Hygienic Design – Practical Applications

THERE'S A FIRST TIME FOR EVERYTHING | In breweries, quite often one hears statements like "Why do we need hygienic design? We clean everything all the time anyway. Hygienic design is the same as aseptic operations and we don't need that." In practice, this can have disastrous consequences. Hygienic design means that all surfaces that come into contact with the product and all external surfaces must be so fabricated that neither contamination nor soiling can readily endure on them. Every surface must also be able to be cleaned easily.

THOSE RESPONSIBLE for keeping breweries clean must ensure that they do not allow their facilities to harbor contaminants (one could say to become "infected"). This is a question of the modus operandi and is, of course, self-evident for a conscientious brewer. However, the raw materials and, above all, the processing aids (air, CO_2, diatomaceous earth, process water) play a role. There's a first time for everything in life. No brewery is immune to microbial contamination. Nevertheless, once contamination is discovered, it should be eradicated as quickly as possible. This will only work if the equipment has been hygienically designed.

Does hygienic design not simply mean aseptic? The answer is no. An aseptic level of operation is necessary only when cold filling beverages with little in the way of inherent protection. These beverages possess a more or less neutral pH, are still rather than sparkling and contain a wide range of ingredients that promote the growth of microbes, for instance, sugars, proteins and vitamins, among others. Due to low levels of residual fermentable carbohydrates, a slightly acidic pH and the presence of CO_2 (hops and a low alcohol content do their part as well), the fundamental composition of beer protects it enough so that it can be filled using a "normal" process.

This does not necessarily apply to non-alcoholic beers, especially those produced using methods involving interrupted fermentation. Thus, aseptic cold filling is not essential in a traditional brewery setting, but it is for the production of iced tea drinks, nectars, whey-based beverages, etc. without downstream pasteurization.

Piping

Hygienic design means that the equipment is fashioned so that contamination and soiling do not gain a toehold and/or can easily be washed off if they do. This applies to external surfaces as much as it does to those coming into contact with the product. One should always keep this prudent piece of advice in mind: "The less soiling and other contaminants there are on the outside, the less the probability that they will find their way inside." When installing piping (see fig. 1 for an unhygienic pipe coupling), one should therefore remember the following:

- Piping must be laid in such a way that it can drain;
- if a dead end is unavoidable, then the lowest point of the pipe must be fitted with an opening (threaded fitting with a dummy cap or a butterfly valve);
- redundant dome pipe caps should be avoided if at all possible;
- a pipe cross-section should be selected so that the normal flow rate of the liquid

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Fig. 1 An example of an unhygienic pipe coupling on kegging equipment

Fig. 2 Mistake: a wastewater line permanently connected to a drain

will purge the line of any air (especially important during cleaning and sterilization) under standard operating conditions;

- pipe runs must be as direct and straightforward as possible, i.e. side branches, junctions, forks or diversions must be outfitted with a means for sealing them off (e.g. shut-off valve);
- the valves used to seal them off should be installed at the very beginning of the side branches, so that no dead ends result;
- the layout of the piping should be as straight as possible. Unnecessary bends should be avoided. Downstream from a fork, a pipe diameter should be chosen so that the flow rate remains largely unchanged throughout the piping. This means calculations should be made using the cross-sectional area of a pipe and not its diameter. Such calculations yield "odd" results, such as 2×40 approximates 50 and by no means is equal to 80 (refer to the box);
- pipes routing wastewater to a drain must stop before reaching the drain. Under no circumstances should these pipes be directly connected to the drain. Airtight connections with the drain should especially be avoided (fig. 2); otherwise, microbes from the sewer can "migrate" into the equipment.

Valves with a Controlled Leakage Space

In order to reliably separate two "hostile" media flowing through hard-piped equipment, a valve with a controlled leakage space is very practical and even indispensible. However, though an operator may mean well, mistakes can be made in these situations. Under normal operations, these valves allow a tiny amount of liquid through during switching operations. There is nothing wrong with allowing these liquids to flow towards the drain with a short hose, but please do not install the hose so that the liquid has to flow upwards, against an incline (fig. 3). Otherwise, the liquid that trickles away from the valve during the last switching operation can be pulled back into the valve. Who knows what that liquid has been exposed to since it left the valve in the first place?

In breweries, many are of the opinion that water, sterile air and CO_2 are "always available", but what happens if for whatever reason, beer or yeast enters one of the water, air or CO_2 lines? The lines should be able to be cleaned (fig. 4). Hypothetically, this would best be carried out with a CIP system, but is it practical as well? If the lines are so laid out that they can be cleaned using the CIP system, then why not do so, just to be on the safe side.

Measuring Technology and Threaded Pipe Fittings

Another relevant aspect of hygienic design is the means by which sensors (pressure gauges, thermometers, etc.) are integrated into a system of piping. It is strongly recommended that a simple T-fitting with threaded dairy couplings (DIN 11851) not be used for this purpose. On one hand, the threaded dairy couplings are not completely hygienic, and on the other, the cleaning solution does not flow well through a T-fitting and thus does not sufficiently clean it. In order to achieve the integration of sensors hygienically, two different systems, Variline® and Cleanadapt, have been proven to be quite useful. Both are so good, in fact, that almost every supplier manufactures sensors that fit each system.

As already mentioned, those "good old" dairy fittings (DIN 11851) are not safe from a hygienic standpoint (figure 5 shows an

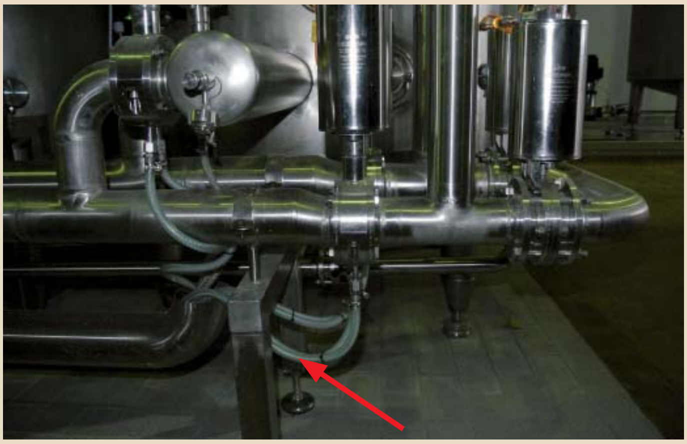

Fig. 3 Leaked liquid is forced to flow upwards

Fig. 4 A CO_2 distribution manifold in the bright beer cellar: no cleaning is possible

example of the internal surface of a cold rolled, expanded dairy fitting. A gap of this kind does not exist with the welded fittings common today). This is primarily because the conical ferrule is not centered and consequently is not flush in the threaded coupling, resulting in a poorly defined compression of the gasket. This can cause the product to seep behind the gasket, where it will never be reached during cleaning and can even lead to corrosion. If existing dairy couplings cannot immediately be replaced with new, hygienic couplings (DIN 11853 or 11864), a less expensive option would be to simply replace the conventional gaskets with hygienic k-Flex gasket inserts. However, their use is restricted to threaded fittings and therefore offers an incomplete solution (e.g. plate heat exchangers, CCTs, blending pumps, etc.), because every time they are opened, the gasket insert falls out of the coupler. Brewers will find little pleasure in working with them.

The area is calculated as follows:

$A = (d/2)^2 * \varpi$

DN40: $A = (38\ mm/2)^2 * \varpi = 1134\ mm^2$ -> $2*A = 2268\ mm^2$

DN50: $A = (50\ mm/2)^2 * \varpi = 1963\ mm^2$

A further disadvantage of these gasket inserts, which also applies to the threaded fittings hygienically designed according to DIN 11853 and 11864, is that there is a defined stop. The gasket cannot compensate for this, thus requiring that the piping is laid out very precisely.

Even with the dairy fittings (DIN 11851) commonly encountered, brewers can produce clean beer, provided that they also routinely clean behind the seals (this takes time and effort) and – very importantly – that they no longer use expanded fittings. Expanded conical ferrules and threaded couplings should be replaced as quickly as possible, but there is one small consolation: The nuts for these old expanded couplings can be kept (and cleaned), since they are identical to DIN 11853 or 11864.

Wort Aeration

Wort aeration is the part of the brewing process that is perhaps the most susceptible to microbial contamination. Sintered metal elements, often called "stones", are still frequently employed for dispersing air very finely throughout the wort. They also offer a perfect hiding place for beer-spoiling microbes. Once they are in the fine porous structure, microbes are almost impossible to eliminate, even through the application of hot caustic and steam.

And for those who remain unconvinced – once again just for good measure – "There's always a first time – even if everything's gone well so far." In any case, the sintered metal aeration stone has thousands of hectoliters of beer "on its conscience". Much safer are wort aeration systems that utilize the Venturi principle to get the job done.

Fig. 5 Threaded dairy coupling: the product seeps into this gap and out of reach of cleaning agents

Conclusion

In summary, common mistakes when cleaning equipment and fittings most often occur with the following:

- Incompatible cleaning parameters;
- insufficient flow rates;
- undefined flow paths and parallel flow;
- air accumulation, dome pipe caps;
- poorly welded seams;
- incorrect installation of components;
- improper components;
- problematic pipe routing;
- unsuitable cleaning agents;
- inappropriate piping and gasket materials.

One way to be on the safe side is to ensure that new parts are EHEDG-approved. EHEDG is an abbreviation for the European Hygienic Engineering and Design Group, an independent organization comprised of representatives from research institutes, equipment manufacturers, experts from the food industry and the relevant government agencies. The EHEDG inspects equipment and fittings for cleanability and issues recommendations regarding hygienic design.

If brewers are careful that no contamination or soiling are present, piping can drain well, outlets are directed downwards at an angle, no puddles are allowed to form, only hygienically designed threaded fittings and nuts are used where they come into contact with the product, and there are no gaps or crevices anywhere, then they can be confident they're on the right track. In any event, turnkey systems should also be inspected with a critical eye, because equipment manufacturers (still) make mistakes, too. ■