Monitoring the Cleaning, Sterilization and Filling of Kegs

CHRIS NIMPTSCHE
Outline:

1.) Review of keg processing - high pressure steam racker

2.) Keg monitoring

3) Cleaning – emphasis on Saturated steam

4) Cleaning wooden barrels

4.) Filling

5.) Applications for keg monitoring - Case studies
A keg is a sealed, pressurized, black box / autoclave…
1.) External wash
2.) **Internal washing/disinfection**
3.) **Racking**
4.) Capping & Labeling
5.) Palletizing/Handling
Keg handling
External wash

Brush station
Modern Rackers come in many shapes and sizes but they all have the same basic functions and **all are black boxes.**
How do you know all is ok inside your kegs?

Test kegs

1.) Sight Glass
2.) Rotech keg monitor
Black boxes – No more… the Rotech Keg Monitor

KEG CLAMP AND RELEASE DETECTOR
START BUTTON
INFRA-RED DATA SEND/RECEIVE
STATUS LED
ELECTRONIC UNIT AND BATTERY
PRESSURE TAPPING
TEMPERATURE PROBE 'SPEAR'
TEMPERATURE PROBE 'MIDDLE' (HALF-WAY UP KEG)
LEVEL SENSOR AND FLOAT
TEMPERATURE PROBE 'NECK'

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Overview

- Accurate information from inside the keg is essential for quality control; and for fast, efficient, and hygienic operation of the filling line.
- The Rotech keg provides this by converting your standard keg (any size) to electronic.
- This easy-to-use keg collects data; powerful friendly software makes it easy to analyse.
- Rotech provides free backup and analysis for 1 year – based on 15 years experience.
Viewing the results

Typical trace from lane filler

- Purple colour shows saturated steam
- Black and white bands show clamp and release on each head
- Every part of every cycle can be examined in 1/2-second steps
Applications

- **Quality control – Hygiene:**
  - Display clearly shows steam quality
  - Software automatically calculates contact time above any set temperature
  - Pinpoint risks – e.g. negative pressures, detergent carry-over, poor gas purging, etc.

- **Quality control – Gas balance in the beer:**
  - Analyse fill cycle for pressure control, frothing
Applications (continued)

- **HACCP/ISO9002 compliance**
  - Rotech Keg records are precise timed and dated statements of quality

- **Engineering Problem solving**
  - Find any engineering problem very rapidly, e.g. faulty sensors, sticking valves, wrong times
  - Check the effect of adjustments or repairs in minutes
Applications (continued)

Process improvement

- Improve washing and hygiene by attention to pressures, temperatures, times
- Save energy and utilities (air, steam, gas)
- Improve filling – avoid frothing, avoid keg overfilling
- Increase throughput - cut unnecessary delays
### Some Typical Racker Faults/Opportunities

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Event/opportunity</th>
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<tbody>
<tr>
<td>1</td>
<td>Avoid delays - increase throughput, fill more kegs per hour</td>
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<tr>
<td>2</td>
<td>Poor washing (lack of splashing onto keg walls)</td>
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<tr>
<td>3</td>
<td>No trickle-back (spear tube not being washed)</td>
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<tr>
<td>4</td>
<td>Excessive air consumption (purging)</td>
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<tr>
<td>5</td>
<td>Excessive sterile air consumption</td>
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<tr>
<td>6</td>
<td>Liquid carry-over from head to head</td>
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<tr>
<td>7</td>
<td>Lane-to-lane temperature variations</td>
</tr>
<tr>
<td>8</td>
<td>Excessive steam purging/steam consumption</td>
</tr>
<tr>
<td>9</td>
<td>Negative pressure due to excessive steaming (risk of infection)</td>
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<tr>
<td>10</td>
<td>Negative pressure improvement</td>
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<tr>
<td>11</td>
<td>Excessive use of utilities (detergent/rinse water)</td>
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<tr>
<td>12</td>
<td>Air in the keg during steam hold (poor disinfection)</td>
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<tr>
<td>13</td>
<td>Low steam temperatures</td>
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<tr>
<td>14</td>
<td>Short steam disinfection cycle</td>
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<tr>
<td>15</td>
<td>Poor steam quality (steam not saturated)</td>
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<tr>
<td>16</td>
<td>Good &amp; bad steam quality</td>
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<tr>
<td>17</td>
<td>Improvements to GEA-Till steam/gas cycle</td>
</tr>
<tr>
<td>18</td>
<td>Steam quality improvement, assure good disinfection</td>
</tr>
<tr>
<td>19</td>
<td>Unnecessary steam/vent/re-steam cycles</td>
</tr>
<tr>
<td>20</td>
<td>Negative pressure due to external spray (risk of infection)</td>
</tr>
<tr>
<td>21</td>
<td>Poor CO2 purging - air/O2 in the beer</td>
</tr>
<tr>
<td>22</td>
<td>Poor CO2 purge, condensate in beer</td>
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<tr>
<td>23</td>
<td>Excessive CO2 usage</td>
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<tr>
<td>24</td>
<td>Very poor fill (low pressure)</td>
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<tr>
<td>25</td>
<td>Foaming/frothing during filling</td>
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<tr>
<td>26</td>
<td>Loss of gas balance in the beer</td>
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<tr>
<td>27</td>
<td>Poor, or no slow-fast-slow filling profile</td>
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<tr>
<td>28</td>
<td>Improvements to filling times</td>
</tr>
<tr>
<td>29</td>
<td>Over-filling with beer</td>
</tr>
<tr>
<td>30</td>
<td>Lane-to-lane final top pressure variations</td>
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</tbody>
</table>

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An emphasis on Saturated Steam.

Definitions.
Sterilization

Any item is considered to be sterile when it is completely free of all living microorganisms and viruses. The definition is categorical and absolute (i.e., an item is either sterile or it is not). A sterilization procedure is one that kills all microorganisms, including high numbers of bacterial endospores. The procedure is defined as a process, after which the probability of a microorganism surviving on an item subjected to treatment is less than one in one million (10^-6). This is referred to as the “sterility assurance level.”
Disinfection

Disinfection is generally a less lethal process than sterilization. It eliminates nearly all recognized pathogenic microorganisms but not necessarily all microbial forms (e.g., bacterial spores) on inanimate objects. Disinfection does not ensure an “overkill” and therefore lacks the margin of safety achieved by sterilization procedures. The effectiveness of a disinfection procedure is controlled significantly by a number of factors, each one of which may have a pronounced effect on the end result. Among these are: the nature and number of contaminating microorganisms (especially the presence of bacterial spores); the amount of organic matter present (e.g., soil etc).
Disinfection is a procedure that reduces the level of microbial contamination, but there is a broad range of activity that extends from sterility at one extreme to a minimal reduction in the number of microbial contaminants at the other. **By definition, chemical disinfection and in particular, high-level disinfection differs from chemical sterilization by its lack of sporicidal power.** This is an over simplification of the actual situation because a few chemical germicides used as disinfectants do, in fact, kill large numbers of spores even though high concentrations and several hours of exposure may be required. Non-sporicidal disinfectants may differ in their capacity to accomplish disinfection or decontamination.
Low-level Disinfection:

This procedure kills most vegetative bacteria except *M. tuberculosis*, some fungi, and inactivates some viruses. The EPA approves chemical germicides used in this procedure in the US as “hospital disinfectants” or “sanitizers.”
Brewing Specific Research
## Comparative Sterilization Times

<table>
<thead>
<tr>
<th>MOIST HEAT</th>
<th>DRY HEAT</th>
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<tbody>
<tr>
<td>(Saturated steam)</td>
<td>(Superheated steam)</td>
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<table>
<thead>
<tr>
<th>Temp. °C/°F</th>
<th>Time</th>
<th>Temp. °C/°F</th>
<th>Time</th>
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<tbody>
<tr>
<td>100 / 212</td>
<td>20 hours</td>
<td>120 / 257</td>
<td>8 hours</td>
</tr>
<tr>
<td>110 / 230</td>
<td>2½ hours</td>
<td>140 / 284</td>
<td>2½ hours</td>
</tr>
<tr>
<td>115 / 239</td>
<td>50 minutes</td>
<td>160 / 320</td>
<td>1 hour</td>
</tr>
<tr>
<td>120 / 248</td>
<td>15 minutes</td>
<td>170 / 338</td>
<td>40 minutes</td>
</tr>
<tr>
<td>125 / 257</td>
<td>6½ minutes</td>
<td>180 / 356</td>
<td>20 minutes</td>
</tr>
<tr>
<td>130 / 266</td>
<td>2½ minutes</td>
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**Recommended Procedure for Destroying All Beer-Spoilage Organisms:** Avis & Smith at Burton Brewery UK

135 / 275 1 minute @ approx maximum 40 PSI
Great Disinfection

Graph showing the results of steam sterilization with key data points:
- **Pressure**
  - Max: 27.9
  - Min: 12.1
- **Neck Temp.**
  - Max: 270.6
  - Min: 186.3
- **Middle Temp.**
  - Max: 270.2
  - Min: 163.6
- **Top Temp.**
  - Max: 270.6
  - Min: 169.1
- **Contents**
  - Max: 0.15
  - Min: 0.00

Key events:
- **Start steam purge**
- **End steam purge after 7 seconds**
- **80 second steam hold at close to ideal temperatures**
Disinfection that keeps you awake

[Graph showing temperature and pressure changes over time with labels for Max Temp. 107°C, Non-saturated Air/Steam Mix, Low Steam Pressure, and Short Air Purge.]
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Micro testing – time consuming
Wooden Barrels:

“The only way to sanitize a wooden barrel is with gasoline and a match”

Dr. MJ Lewis, 1982 UCD brewing lecture
Why Barrels Harbor Microbes

Rough surfaces are easy to attach to and are protective. Porous nature gives additional shelter and nutrient source (wood, sugars, product).
Good Fill

Superheat - Max: 6.00 Min: -2.00

Pressure A
Max: 34.8 Min: 6.6

Neck Temp. A
Max: 273.7 Min: 38.0

Middle Temp. A
Max: 275.2 Min: 40.3

Vent steam at 255.0, both temps. fall

CO2 on at 258.0, temps. continue to fall

Close drain at 265.5
Fill with Problems
Continuous Volume Measurement

Volume Rate
Max: 13 gals. (49.8 liters)
Min: -21.68 gals.

Stop at 13.16 US gals. (49.8 liters)

Transition to fast fill

1.3 gals. of detergent
3.3 gals. of rinse water
1.0 gals. first wash

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Example of accelerated fill

L8 'Before' Beer on at 303.0
L8 'After' Beer on at 304.0
L8 'Before' Transition at 311.5
L8 'After' Transition at 310.5
L8 Fills finished at 334.0
Illustration of possible Sterile Air over-purging (Head 2)

Keg empty at 225.5

Air off at 229.5
Quick Comparison of Multiple Lanes

Lane 7, pressure anomaly

Final Top Pressures
Applications for the *Rotech Keg Monitor*:

1.) Monitoring of racker;
2.) Finding faults;
3.) Commissioning of rackers
4.) Audits.
Case Studies:

1.) Sierra Nevada Consulting:

Finding an anomaly.
Engineering checks - Illustration of anomalies
Engineering checks - Illustration of anomalies
Case Studies:

2.) Victory Brewing

Commissioning a new keg line.
Case Studies:

3.) Ballast Point
Commissioning a new keg line.
Before:
After:

- Keg empty @ 166.5 sec
- Much higher steam hold temperatures @ 250 - 253 deg F
- Keg valve closed and steam purge ends @ 173 sec
- Steam dwell time = 45 seconds
Case Studies:

4.) Russian River
Commissioning a new keg line.
Before:
Acknowledgements

• Justin Walshe, Rotech (Swindon) Ltd.
• Filip Beyens, Lambrechts
• Henning Schlabach, Schaefer Kegs
• Brewers Association
• Sierra Nevada, Victory, Ballast Point, Russian River, Karl Ockert, Steven Pauwels and Kathleen Lawson
Thank you!

Egyptian Proverb -
Do not cease to drink beer, to eat, to intoxicate thyself, to make love, and to celebrate the good days.