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Modern Keg Technology in Germany

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ABSTRACT

Draught beer continues to hold a high percentage of the market in Germany. Therefore the German brewers pay careful attention to the cleaning and filling of kegs. While the basic process remains the same there have been significant advances in the technology and in line speed. Labor and energy savings play an important role. The paper discusses the typical standards and latest developments within the German brewing industry.

SINTÉSIS

Cerveza de barril continua manteniendo un alto porcentaje del mercado en Alemania. Por consiguiente los cerveceros le prestan atención cuidadosa a la limpieza y llenado de barriles. Mientras el proceso básico sigue siendo el mismo, han habido cambios significantes en la tecnología y en la velocidad de la línea. Ahorros en mano de obra y energía juegan un papel importante. El artículo discute las normas típicas y los últimos desarrollos dentro de la industria cervecera alemana.

INTRODUCTION

The basic process is well-known. The keg, a single opening container of various sizes, is filled and emptied via a valve and spear, the fitting, using CO_2 to maintain the adequate equilibrium pressure inside the keg at any stage. Contamination from outside is theroretically supposed to be impossible. Before filling, the keg must be cleaned carefully to remove all organic or inorganic matter which could contaminate the beer or reduce its shelf life. No foaming must occur while filling. High capacity and strict quality standards as well as the steadily increasing labor costs require fully automatic plants.

The change from the conventional cask to the keg has been made comparatively late in Germany, over the last five years or so. This means that the German keg industry has jumped into the second generation of machinery. In Germany there are several hundred independent breweries of small to medium output, only a few having output of between 2 and 3 million hectoliters per year.

The German brewers consider the keg to be a good vehicle for advertising, thus creating a colorful appearance of the same and requiring of course good maintenance and cleaning of the keg itself, with special attention to its exterior.

KEG-SIZE, SHAPE AND FITTING

The standard keg today is the 30 liter or 50 liter cylindrical keg. This comes in two versions, the pure stainless keg, which has about 80 percent of the market, and the stainless steel keg covered with polyurethane, the so called Schafer Plus-keg, with the remaining 20 percent of the market, see Figure 1. The polyurethane cover allows for any color and for the imprint of the brewery's logo, thus making the keg an excellent carrier for the advertising message. The large 100 liter keg is no longer in use. There are also a wide variety of 7.5 liter, 15 liter and 20 liter differently shaped kegs, which are mainly created for party use. The belly shaped type is, of course, a reminder of the good old cask or barrel. Micromatic fittings are in common use, in either the well or basket type or the flat top version.

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At Interbrau '89 in Munich, a completely new type of keg was introduced, the Keggy, see Figure 2. It is a polyurethane covered 12.5 liter stainless steel container with a built in liquid CO_2 cartridge and a two stage pressure reducing valve which reduces the CO_2 pressure from about 60 bar to 1.8 bar. Along with a specially designed dispensing head, the Keggy forms a complete system to bring real draft beer to private homes. The capacity of 12.5 liters reflects approximately the content of a case twenty-four bottles of 0.5 liters, which is still the standard package in Germany.

Fig. 1. The wide variety of keg sizes and shapes in use.

Fig. 2. The new Keggy home draught beer unit.

CLEANING PROCESS

Only if a returned keg is tight, and is still under CO_2 pressure, is it considered to be without contamination and is directly moved to further processing, that is cleaning and filling. Universally in Germany, recuperated water, caustic, acid, clean water and steam are applied one after the other on the required number of cleaning heads. These heads can be installed, at the option of the brewer, on one large machine, or on separate precleaning and cleaning and filling machines, see Figure 3.

As cleaning is the most time and energy consuming part of the whole process, it should be done as intensely as necessary but no more than is needed. The required cleaning intensity, however, is strongly influenced not only by the type of beer, may it be lager or weiss beer, for example, but also by the recycle time of the kegs. Due to the differing size of the breweries and due to the differing marketing channels recycle times may vary from a total of two weeks, if the kegs are sold in the nearby area, up to more than six months if they have gone into export.

Unfortunately, so far there is no way to sort out such kegs which need special care. This means, in other words, the whole process of cleaning has to be adapted to the worst possible keg. And again this means that normally more cleaning efforts are undertaken than necessary. Cleaning seems to be over-done for many kegs.

A typical sequence of cleaning cycles is shown in Figure 4. It shows the various media, the scale is 60 seconds, that's about 2 minutes for the caustic, about 2 minutes for sterilization, a little bit less for recouperated water, and about 20 seconds for acid. The figure shows a standard process used in Germany.

From that time schedule, which may be adapted to each individual requirement, plus the necessary idle periods for the filling and emptying of the applied media, and the transport time from station to station, the number of heads which have to be installed can be calculated, according to the output capacity of the line.

This number, of course, is clearly related to the capacity of the single machine, which determines the residence time of each keg on the machine in total, and on each individual head. It is optional, whether all cleaning heads are installed in the main racking machine, or whether some are installed in a separate precleaning machine. If such a precleaning machine is available, the transport time to the main racking machine can be used for soaking of the keg, fully or partially filled with caustic. Normally, an extended conveyor has to be installed between the two machines in order to achieve a reasonable soaking time of several minutes.

Rather than increasing the cleaning time, if necessary, there is a way to increase the cleaning intensity by superimposing hydrodynamic forces to the normal flushing method. Such hydrodynamic forces may be created by blowing compressed sterile air through the liquid, as shown in Figure 4. The keg is positioned upside down, it is filled to a certain level and air is blown through the CO_2 valve creating a strong turbulence. As turbulence is most effective close to the liquid level the cleaning liquid may be filled in steps with intermediate blowing of the sterile air. Normally the turbulence cleaning is done during the caustic cycle. It can be seen from the picture that it also is extremely effective on the spear, the cleaning of which normally is weak with mere flushing.

The turbulence method reflects, in a more intense way, the oscillating motion which was applied in former times to barrels by turning them around, as they were cleaned through the side bung (Figure 5).

A comparison of the effectiveness of such hydrodynamic forces should aim at the question of which method does create the strongest forces. An indication of the effect of various combinations of cleaning is shown in Figure 6. This data was recorded by the Staatliche Brautechnische Pruf- und Versuchsanstalt Weihenstephan on the basis of a large number of kegs which had been returned after up to seven months.

After a cycle of pre-cleaning, 5 minutes soaking, and turbulence cleaning, no keg was found to have any trace of contamination, so this is presumed to be 100 percent clean. If turbulence cleaning was eliminated this was reduced to 85 percent. If there was just pre-cleaning and no soaking, but with turbulence cleaning the value was up to 94 percent. And with pre-cleaning but no soaking and without turbulence cleaning the figure was 64 percent. Of course these figures only are considered to be quantitative rather than qualitive because the basis was a certain selection of kegs.

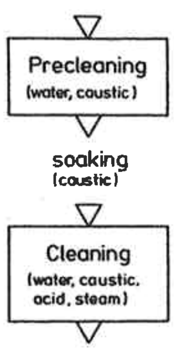

Fig. 3. Various cleaning steps (combination optional).

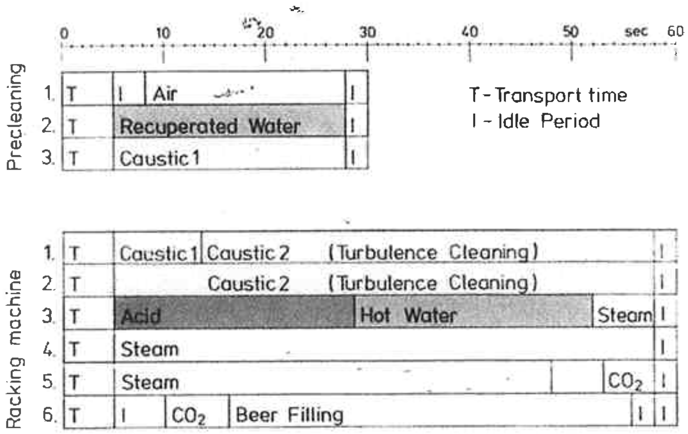

Fig. 4. Standard cleaning cycles.

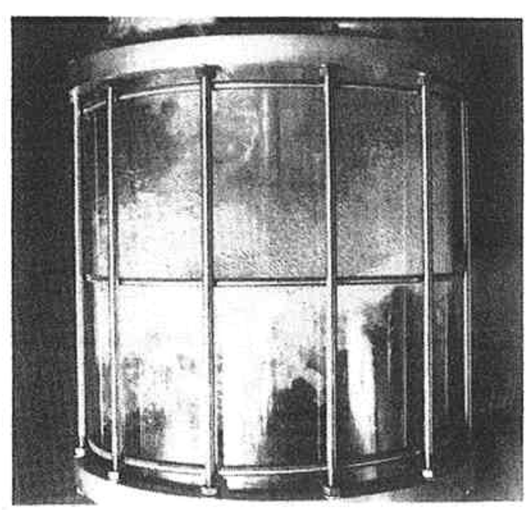

Fig. 5. A window view of turbulence cleaning.

FILLING

For good quality of the beer and capacity control very careful filling is required. You may call this black filling, or filling without any foam. The filling process itself may be reflected by what is called the beer run curve. Such a typical curve is shown in Figure 7, reflecting a slow start, quick filling and slow ending. Such machines would have an elecronically controlled multiple setting CO_2 counterpressure valve.

The normal time for filling a 50 liter keg is between 40 and 50 seconds, thus limiting the capacity of a single filling head machine to something around 60 or 70 kegs per hour maximum. Of course the constant closing and opening of the valves, in other words the discontinous beer run, is a disadvantage of a single head machine.

In order to eliminate that bottleneck with respect to capacity on the one hand and also to reduce space requirements per keg of output, in the latest designs two filling heads have been installed in a linear machine. In principle they can be installed in line or parallel. If they are installed in line, that means one after the other, then you have a filling curve with twice the flux and still retain the problem of the beer flow being on and then off. But if the two filling heads are installed parallel, the two independent filling curves can be electronically controlled so that they do superimpose, in such a way that the resulting curve then turns out to be very even. This means it is possible for a linear machine with two filling heads to achieve a continous beer run and a very constant curve and this of course allows you to design a high capacity manchine with piping and the buffer tanks based on the lower beer flux rate.

A principal of such a two head filling machine is found in Figure 8. To the upper left is the linear part of the machine, when the keg is moved into the filling postion, and once it is clamped the movable support moves the keg either to the right side or to the left side and the second keg is then put into position. During this time the beer is filling on the first head. Once the second keg is in position, and reaches the fast fill portion of its cycle, fast filling of the first keg ends, resulting in the beer filling curve as shown in Figure 7.

Following is some technical data which is based on current practice in Germany.

Today it is more or less common to pasteurize beer, however, even some big breweries don't because they feel it is part of their reputation to provide real draft beer. But still this has an impact on the shelf life. The shelf life is guaranteed in Germany today very strongly for 3 weeks, and sometimes for up to six months or even more. Market aspects, distribution channels, and, also, the image of a beer brand has an impact on whether to pasteurize or not.

Today, the first large scale tests on cold filtration are being performed. Absolutely no stabilizing compounds are allowed according to the old German law dating from the middle ages, the "Deutsches Reinheitsgebot". Though this law has been overruled by the European Economic Community it is stull followed by the brewers as a good marketing point.

The CO_2 content of the beer is up to 5.5 grams per liter, and the beer pressure should be 2.5 bar. The filling temperature should be from 1 to 6°C, depending upon CO_2 content and pressure.

Waste beer is about 50 ml/keg with flat top fittings and about 70 ml/keg with the basket type, which is the type commonly used in North America.

The oxygen pick-up must not be more than 0.03 to 0.05 ml/keg maximum. The average expendables consumption is 25 grams per 50 liter keg of concentrated caustic and about 10 grams of concentrated nitric or phosphoric acid. If turbulence cleaning is applied, which of course is an energy consuming process, and should only be applied if necessary, the air consumption is about 25 normal liters per second of the cleaning cycle. Steam consumption is about 0.2 kg per 50 liter keg.

Following is a description of some of the standard characteristics of a modern plant today.

A modern keg plant is fully automatic with only one operator to supervise the plant. Sometimes a second man is there but he normally is the forklift driver who serves the palletizer and the depalletizer.

Great attention is paid to the noise level. In particular, conveying systems have to be designed so that the noise level is low, and this can be achieved by a so called fixed-cycle operation. This is done in such a way that the conveying system is divided into several sections which are independently driven by two speed motors. They are controlled so the kegs are only moved as required and the kegs never are allowed to touch each other. Therefore it is a no-contract operation with

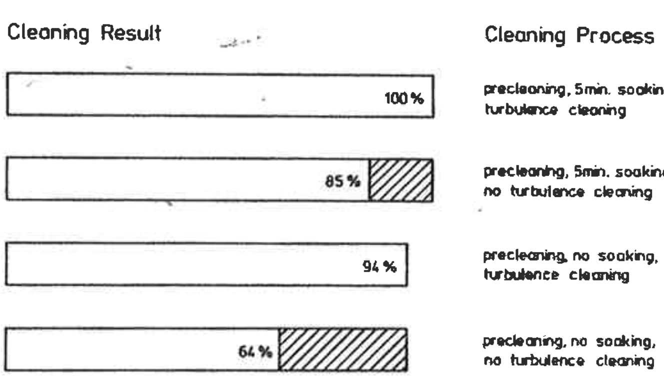

Fig. 6. Effect of various cleaning steps.

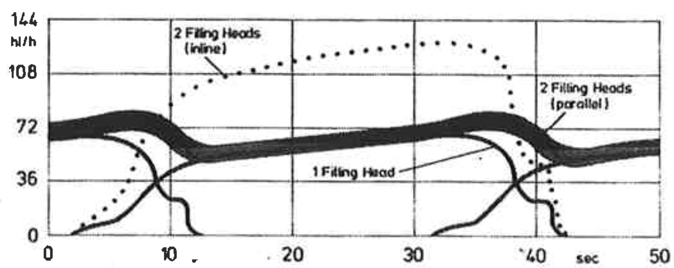

Fig. 7. Beer run curve.

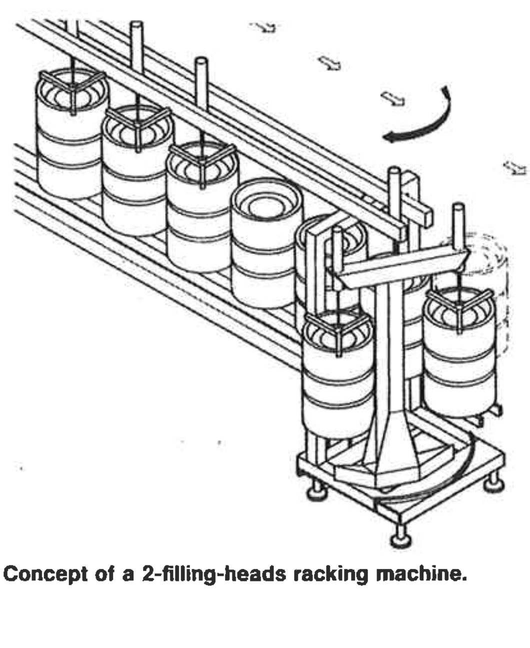

Fig. 8. Concept of a 2-filling-heads racking machine.