CO₂ flow to the keg. When the valve's lever is perpendicular to the valve stem, the shutoff valve is closed; it is open when the lever is parallel to the stem.

The regulator has two pressure gauges. The high pressure gauge, opposite the coupling nut, measures the pressure inside the CO₂ cylinder in pounds per square inch. The low pressure gauge, located on the top of the regulator body, measures the internal regulator pressure. If this pressure is greater than the pressure inside the keg, the regulator will deliver gas to the keg until the regulator pressure and the keg pressure are equal. You can simultaneously increase the regulator's internal pressure and the pressure in the keg by turning the regulator's adjusting screw clockwise. You can decrease the regulator's internal pressure (but not the keg pressure) by turning the adjusting screw counterclockwise.

The regulator also contains a pressure relief valve that will help to protect the regulator from damage if the internal regulator pressure gets too high.

Initial Assembly and Leak Test

- Use a wrench to tighten the connections on the gas connector kit and the faucet tubing kit. The swivel nut should be snug, but do not over-tighten.
- Attach the gas connector kit to the regulator's shutoff valve and tighten with a wrench.
- Attach the regulator to the CO₂ tank. Make sure to place the nylon washer between the cylinder and the regulator. Tighten firmly with a wrench. Make sure the regulator's shutoff valve is closed, and the adjusting screw is backed all the way out. Crack open the valve at the top of the CO₂ cylinder. There should be no hissing or other signs of leaks and regulator gauge readings should remain steady.
- Attach the disconnects to the keg's posts. The black liquid disconnect attaches to the keg's liquid/out post. The gray gas disconnect to the keg's gas/in post.
- Open the regulator's shutoff valve. Pressurize the keg to 10-15 PSI by turning the adjusting screw clockwise. Test all threaded connections, quick disconnects and pressure relief valves with soapy water or gas leak detector (available at any hardware store). Even a small leak will drain your CO₂ cylinder, and in some cases it could even be dangerous.

SAMPLE KEGGING PROCEDURE

When fermentation is complete, you are ready to keg. Thoroughly clean and sanitize your equipment: Remove the oval tank lid by lifting upward on the metal locking bars. Fill tank with 2 1/2 gallons of the sanitizing solution of your choice. We recommend using Star San, as it requires no rinsing. Do not use chlorine, as it reacts with stainless steel and may cause 'pitting' of the surface. Flip the keg upside down once to ensure that all surfaces remain in contact with the sanitizer. Attach gas line (gray disconnect) to "In" post of tank. Attach liquid line (black disconnect, with faucet) to "out" post.

Carbonation

There are two options to carbonate using the Cornelius kegging system: sugar priming as you do with bottles or force carbonating using the CO2 from your tank.

Sugar priming

Dissolve 1/3 cup corn sugar in a cup of water and boil for at least five minutes. Add to an empty, sanitized keg.

- To reduce oxidation during transfer, you may wish to purge the air out of the keg. Attach the gas/in line. With the lid off, adjust the regulator to a low pressure (less than 5 PSI) and run CO2 into the open keg for several seconds. CO2 is heavier than air and will displace it.
- Siphon beer from the secondary fermenter into the keg.
- Attach the lid and pressurize to about 10 PSI to seat the lid.
- Keep keg in an area with temperatures equal to or above that of fermentation temperature to finish carbonating. Expect carbonation to be complete after a few weeks.

Forced carbonation

When beer is stored under CO2 pressure, it will gradually absorb the carbon dioxide gas until it reaches a state of equilibrium. There are two factors that determine how much CO2 will become dissolved in beer: temperature, and pressure.

Temperature's effect on CO2 solubility is very straightforward. It is easier to dissolve CO2 in cold beer than warm beer.

There is an equally simple rule pertaining to pressure: the higher the CO2 pressure, the more readily CO2 gets dissolved in beer.

Brewers express the amount of carbonation in a beer in volumes. A volume is defined as the volume the CO2 in beer would occupy at 0i F and atmospheric pressure, relative to the volume of the beer itself. For example, the CO2 in one pint of British Ale carbonated to 2 volumes of CO2 would occupy two pints of space.

For reference, here is a list of beer styles and the corresponding amount of carbonation:

- British Ale: 1.8 to 2.2 volumes
- German Lager: 2.5 volumes
- American Lagers and Ale: 2.6 to 2.8 volumes
- Wheat Beers: 3.0 volumes

Crack open the valve on the CO2 cylinder. Adjust gas regulator to a low pressure (1 to 5 PSI). Open the regulator shutoff valve (located at the base of the regulator) by turning it down in line with the tubing. Depress the faucet head to begin liquid flow. After running the sanitizing solution through the system, release pressure by, first, turning regulator shutoff valve to the off position; second, release pressure in tank by pulling upward on the pressure relief valve in the keg lid. If you are not using a no-rinse sanitizer, finish with a sterile water rinse.

With the assistance of Table 1, it is possible to precisely carbonate a beer to any arbitrary level of carbonation. The carbonation chart shows the relationship of CO2 solubility in beer at various temperatures and pressures. The top row contains the pressure in pounds per square inch. The first column lists beer temperatures. The numbers in the center represent the volumes of CO2 that will be dissolved in the beer at equilibrium.

In order to duplicate the carbonation of a German Lager, for example, you would need to force 2.5 volumes of CO2 into the beer. If you know your refrigerator is set at 45i F, you can consult Table 1 to determine that 2.5 volumes of CO2 is achieved at 15 PSI. If you were to lower the temperature of the refrigerator to 35i F, you would need just 10 PSI of pressure to achieve the same level of carbonation.

Table 1. Carbonation Chart

Temp	5 PSI	10 PSI	15 PSI	20 PSI	25 PSI	30 PSI
30° F	2.23	2.82				
35° F	2.02	2.52	3.02			
40° F	1.83	2.30	2.75	3.19		
45° F	1.66	2.08	2.51	2.94		
50° F	1.50	1.90	2.30	2.70	3.10	
55° F		1.75	2.12	2.47	2.83	3.18
60° F		1.62	1.95	2.27	2.60	2.92

Simply setting the regulator pressure to the proper level will cause the beer to become carbonated. However, it may take many days for the beer to reach equilibrium with this method. Many brewers speed up the carbonation process by shaking the keg back and forth, which drastically increases the surface area of beer in direct contact with CO2. As you do this, you will hear the regulator delivering CO2 as it is being rapidly dissolved into the beer. You should shake the keg until it becomes increasingly difficult to get CO2 to dissolve into the beer. When you are finished, leave the CO2 line attached to the beer so it may complete the process.

You can further speed up the carbonation process by over-pressurizing the keg during the shaking process. By setting the regulator to a very high pressure, say 30 PSI, it will be easier to force CO2 into the beer.

There is a possibility that you can over-carbonate the beer with this method, however. Be sure to lower the regulator pressure to the proper pressure when you are finished shaking.

If the beer becomes over-carbonated, it is possible to decarbonate the beer. You should periodically pull the pressure relief valve on the keg, de-pressurizing the head space. This will cause CO2 to come out of solution and re-pressurize the head space, at which point you can repeat the process. In extreme cases of over-carbonation, or very full kegs, you may find it advantageous to leave the keg open to the atmosphere by attaching a gas disconnect to the "IN" post.

Dispensing beer

In order to dispense a nice glass of beer (as opposed to a glass of foam), the beer needs to be gradually transitioned from the relatively high pressures inside the keg to the low (atmospheric) pressures outside of the keg. Foaming is caused when the beer experiences a rapid drop in pressure, and also when the beer splashes into a glass at excessive velocity.

In general, there are two ways to pour a good beer from a draft system. You can constantly manipulate the pressures inside the keg, or you can build a well-balanced system which requires no manipulation.

Constantly manipulating pressures

- When you wish to begin dispensing beer, reduce the regulator pressure to a low pressure, between 3 and 5 PSI.
- Reduce the head pressure by opening the pressure relief valve on the keg.
- Dispense beer.
- Over time, the head space will re-pressurize, and you may need to relieve the keg pressure prior to dispensing again.
- Restore the keg pressure to proper carbonation pressures for storage.

A balanced system

The optimal dispensing scenario is that you dispense beer at the same pressure at which it is carbonated, and you never modify the pressure inside the keg. In order to accomplish this you need to balance the applied pressure, or the pressure in the keg's head space, and the total restriction of the beverage system.

Nearly all of the restriction in a beverage system comes from the beverage tubing. It is harder to push beer through a long length of tubing than a short length because of the frictional resistance of the tubing's surface. The frictional resistance generated by tubing is called flow resistance.

The actual flow resistance of a tube is influenced by many factors, such as material, inner diameter and the degree to which it bent or coiled. The most dramatic effect is tubing diameter. All other things being equal, it is much harder to force beer through a narrow diameter tube than a large diameter one. The approximate flow resistance of 1/4" vinyl beverage tubing is 0.65-0.85 pounds/foot. Compare that to narrower 3/16" beverage tubing at approximately 2.2-3.0 pounds/foot. In practical terms, if you carbonate beer at 15 PSI, this means you will need 13-23 feet of 1/4" beverage tubing to have a balanced system. In comparison, you will need just 5-7 feet of 3/16" tubing to achieve the same result.

For most home brewers' draft systems, it is impractical to use anything but 3/16" beverage tubing. In most cases 5-7 feet will give good results, however you may need to modify the length if your conditions are unusual.

Cleaning

The most rigorous way to keep kegs clean and sanitary is to completely disassemble them after each use. You will need a ratchet with deep sockets to remove ball lock posts. Underneath the ball lock posts are down-tubes: a short gas down tube and a much longer liquid down tube. Each down tube has an o-ring attached to it. With the post removed, apply pressure to the top of the poppet valve with a small screwdriver. Even the disconnects can be disassembled and fully cleaned. Use a stainless strainer to rinse all the small parts, and then clean them in a solution of Powdered Brewery Wash (PBW). Clean the keg shell with any non-abrasive cleaner. Chlorine can pit stainless steel if left for more than a few minutes and is not recommended.