

Keg monitoring during cleaning and filling

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Preventive quality assurance is becoming evermore important against a background of more stringent requirements and an increase in individual fills as containers become smaller.

As a rule, problems encountered in daily operation can be divided into 3 categories:

- Problems which cause an immediate stoppage of the plant or of individual production lines: this relates to upsets which could have grave commercial consequential implications, e.g. potential infections from serious upsets in the disinfection process or beers being off-specification;
- Problems which can be remedied during ongoing operation: this accounts for the majority of upsets arising, such as defective kegs, sensors or leaks;
- Chronic problems: this refers mainly to problems as a result of process equipment inadequacies which can be overcome through various deft interventions by operators. Their origin can possibly be determined, the problem is frequently not eliminated.

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A modern keg plant with several lines or rotary machines is complex, with hundreds of valves, pressure switches, temperature sensors and other components. Even the best maintenance and repair cannot prevent malfunctions arising from time to time. The detection of malfunctions or evidencing of optimal process conditions for product quality and hygiene is absolutely essential.

■ Keg hygiene

In principle, the keg is a closed system and thus represents a hygienic unit. This, together with its operative friendliness during distribution, was one of the main arguments in its favour in replacing casks.

But after the keg leaves the brewery, the brewer relinquishes control over the container and its contents. Only when the keg comes back to the brewery is it possible to determine with assurance that it will be handled properly. The time in circulation and the treatment it receives from the person in whose possession it has been up to the point of return is open to speculation. For safety's sake, it should be assumed that the keg is contaminated and possibly very dirty when returned to the brewery. Those breweries which have a high export share face difficult problems because a separation of kegs in accordance with origin cannot be done or would be a big logistic challenge.

Due to the reasons mentioned above, it is advantageous to select a minimal standard for cleaning and disinfection which can in all cases be assured by the plant. On the other hand, it must be ensured that the plant can meet or exceed this standard. Should this not be the case, an alarm has to be given or the plant has to stop.

It is impossible to check every keg as is done in bottle filling. It is only possible to carry out indirect monitoring of plant operations in order to assure optimal cleaning success.

Adequate keg hygiene is achieved when all contaminants, in particular beer spoiling agents, are inactivated, when the residual O₂ quantity in the keg is as low as possible and when recontamination from the plant itself can be excluded. This does not go as far as sterility but most causes of

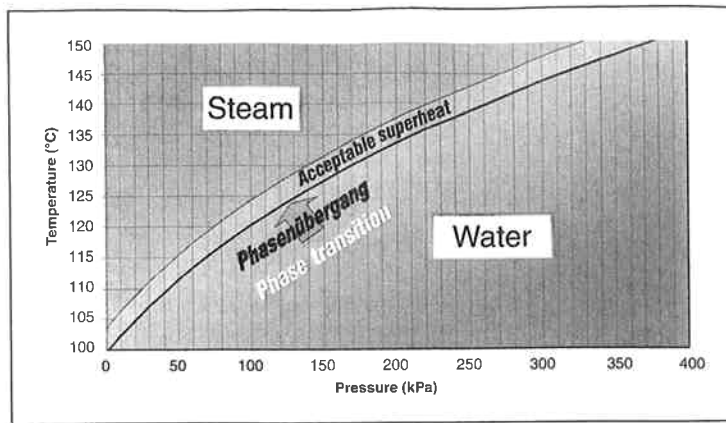


Fig. 1 Steam characteristics for optimal keg disinfection

| Wet heat (saturated steam) | | Dry heat (superheated steam) | |
|----------------------------|---------|------------------------------|--------|
| Temp. (°C) | Time | Temp. (°C) | Time |
| 100 | 20 h | 120 | 8 h |
| 110 | 2 ½ h | 140 | 2 ½ h |
| 115 | 50 min | 160 | 1 h |
| 121 | 15 min | 170 | 40 min |
| 125 | 6 ½ min | 180 | 20 min |
| 130 | 2 ½ min | | |

Table 1 Comparison of disinfection times

changes in taste, haze formation and thus grounds for return can be reduced to a minimum.

The classical test of keg cleaning is by microbiological analysis of the last rinsing water or of the filled keg presupposing that stage control does not yield any positive readings up to the bright beer tank or the filler inlet.

Kegs are usually disinfected with steam; the physical characteristics of which – temperature, contact time, degree of saturation – have an influence on effectiveness. The use of saturated steam which actually condenses during contact time is the only way of achieving an optimal heat transfer to the inner keg wall and the riser pipe.

One of the main functions of the keg plant is to ensure this on all lines simultaneously. Routine checks on the plant and preset parameters using an appropriate system can provide useful results and free up the plant laboratory accordingly. A periodic microbiological test using swabs on cleaned kegs or on filled beer needs to be done then only as back-up.

■ A quick look at steam

The particular thermodynamic characteristics of steam, in particular at phase transition, on evaporation or condensation and the pressure available make it difficult to set the steam condition for optimal keg disinfection. Figure 1 shows the steam condition at suitable temperatures and pres-

ures and possible acceptable deviations from the ideal function.

Table 1 shows disinfection times as a function of temperature and steam condition.

Due to the short treatment times in the individual cleaning steps, it is apparent that assured disinfection is possible only with saturated steam in the temperature/time-based periods as shown.

■ Cleaning

The steam used and cleaning proper are intimately related to each other. Substances which bake on solid during disinfection create corresponding problems in the next cleaning cycle. Investigations have shown that in plants which use steam treatment prior to the first caustic step, temperatures above 55°C lead to baking on of residual dirt which is then very difficult to remove from the inner surface.

Further problems arise during cleaning from cleaning agents which frequently do not reach a temperature of 80°C in the keg. The reason for this is to be found oftentimes in the installation of sensors in the storage vessels. As a result of pipe runs and cooling in the keg, temperatures of only 75°C are oftentimes reached.

Other mistakes such as e.g. deviations from the set point concentration of cleaning agents cannot (yet) be checked with a keg monitor.

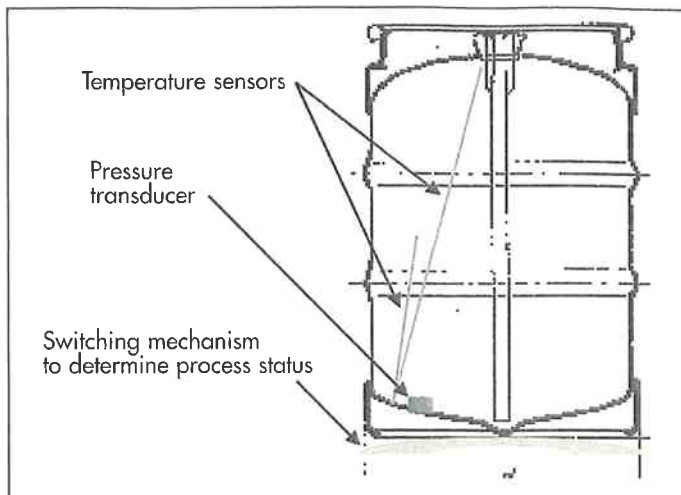


Fig. 2 Schematic of keg monitoring system

■ Filling

The main specifications to be met in filling are described by the terms “foam-free”, “oxygen-free” and “isobarometric”. Nonetheless, similar mistakes can also be made here.

To start with, the steam present after disinfection should be replaced by purging gas at a pressure which, on the one hand, prevents gas coming out of solution from the beer flowing into the keg and, on the other hand, the pre-pressuring level should be as low as possible to minimise losses.

■ In summary

Looked upon as a whole, there are numerous problems which can arise in keg plants. Those listed above are by way of example and are not meant to be exhaustive.

Many faults described could be identified and corrected ahead of time by regular use of a keg monitor so that no complaints arise and cleaning and filling can be optimised. Keg monitoring represents an easy-to-use tool which gives rapid indications of the functional integrity of the plant and does a good job in looking for faults.

■ Test series

In the context of investigations which served to check the performance capability of a keg monitoring system, 16 breweries of various sizes were visited in Germany and the keg plants checked. Plant configurations differed in accordance with the number and the heterogeneous size distribution of plants. A keg monitoring system supplied by Rotech/U.K., represented in Germany by Steinfurth Mess-Systeme GmbH, was used in testing.

None of these breweries previously used keg monitoring systems. Testing of the

functionality of the plants was done as a rule using a test keg. Temperature and pressure readings were taken by an operator who went along with the keg. In rotary designs, even this was not possible, only a microbiological check of the filled beer could be carried out.

■ Description of Rotech system – Mark IV

The system used consists of a standard factory keg which had two temperature sensors (Pt 100 resistance thermometers) and a pressure transducer introduced through the keg bottom into the inside of the keg. A switch contact installed externally on the keg bottom differentiates between connected and non-connected condition. A battery-operated data logger is also installed on the keg bottom which records incoming data at intervals of 0.5 sec. Evaluation is on a PC, data transfer is done using an infrared interface.

Software included in the package provides simple and fast evaluation of critical process steps. Evaluation is done based on three curves which represent the temperature profiles at two different measuring points and the pressure profile. This is supported by dividing the process into steps in which the keg is/is not connected to the cleaning/filling heads.

The programme offers additional options, e.g. selecting set point ranges which have to be maintained in the process. Furthermore, absolute values can be read at every point on the curve. Integration into programmes for factory data collection is envisaged.

■ Summary

Something of value emerged for the breweries in all instances. In the context of the checks, the system used was tested for

reliability and every-day suitability in a rough environment in keg plants, and it passed the test. Filling processes could be optimised, disinfection status documented and improved. Savings potential in the area of energy costs/consumption also emerged.

Keg cleaning

Keg cleaning is characterised generally by extremely short treatment times. Only about 3 – 4 min elapse between residual emptying and filling in some plants. Correspondingly, cleaning agent concentration and temperature have to be at an optimum. It is often forgotten that a small pressure vessel is involved and, for this, cleaning times are extremely short.

Generally, especially the cleaning agents enter the keg at temperatures which are too low. The temperature should be measured preferentially in the cleaning agent return line and this signal should be used with a corresponding controller whereby radiation losses in the cleaning agent supply line and in the keg itself are compensated for. The increased energy expenditure for heating the cleaning agent is a disadvantage but should be accepted.

Carry-over of cleaning agents took place only in few cases. Usually, this related to carry-over of water mix in the first caustic cleaning. Multiple checks of caustic concentration would seem to be called for in as far as no inline control is installed.

Disinfection

Only in two of the keg plants investigated did steam sterilisation take place during which steam actually condensed. In all other instances, superheated steam was used, this did not correlate with the required sterilisation times (see Table 1). In extreme cases, values of even 150°C were achieved. Residue lay-down may not just become a permanent fouling layer due to baking on to the metal surface but, on account of the roughened structure, it offers a better growth possibility for micro-organisms.

Furthermore, one plant had no steam phase at all due to valve failure.

Filling

A frequent mistake made in filling relates to overly excessive pre-pressuring in kegs. At a line pressure of 2 bar, pre-pressuring at 5 bar took place in one case. The pressure dropped accordingly up to the beginning of filling. The increased CO₂ requirements are clearly apparent, up to 50% savings could be achieved here.

The principle of isobarometric filling was also not always assured. Older units in particular which were fitted with various return gas valves were often deficient in this area. A steady pressure drop was observed throughout the whole filling period. Plants having a return gas monitor produced significantly better results though pressure also fluctuated but the fluctuation range was correspondingly narrower.

Fillers operating below saturation pressure were not seen.

Keg monitor

It was easy to identify faults as a consequence of very clear visualisation. By having the set point input in the operating window, conditions outside the ideal process range were recognisable without detailed knowledge of the software.

For complete and conclusive interpretation of measurements, some experience is required, as is a process flow diagram of the plant. Without a detailed process description, evaluation is limited to more or less general statements. Support and analysis of results by experienced personnel is included in the supply package of the system for a specific time period.

Systems offered in Germany from three different suppliers have different configurations. In any event, it should be ensured that flow conditions in the keg are not falsified by changes on the keg or as a consequence of internals.

The number of sensors is essentially the same with all suppliers. It can, however, be said that an increase in the number of sensors does not provide more information.

■ Briefly

Overall, keg plants are checked only in rare cases. Results of investigations show, however, that there is a clear need to act proactively.

The devices on offer are easy to operate. A certain measure of experience is, however, required in order to correctly interpret the measured values, training by the supplier of the data logger seems to be well worthwhile. When properly interpreted, mistakes in cleaning and in filling processes can be identified without fail and corrected by taking corresponding action.

Keg monitoring systems represent a useful addition to plant controls in terms of plant equipment issues and in terms of product safety. ■