Aseptic Keg Filling

By R. F. Risley

ABSTRACT

This paper focuses upon the benefits of a Single Valve Kegging Operation and demonstrates the value of utilization of two detergents—caustic and acid—for cleaning. These are then expanded upon to look at the state-of-the-art for high speed kegging, that is, up to 770 kegs per hour from one filler.

SINTÉSIS

Este artículo se enfoca sobre los beneficios de la operación de embarrilaje con válvula sencilla y demuestra el valor de utilizar dos detergentes—limpieza con caustica y ácido. Luego expanden estos para estudiar la técnica mas avanzada en embarrilamiento a alta velocidad, esto es, hasta 770 barriles por hora por una llenadora.

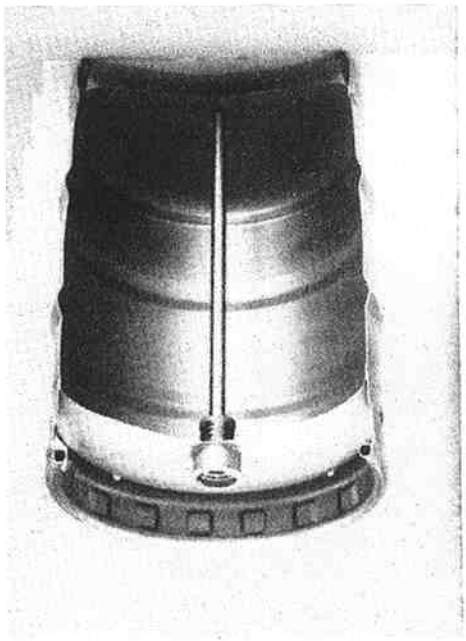
I chose the title *Aseptic Keg Filling* because I feel this is the most important feature with the new kegging concepts today. We say aseptic filling for one reason and that is to engender the thought of quality from a package and process standpoint which will result in better shelf life.

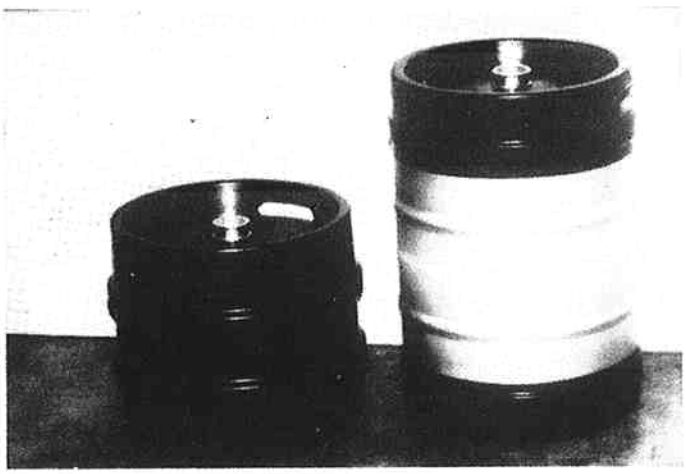
I want to go into the situation today with regard to containers, the situation today with regard to process, and I would even like to take a look at the tomorrow situation for kegging. Before we do, however, let's take a look at some background. Let's see where we've come from with our kegging operations. Actually the original draft beer concept began with delivery of the beer in the wood barrels. They progressed to being pitched with tar for improving CO_2 retention and improving shelf life. The tar stopped the barrel from leaking. My guess is that shelf life for these containers based on a quality product would be extremely limited. The metal keg was developed and at the time was considered the ultimate in kegging—a major step forward. First made from aluminum and then made from stainless steel. Shelf life is improved; however, we still have the wood or plastic bung and we depend upon humans for inspection, as well as the need for refrigeration. With this open style keg we obviously have the opportunity for recontamination after cleaning because of the filling method where our racker is exposed to the atmosphere before and after insertion into our keg. This is not conducive to an aseptic fill concept. The single valve keg concept was introduced in Europe and done so because of the desire to ship longer distances, thereby requiring better shelf life for the product because the turn around time was extended. I must say that along with this single valve concept it's become popular in Europe to pasteurize the kegged beer as well as to improve the shelf life. Oftentimes these kegs have a turn around of 90 days or longer.

This single valve keg is available in many configurations and sizes from the most popular half barrel or 58.6 liter size to the 30 liter size to the becoming popular 20 liter size. The single valve keg offers many advantages over the conventional barrels. It has the 58.6 nominal capacity with the Barnes neck and an alloyed stainless steel reinforcing ring in both the top and bottom to minimize the damage potential experienced from the conventional stainless steel reinforcing ring.

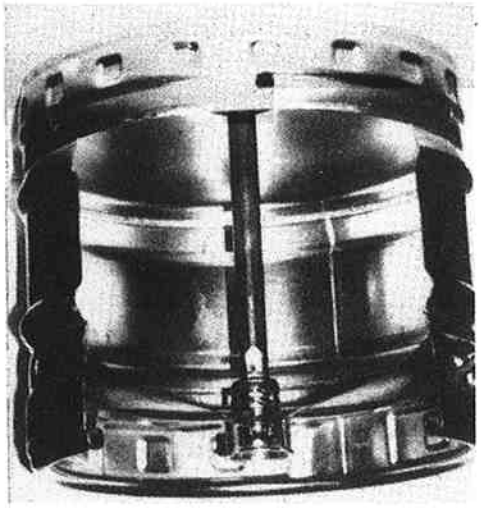
The key to the aseptic filling capability in our kegging operations is really the single valve concept and this is actually a misnomer. Our single valve is really two valves in one position, a ball valve or check valve and a ring valve. One is for drain and one is for detergent supply in the cleaning process.

R. F. Risley is President of GEA Food and Process Systems Corporation located in Columbia, Maryland (301-997-9500), and is responsible for Wiegand evaporators, Till kegging equipment, Ahlborn plate exchangers, and valves. He has been a member of the MBAA since 1974, has graduated from the University of Wisconsin as a mechanical engineer, and is a registered professional engineer.





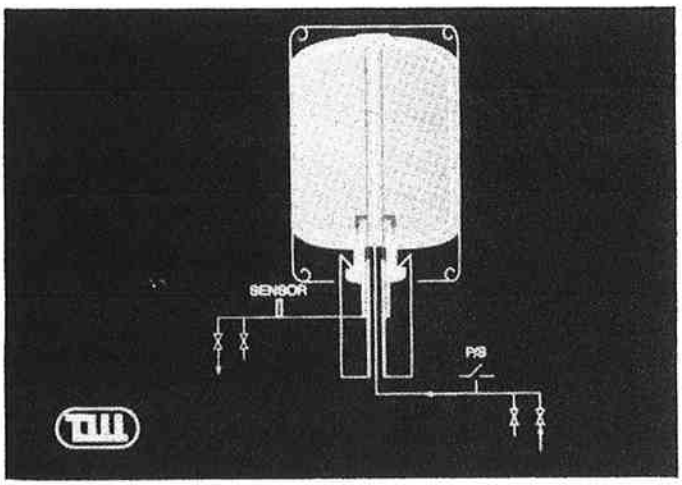
Now that we have quickly reviewed some history of the barrel and kegging concepts, let's look at the process for aseptic filling. If we called aseptic filling a problem or an opportunity, we first must define the problem before we can solve the problem or opportunity. When we look at the need for aseptic filling for products such as beers, soft drinks, and other perishable products, we have to consider the potential for microorganism growth. If we are to design a cleaning system or process to assure the aseptics concept, we have to understand what has to be cleaned.



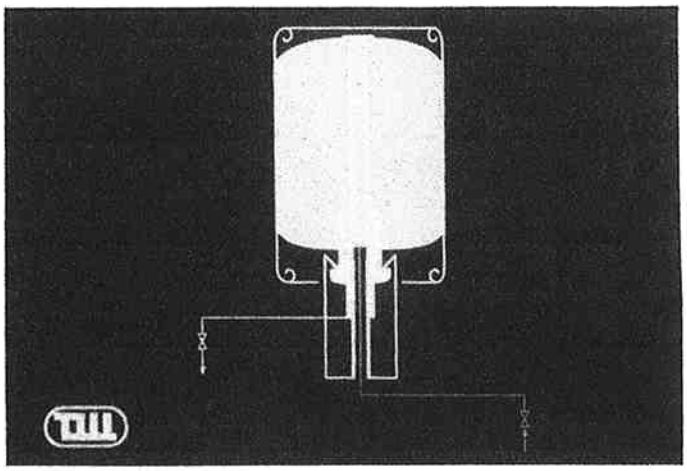
We are basically concerned in the brewing operation as it relates to kegging for the organics and the inorganics that are often present in containers that deal with beer. As you know these kegs are returned sometimes partially filled, sometimes with one or two gallons of beer or less in them, sometimes with beer and CO_2 pressure, and sometimes with just beer. These kegs can be stored outside for long periods of time, or they can experience the ideal condition of rapid turn around and little opportunity for microorganism growth. The keg condition varies; therefore, we have to provide cleaning for the worst situation, and the worst situation would be mold and yeast present inside the keg. These organics require a detergent-like caustic. Therefore, our recommendation for the first step of our operation is to consider caustic for the organics.

We are half the way when we have adequately taken care of the organics. The other requirement long-term for the internals in our keg is to consider the inorganics, the beer stone. Just as some of us have experienced a calcium carbonate buildup in water pipes, many brewers have experienced problems with a beer stone buildup inside the keg where they are not using a proper detergent to dissolve the inorganics. We recommend an acid for this. The acid will dissolve the beer stone and thereby eliminate the possibilities to harbor the yeast and mold and/or promote their growth in time. You can imagine how difficult cleaning for your organics will be when you have to penetrate porous beer stone to catch the microorganisms.

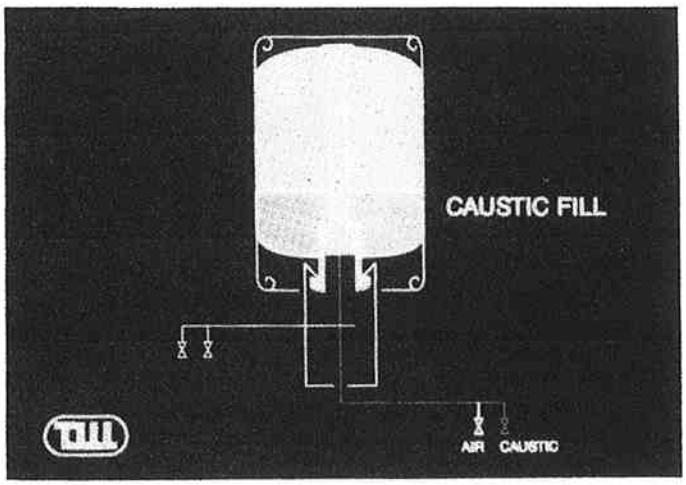
I would like to go through our process very quickly to describe our method to assure you of an aseptically cleaned keg for proper packaging of your draft beer.



In the first step we recommend draining of the residues that remain in the keg upon its return; however, before we do this, we like to make a pressure check on the valve to determine if the keg has been returned with CO_2 pressure in the keg or whether the keg has been returned without pressure. Why do we do this? We do this so that we can have a first indication of the condition of the valve. If the valve is bad, it will not retain the internal pressure of the keg. If the valve has been tampered with, it will not retain the internal pressure of the keg. We then record this information in our computer for rejection of the keg after cleaning and before filling. That is not to waste the beer. O.K. in our process we have done a pressure check and we have drained the residues.



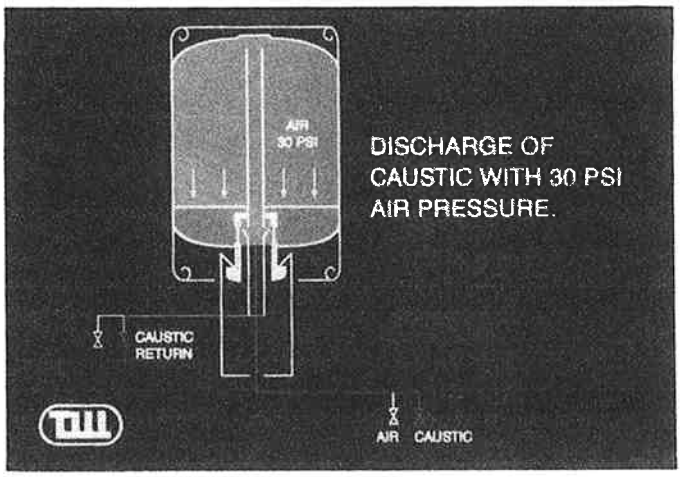
The next step in our process calls for a mix water rinse. We utilize the internal valve for the inlet and the ring valve for the outlet. In doing so we have greater volume capability on the drain side than we have on the inlet side and with this, we can assure proper drainage of the keg as we are rinsing the keg with this mix water. It is a very important point to avoid the so called bath tub ring that can be present if you don't have the proper draining capability.



Next we utilize hot caustic that is 185°F to begin our aseptic cleaning process. This caustic will remove the organics, the mold, the yeast, and in addition provide a mechanical scrubbing. How can we provide a mechanical scrubbing on the internal wall for a closed container? The theory works like this. We have an intermittent flow. When we interrupt the flow of the hot caustic as it comes up along the top and down the side and out the bottom of the keg, we have a first surface of liquid that actually scrapes the side well. This scraping

effect is only possible because of our intermittent rinsing concept. If we had a continuous flow, theory tells us that the velocity of the flow directly adjacent to the side wall will be reduced to almost zero, and that by interrupting the flow we achieve this scraping effect. The most difficult contact point on the internal part of the keg is the spear itself. For this reason, our process incorporates a special feature for cleaning the spear. The liquid surface tension allows full coverage of the spear in our cleaning process by limiting the velocity so that the liquid just comes to the top of the spear and then flows down the sides of the spear. You might ask how can you assure us that these flow conditions occur and are consistent throughout daily operation. We do this with a sight glass keg. This sight glass keg is periodically run through the line to give your quality assurance people the confidence that the various processes are correct in their flows of the detergents.

Now we've drained out the beer residue, we've utilized water a second time, that's hot water to rinse the inside of the keg and we've attacked the organics with the 185° hot caustic and we've done this in a way to assure proper contact for all of the inside components of the keg. You might say we've accomplished our task as far as our organics are concerned. We have, however, one additional step to attack the organics and that is after all of our caustic rinsing and spraying, we now insist upon a caustic flooding of the valve and the



valve components. We fill the keg with approximately six liters of hot caustic at 185°F and we allow this keg a rest period of about a minute or almost a minute so that we can in a submerged condition cook the valve and the valve components. This would be similar to the action experienced in a bottle soaker where the hot caustic has an opportunity to attack the organics in a submerged condition. The next step, now that we have cooked the valve for almost a minute in hot caustic is to remove the caustic. We do this with a special treatment of pressurized air. This air is sterile. How did the air become sterile? The air is filtered with an ultrafilter to assure sterility before the air is utilized in the kegging process. This air is injected into the keg through the center valve and the keg becomes pressurized to about 30 psi. This 30 psi will act as a force to power the drain of the caustic. This power creates a high velocity or a turbulent caustic flow through the valve and the valve components to assure more of a mechanical scrub, to assure the elimination of the organics. The caustic is returned to the caustic reservoir where an automatic dosing system assures the proper strength of caustic and an automatic tempering system utilizing steam coils assures the proper temperature of the caustic.

The next step incorporates a pre-rinse with mix water to make sure that we have removed all traces of caustic inside the keg. You might ask how can you determine, first that you even used caustic, and secondly that you haven't left the caustic in the keg? This is actually quite simply done with two devices. One a pressure check at the inlet of the keg for the presence of caustic pressure from the inlet pipe and secondly we utilize an ultrasonic probe to assure the correct process cycle. The ultrasonic probe's purpose is to verify a wet or dry condition inside the keg. Since it is placed downstream of the keg outlet, it can give a reliable indication of the effluents which are leaving the keg. This probe's operation is based upon ultrasonics as opposed to conductivity and, therefore, is not affected by cleaning solution residues, carbonates, or solution makeup differences.

The concept of using a pressure switch to identify the proper inlet conditions for all of our detergents, rinses, and waters, along with the wet dry probe becomes your security system. We have incorporated into the programs the must for proper rinsing and proper draining. Any deviation from the process, any malfunction from any inlet, any outlet, and/or the keg itself will result in a rejection of the keg which is usually followed by a visual inspection to determine the cause of the problem.

Back to our process, we have now attacked all of the organics. For all intents and purposes we have an organic-free container and now we want to attack the inorganics, the beer stone. We obviously do this with an acid. Our choice is a phosphoric acid and we do it in the same manner that was incorporated in the cleaning process for the hot caustic. We have hot acid. We start with the interrupted flow or intermittent flow of the acid on the bottom of the keg, the side walls, and the top of the keg. We then incorporate the same concept as was done on the caustic spray for the spear. Incidentally this is a patented process—this ability to flow on the spear and only the spear assures proper contact for elimination of the organics and inorganics. Having accomplished the same process with the acid that we did on the caustic, we can now be assured that we have no organics or beer stone to harbor the future growth of microorganisms on the inside of our keg.

After purging the keg of acid with sterile air we rinse the internals again with mix water. The keg is now ready for a final rinse with fresh 185° hot water which is pulsation sprayed into the keg to guarantee an effective final rinse.

This hot water is then returned to the mix water tank for prerinsing. The final rinse ends with a purge with steam to evacuate the keg and raise its temperature to over 200°F. With the keg at high temperature we close the drain valve and pressurize it to 25 psi allowing the keg and valve to hold this pressure and temperature for one minute. We may safely say that *now* the keg itself has been sterilized; however, there is more to do to guarantee the integrity of our package. We have another opportunity here to make a second pressure check to determine if the valve is good. If you remember, the valve can malfunction because of tampering and/or it could be damaged from shipment or worn from use. We now have a clean keg. There is no point in filling this clean keg if the valve is damaged.

There is some controversy regarding the utilization of steam for sterilizing kegs. A major brewer has converted from steam for sterilization to the utilization of hot water. That is 190° water. The brewer has done this because of the concern for the chemicals in the feed water treatment for the boiler which in effect are present in the steam even after filtration. We have taken a different approach and utilized a newly developed clean steam system which permits the use of steam that does not contain the feed water contaminants from the boiler. The clean steam concept incorporates the use of a plate heat exchanger to super heat the water and a small reservoir to allow the vaporization of the water, thereby producing the