

# Practical Keg Cleaning and Racker Performance

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## ABSTRACT

Quality draught beer can only be maintained with proper attention to keg cleanliness. The enclosed nature of the keg has traditionally made it difficult to control the cleaning process. With the help of a monitoring device, it is possible to record exactly what happens inside the keg as it is cleaned, disinfected, and filled. The data provided make it possible to identify common racking problems that might otherwise be overlooked. Armed with this information, the brewer can directly address and quickly solve such problems, thereby controlling the racking process to provide optimal keg cleaning and achieving the goal of shipping beer to the customer in the best possible condition.

**Keywords:** cleaning, disinfection, kegs, performance, racking

## SÍNTESIS

La calidad de cerveza de sifón sólo se puede mantener si se le presta la atención apropiada a la limpieza del keg. El hecho que el keg es un sistema cerrado ha sido tradicionalmente un escollo al control del proceso de limpieza. Existe un dispositivo de monitoreo que permite registrar lo que ocurre dentro del keg mientras se este lavando, desinfectando y llenando. Los datos proveen la posibilidad de identificar problemas comunes que normalmente pasarían desapercibidos. Con esta información en sus manos, el cervecero puede dirigirse directamente a, y rápidamente resolver, dichos problemas, así controlando el proceso de lavado y llenado de los kegs, optimizando el proceso de lavado y así consiguiendo la satisfacción de despachar su cerveza a sus clientes en el mejor estado posible.

**Palabras claves:** limpieza, desinfección, kegs, desempeño, llenado de kegs

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## Introduction

Proper keg cleaning is critical to the racking process and draught beer quality. Thorough cleaning and disinfecting of the kegs during racking is imperative in order to provide the customer with a guarantee that one's draught beer is in optimal condition. Whereas this is a simple premise, in practice, it can be an elusive goal. Keg sanitation is a blind process. Cleaning-in-place sequences similar to tank cleaning are used, utilizing a variety of rinsing and washing techniques (Table 1). A few critical differences make keg cleaning more challenging than tank cleaning; kegs are enclosed systems with neither portal nor sample valve and offer no opportunity for visual inspection or rinse water sampling, and cleaning generally takes place in automated and moving lines.

Situations arise in which the brewery may not be entirely satisfied with the performance of the racker, and yet initial examination of the utilities and racker programming does not indicate problems. The brewer may be unhappy with the speed of the racker and may even encounter occasional microbiological positives in supposedly clean kegs. The steam and carbon dioxide (CO<sub>2</sub>) supply to the racker may seem normal; beer flow, unobstructed; and process times, unaltered; yet the racker performs less efficiently than desired. In such cases, it is time for an in-depth audit of the process.

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## Methods

One method of monitoring racker performance is the classic sight-keg (Fig. 1). Such a keg may be purchased, but just as often it may be manufactured in-house by the brewery. It usually features an analog thermometer and manometer and often has one or two windows built into the side. Such a keg is often bulky and may be off balance or not fit through the racker as would a normal keg. The sight glasses, intended to offer a visual check of wash spray patterns inside the keg, usually fog over immediately and remain that way, or else are covered by running water, and are generally not very useful. Analog thermometers and manometers require that personnel remain in attendance next to the keg and record all the relevant readings by hand as they occur. This is often impossible because of time constraints, since many activities occur rapidly inside the keg during the 60 s the keg sits at any one station on the racker, and because, on most multiple-lane rackers, one would have to crawl inside the machine during operations to read the gauges, a difficult and unsafe practice.

There are, however, a number of manufacturers who offer electronic-monitoring kegs. We have been working with a monitoring keg from Rotech, Ltd. (Swindon, U.K.), that is equipped with PT1000 temperature sensors (Sensing Devices, Ltd., Southport, Merseyside, U.K.), a bridge-style pressure transducer, a clamp detector, and a microprocessor to continuously record the process data (Fig. 2). The ability to continuously record data collected from precision instruments allows a much more accurate and comprehensive analysis than human-observed analog gauges can supply, especially when combined with software to illustrate the details. The nickel metal hydride (NiMH) batteries allow nearly 50 h of operation before needing a recharge. The microprocessor can store 2.5 h of data at a time, and the data download is simple because of an infrared transfer straight from the keg to the computer. The electronics and battery are completely submersible, although it is not rec-

ommended to subject them to brushes or direct water jets inside the keg external washing tunnel.

Sample traces are provided to demonstrate what the monitoring keg is capable of recording. Also, the problems uncovered, as well as corrective actions, are discussed.

### Analysis

The trace in Figure 3 identifies four immediate problems: negative pressure (vacuum) is evident during the steam hold, steam temperature is low, steam is undersaturated, and there is fobbing during the fill.

A vacuum in the keg can pose a significant risk of introducing nonsterile air into the keg if seals are bad. Good seals will generally be able to withstand a vacuum of this slight level, but a damaged seal is more susceptible to leakage from both positive and negative pressures. In this case, the vacuum occurred after the cleaning process was finished and during the disinfecting step of racking, a particularly poor time to test the seals of the keg fleet. The vacuum was caused as the steam inside the keg cooled, and then it collapsed as the internal temperature dropped to 191°F during the steam hold. On a racker with a single steam hold, a side effect of such a vacuum would be increased CO<sub>2</sub> consumption. CO<sub>2</sub> is used to purge the steam from the keg prior to pressurizing, in preparation for the fill. A great amount of CO<sub>2</sub> would be sucked out of the supply line to fill the void caused by the vacuum, and only then would that gas be dispelled. Over the course of the day's racking operation, this would lead to increased gas consumption.

Figure 4 shows that the maximum void temperature reached was 228°F, which dropped to 191°F by the end of the steam hold. There is a steam table embedded in the software that provides a color change to the trace line when saturation conditions are achieved. In this case, the steam was at least 5 degrees below saturation point and was probably mixed with air, which inhibits sidewall condensation. Sterilization and disinfection with steam are a function of time and temperature, as well as humidity or steam saturation (Table 2). The lower the temperature, the longer it takes to achieve disinfection. The closer to the saturation point, the faster the disinfection. Pure, saturated steam, which condenses on keg internal surfaces, is a much more effective media for disinfection than is dry heat. Supersaturated steam behaves as dry heat, that is, it will not condense on the keg walls. An air-steam mix exhibits the same behavior as supersaturated steam. In trying to achieve the performance goal of one keg per minute on the racker, it is beneficial to have the keg reach 266°F, in order to have good disinfection within the allotted 60 s per head (1).

The fourth problem identified was fobbing during the fill (Fig. 5). When beer fobs, the CO<sub>2</sub> in solution is released because of the difference in pressure between the keg and the beer. It is almost impossible to put this CO<sub>2</sub> back into solution, since it leaves the keg as the fill continues. When headspace pressure is adjusted at the end of the fill, some of the CO<sub>2</sub> in

the headspace will go back into solution in the beer. However, the relative proportion of headspace to beer is very small in a keg, and the final carbonation level is liable to be lower than desired. Another problem with fobbing is that the foam-active substances in beer only react once and are lost thereafter. Foam created during the fill means that much less foam when the client



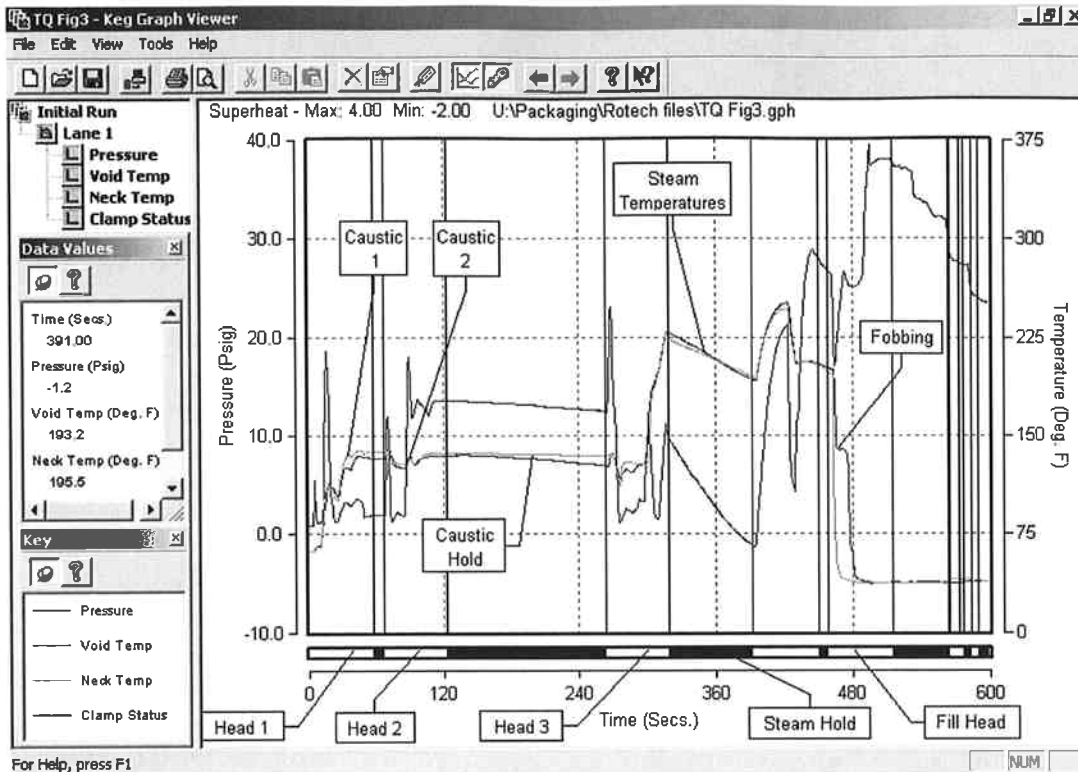
Figure 1. Classic sight-keg.



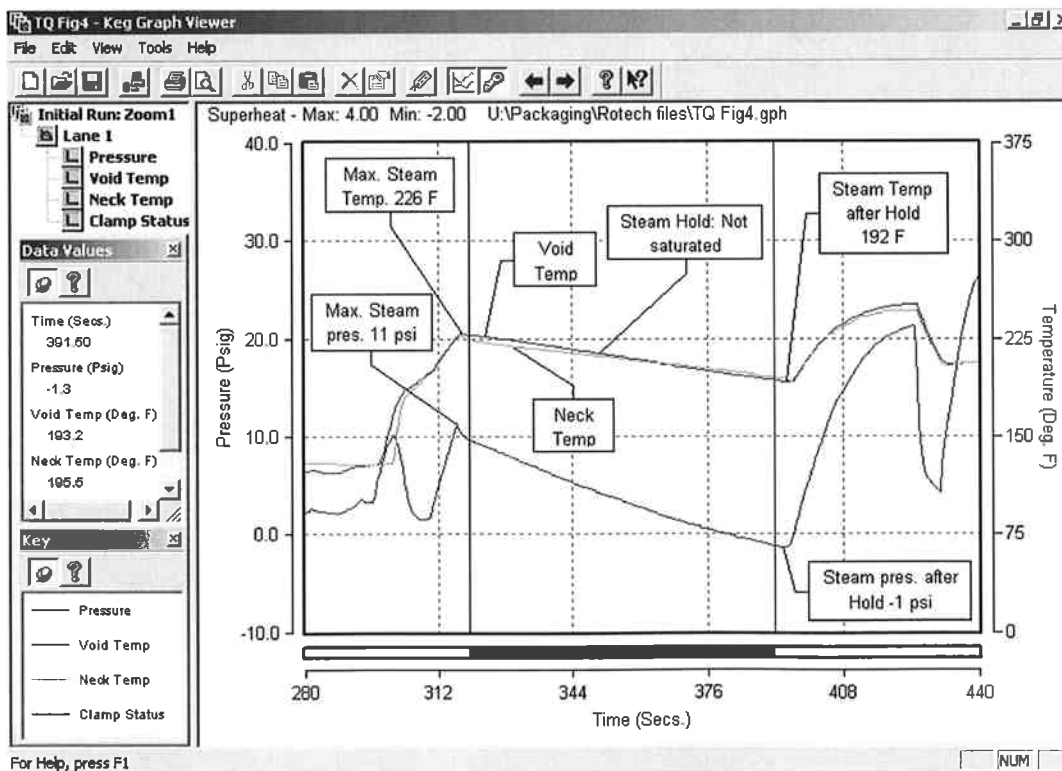
Figure 2. Rotech monitoring keg (Rotech, Ltd., Swindon, U.K.).

Table 1. Typical racking sequence

Head	External cleaning
Head 1	De-ullaging and prewash
Head 2	Caustic wash 1
Head 3	Caustic wash 2
Head 4	Acid wash
Head 5	Rinse and steam
Head 6	Steam hold
Head 7	CO <sub>2</sub> purge, pressurization, and fill



**Figure 3.** Racker trace indicating various problems. The colors for the key are the following: purple = pressure, red = void temp, green = neck temp, and black = clamp status in the bar underneath the graph. At 240 s, the lines are purple, green, and red, from top to bottom. Clamp status: not clamped down.



**Figure 4.** Racker trace of unsaturated, low-temperature steam and vacuum. The colors for the key are the following: purple = pressure, red = void temp, green = neck temp, and black = clamp status in the bar underneath the graph. At 280 s, the lines are green, red, and purple, from top to bottom. Clamp status: keg clamped on steam head 4. The pink (indicating saturated steam) is on the merged red–green lines from approximately 425–430 s.

pours the beer. Even though some people prefer no foam on their beer, it is preferable to control the process and not leave it to the racker. Finally, a racker that fobs beer tends to send more foam to the floor as product loss than does a racker with a quiet, or black, fill. It is easier to adjust the fill volume when there is no foam on the surface of the beer.

### Racker Adjustments and Results

#### Steam

Three of the problems demonstrated are directly associated with steam quality, and since the steam used is evidently not meeting quality standards, one can conclude that disinfection is also inadequate. The trace in Figure 4 shows that the inlet steam pressure (i.e., steam pressure at inlet) is very low, about 10 pounds per square in. (psi), even though the boiler should be able to provide higher pressures. The goal is to achieve saturated steam (indicated by a pink line when looking at the graph on your computer screen) at 266°F for 1 min.

Steam mixed with air is not as effective a disinfectant as pure steam, since the mix will not reach the saturation point and will not condense on the keg inner walls. This condensation, and the resultant release of energy, is what makes steam such an effective disinfectant (2). The first step to correct this problem would be to raise the racker inlet steam pressure to around 30 psi. A steam table shows that saturated steam at this pressure should easily provide the sought-after temperature for disinfecting. The second step would be to adjust the steam purge of air inside the keg, to displace all the air inside the keg and create a pure steam environment. A longer steam purge also preheats the keg; therefore, the steam intended for disin-

fected does not give all its heat and energy to heating the metal. Once the timing is adjusted and the steam pressure is allowed to build inside the keg, a condition of saturated steam at the desired temperature and pressure and for the right amount of time can be achieved (Fig. 6).

Although steam is an excellent method of disinfecting, it does have downsides. Steam must be treated properly; just because steam is used does not mean that it will necessarily do the job. As already mentioned, the steam should be saturated, vacuums need to be avoided, and the steam needs to be monitored to ensure that those conditions are maintained. Another problem that can occur with steam is that, if the wash cycle has been ineffective and dirt remains stuck to the insides of the keg, steam, especially supersaturated steam, can bake the dirt to the sidewall of the keg, and it will remain there through the fill.

Finally, the high temperatures of steam lead to a tendency to damage the seals inside the keg valve assembly. Some brewers

Table 2. Comparative sterilization times<sup>a</sup>

Moist heat (saturated steam)		Dry heat (supersaturated steam)	
Temp. (°C)	Time	Temp. (°C)	Time
100	20 h	120	8 h
110	2.5 h	140	2.5 h
115	50 min	160	1 h
121	15 min	170	40 min
125	6.5 min	180	20 min
130	2.5 min		
135 <sup>b</sup>	1 min <sup>b</sup>		

<sup>a</sup> Data from Sykes (3).

<sup>b</sup> Recommended for destroying beer spoilage microorganisms. Data from Avis et al. (1).

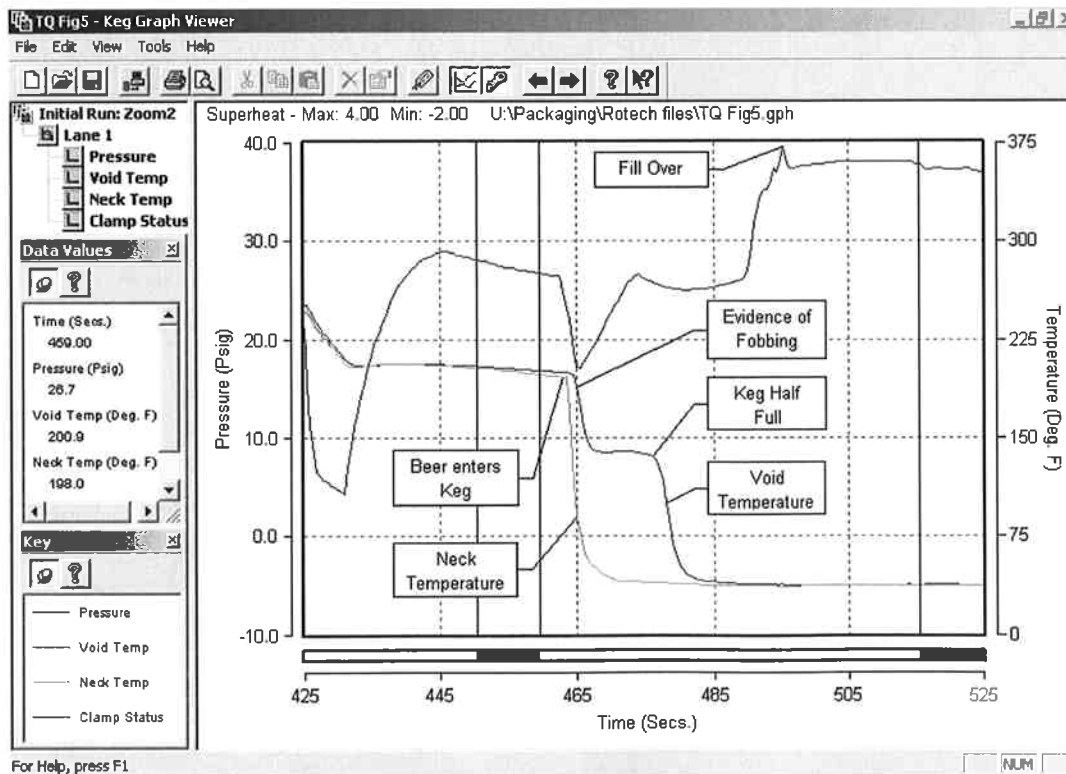


Figure 5. Racker trace demonstrating fobbing. The colors for the key are the following: purple = pressure, red = void temp, green = neck temp, and black = clamp status in the bar underneath the graph. At 465 s, the lines are purple, red, and green, from top to bottom. Clamp status: keg clamped on fill head.