Monitoring the Cleaning, Sterilization and Filling of Kegs

CHRIS NIMPTSCCH

PROFAMO INC.
Analytical Instrumentation
Outline:

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

2.) Keg monitoring

3.) Cleaning – emphasis on saturated steam

4.) Cleaning wooden barrels

5.) Filling

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

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External wash
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

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

### MOIST HEAT
(Saturated steam)

<table>
<thead>
<tr>
<th>Temp. °C/°F</th>
<th>Time</th>
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<tbody>
<tr>
<td>100 / 212</td>
<td>20 hours</td>
</tr>
<tr>
<td>110 / 230</td>
<td>2½ hours</td>
</tr>
<tr>
<td>115 / 239</td>
<td>50 minutes</td>
</tr>
<tr>
<td>120 / 248</td>
<td>15 minutes</td>
</tr>
<tr>
<td>125 / 257</td>
<td>6½ minutes</td>
</tr>
<tr>
<td>130 / 266</td>
<td>2½ minutes</td>
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</tbody>
</table>

### DRY HEAT
(Superheated steam)

<table>
<thead>
<tr>
<th>Temp. °C/°F</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>120 / 257</td>
<td>8 hours</td>
</tr>
<tr>
<td>140 / 284</td>
<td>2½ hours</td>
</tr>
<tr>
<td>160 / 320</td>
<td>1 hour</td>
</tr>
<tr>
<td>170 / 338</td>
<td>40 minutes</td>
</tr>
<tr>
<td>180 / 356</td>
<td>20 minutes</td>
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</tbody>
</table>

**Recommended Procedure for Destroying All Beer-Spoilage Organisms:** Avis & Smith at Burton Brewery UK

135 / 275     1 minute @ approx maximum 40 PSI
Great Disinfection
Disinfection that keeps you awake

Superheat - Max: 6.00 Min: -2.00

Pressure B
- Max: 33.7 Min: 4.1
- Neck Temp. B
  - Max: 236.4 Min: 37.6
- Middle Temp. B
  - Max: 249.2 Min: 41.0

Problem - air in the keg
(Temperatures low and separated)

1. Start steam purge at 155.0
2. Keg empty at 157.5 (start clearing air)
3. Close rinse recovery at 159.0 - too soon

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Micro testing – time consuming
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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

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

Rapid pressure loss and severe foaming as soon as beer flow starts

Poor CO2 purge - keg filled with CO2 and steam

Keg half-full

Keg full (brim-fill spike?)

Pressure
Continuous Volume Measurement

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

Transition to 'fast fill' was at 292.5

Beer on at 283.0

Transition advanced by 2.5 seconds

Full - Original cycle $t = 309.0$

Full - Modified cycle $t = 306.0$
Cost Savings - Illustration of possible Sterile Air over-purging

Keg empty at 225.5

Air off at 229.5
Before and After
Simultaneous utility cost saving and process improvement – ‘Before and After’ example
(reduced air/sterile air consumption, less pooling during wash/rinse)
Quick Comparison of Multiple Lanes

Lane 7, pressure anomaly

Final Top Pressures
Applications for the *Rotech Keg Monitor*

1.) Routine Quality monitoring of racker
2.) Finding faults, verifying fixes
3.) Identifying opportunities for improvement
4.) Commissioning of rackers
5.) 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.
Caustic soak temp too low

Great steam!

Beer line pressure too high
Case Studies:

3.) Ballast Point

Commissioning a new keg line.
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:
Test

• Review four graphs
• Analysis
Acknowledgements

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Thank you! Questions?

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