Two Years Experience in Pasteurizer Water Treatment in a Brazilian Brewery

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ABSTRACT

This paper describes the water treatment program for the pasteurizers at a Brazilian brewery over a two-year period.

The water treatment and monitoring program kept corrosion under control and effectively eliminated biological growth in the pasteurizers. As a result, the frequency of pasteurizer wash-cuts was extended from once per week to once every 60 days. In addition, corrosion damage to basins and associated equipment was greatly reduced.

This treatment program ultimately resulted in increased equipment life and pasteurizer efficiency as well as a dramatic improvement in the work environment and worker safety.

Keywords: pasteurizer, biocide, corrosion, efficiency, safety

SINTÉSIS

Este documento describe el programa de tratamiento de agua para los pasteurizadores en una cervecería brasileña sobre un periodo de dos años.

El programa de tratamiento de agua y monitoreo mantuvo la cor­rosión bajo control y eliminó efectivamente el crecimiento biológico en los pasteurizadores. Como resultado, la frecuencia del lavado de pasteurizadores fue extendida de una vez por semana a una vez cada 60 días. Además el daño por corrosión a las palanganas y equipo asociado se redujo grandemente.

Este programa de tratamiento ultimadamente resultó en un incremento de la vida del equipo y la eficacia del pasteurizador así como una mejora dramática en el ambiente de trabajo y en la seguridad del trabajador.

HISTORICAL BACKGROUND

Founded on March 11, 1983, Indústria de Bebidas Antarctica do Piauí is based in Teresina, capital of Piauí State (Northeastern Brazil). The plant has two bottling lines.

Always striving for continued improvement, Cervejaria Antarctica do Piauí is one of the most modern breweries in the Antarctica Group.

Always strict about the maintenance of their equipment, this brewery decided to implement FoodPro* Technology in all of its pasteurizers.

Until July 1994, weekly washing of pasteurizer basins and structures was required, in view of the significant microbiological growth in the pre-heating and cooling areas. This resulted in a strong odor as a result of organic matter decomposition and clogging of sprays, all of which reduced pasteurization efficiency.

The previous treatment consisted of weekly washings with caustic soda recirculation to remove the organic matter. During the week, caustic soda was added manually to maintain the pH above 10, in an attempt to diminish acid corrosion caused by beer bottle breakage.
SYSTEMS CHARACTERISTICS

Line 1

Equipment: Pasteurizer
Manufacturer: Holstein-Kappert
Type: Ip 45/220
Filters: Basket Type
Metallurgy: Mild Steel/Stainless Steel

Line 2

Equipment: Pasteurizer
Manufacturer: Holstein-Kappert
Type: Pii 60/290
Filters: Basket Type
Metallurgy: Mild Steel/Stainless Steel

OPERATION PRINCIPLE

These pasteurizers are composed of 4 to 5 interconnected water tanks, 8 to 10 sections of which require treatment.

Over these sections, there are grids through which the beer bottles are transported by means of parallel moving and fixed bars. Along their course, the bottles are subject to a temperature profile controlled by a spray system. Depending on the quality of the make-up water used, various degrees of corrosion, scaling and microbiological problems occur that are aggravated by the high temperatures existing in the pasteurization area and by the nutrients coming from beer bottle breakage.

Water Stability Indices

The indices below define the corrosive/scaling potential of the water in relation to calcium carbonate and metallic iron.

A) Langelier (LSI) = -0.06
B) Ryznar (RSI) = 8.42
C) Puckorius (PSI) = 9.25
D) Corrosion Index (Pitting) = 0.57
E) Aggressivity Index = 11

Interpretation: A moderately aggressive water with a tendency toward pitting corrosion.

PHOTOGRAphIC RECORD OF TEST COUPONS DURING THE PERIOD WITHOUT TREATMENT

FIGURE 1
Site: Pre-heating area (35°C)
Exposure time: 35 days, Corrosion rate = 30.35 mpy,
Deposition rate = 6.65 mpy

FIGURE 2
Site: Pasteurization area (65°C)
Exposure time: 35 days, Corrosion rate = 33.49 mpy,
Deposition rate = 8.93 mpy

FIGURE 3
Site: Cooling area (28°C)
Exposure time: 35 days, Corrosion rate = 28.85 mpy,
Deposition rate = 7.65 mpy

PASTEURIZER INSPECTION

During shutdowns, significant microbiological growth was observed, as slime in the entire basin area, along with a large amount of iron oxide as a result of corrosion.

Pasteurizer water contamination from beer bottle breakage is a source of nutrients that enable microorganisms to rapidly reproduce. The highest growth was in the cold areas where temperatures are in the 34 to 40°C range, ideal for microbiological growth.
Microscopic examination showed that the major microorganisms were:

<table>
<thead>
<tr>
<th>Aerobic Bacteria</th>
<th>Anaerobic Bacteria</th>
<th>Fungi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudomonas</td>
<td>Sulphate Reducers</td>
<td>Yeast</td>
</tr>
<tr>
<td>Flavo bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serratia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entero bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escherichia Coli</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As a consequence of the considerable amount of microbiological slime formed, sprays and filters become clogged, bad odor and environmental pollution develop, and under-deposit corrosion occurs. Due to the low level of oxygen under these deposits, the sulphate reducing bacteria produce hydrogen sulphide, which is extremely corrosive. This results in a low pH and the generation of ferrous sulphide, which is cathodic in relation to the pasteurizer construction materials:

\[
10H + SO_4 + 4Fe \rightarrow H_2S + 4Fe + 4H_2O \\
H_2S + Fe \rightarrow FeS + 2H
\]

**PHOTOGRAPHIC RECORD OF MICROBIOLOGICAL GROWTH WITHOUT TREATMENT**

![Photograph](image)

**FIGURE 4**
Microbiological growth in the recirculation pumps' filters.
Time: 35 days.

**FIGURE 5**
Microbiological growth in the cold area, with the sacrificial anode made totally inactive by microbiological growth.
Time: 35 days.

**CHEMICAL TREATMENT PLAN**

In view of the problems identified above, the selection and application of a chemical treatment program must meet the following requirements:

- Thermally stable
- Efficient over a wide pH range
- Does not attack bottle cap lithography
- Compatible with stainless steel, mild steel and copper alloys
- Non-oxidizing
- No sensorial effect
- Low level of toxicity
- Low environmental impact

The above requirements, coupled with a strict control and monitoring program of chemicals addition, were key factors in achieving results that ensured continuous operation for at least 30 days without cleaning.

The treatment program was comprised of corrosion inhibitors, biocides, pH control, a chemical feed system, measurement of deposition, corrosion and microbiological growth control and inspection reports.

**Microbiological Control**

The first order of business was to address microbiological growth, for which a rapid analysis of the existing amount of microorganisms was required, in order to select the appropriate amount of biocide. The traditional method requires at least two days for incubation, which was too long a time to wait, since we needed immediate information. The use of a Bioscan® meter made prompt measurement of the system's microbiological activity possible. Through measurement of a variable called ATP (adenosine triphosphate), a substance found in all living cells, Bioscan can provide instant information. The ATP reaction with a specific enzyme compound, produces light, which is measured in URL and indicates the amount of microbiological activity of a given sample.

**Without Treatment**

<table>
<thead>
<tr>
<th>Readings</th>
<th>1st Week</th>
<th>2nd Week</th>
<th>3rd Week</th>
<th>4th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 01</td>
<td>2000 URL</td>
<td>2100 URL</td>
<td>2500 URL</td>
<td>4500 URL</td>
</tr>
<tr>
<td>Area 06</td>
<td>3900 URL</td>
<td>3500 URL</td>
<td>6000 URL</td>
<td>12000 URL</td>
</tr>
</tbody>
</table>

**With Treatment**

<table>
<thead>
<tr>
<th>Readings</th>
<th>1st Week</th>
<th>2nd Week</th>
<th>3rd Week</th>
<th>4th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 01</td>
<td>200 URL</td>
<td>180 URL</td>
<td>80 URL</td>
<td>180 URL</td>
</tr>
<tr>
<td>Area 06</td>
<td>380 URL</td>
<td>280 URL</td>
<td>180 URL</td>
<td>340 URL</td>
</tr>
</tbody>
</table>

We could then conclude that in this particular pasteurizer, we would be able to maintain readings below 200 URL, without microbiological growth.

Bioscan control of biocide injection into the pasteurizer cold chambers assured that there was no loss of chemicals, the continuous feeding being interrupted whenever readings were lower than 100 URL.

It was also observed that the continuous use of biocide provided a more aseptic environment in the cold chambers.
PHOTOGRAPHIC RECORD OF THE RESULTS OBTAINED IN MICROBIOLOGICAL CONTROL AFTER 83 DAYS OF CONTINUOUS OPERATION

FIGURE 6
Analysis of the amount of microorganisms during Bioscan treatment.

FIGURE 7
Recirculation pump filters after 83 days of continuous use.

FIGURE 8
Aspect of cold chamber and sacrificial anode after 83 days of continuous use.

FIGURE 9
Pasteurizer – Antarctica Brewery
CORROSION CONTROL

pH Control
The corrosive nature of the feed water and lowering of pH caused by bottle breakage required the addition of soda, through pH controllers, to keep the pH within a neutral range.

Manual addition of soda made treatment unfeasible because, when added to the basin, a level of concentration was developed that deactivated the corrosion inhibitor and increased the scaling potential.

Inhibitor Feeding
Using chemical feed pumps, with the residual controlled through laboratory analyses, we achieved optimum results with a minimum amount of treatment chemical.

Feeding System
Chemical feed from container systems was another important measure that provided the following benefits:

1. Cleanliness of the area round the pasteurizer
2. Continuous product feed
3. Elimination of chemical treatment
4. Less exposure of workers to chemicals
5. Expeditious supply

Currently, the chemicals for both lines are supplied in containers, 300 meters from Line 1 and 150 meters for Lines 1 and 2. This system permits safe and practical operation.

CORROSION AND DEPOSITION RATES AFTER TREATMENT

With the elimination of microbiological growth, maintenance of pH in the neutral range and addition of a corrosion inhibitor, the following results were obtained:

- Up to 83 days without cleaning
- After 83 days there was a shutdown to remove bottles, after which the pasteurizer was again closed with no need for cleaning to remove microbiological slimes or iron deposits because the pasteurizer was totally clean.
- 90% reduction in deposition and corrosion rates

RESULTS ACHIEVED

- Washings at 60-day intervals, instead of weekly
- Protection of metal components of pasteurizer
- Increased availability of equipment for production
- Asepsis
- Elimination of bad odor in the area

FIGURES 10 - 11 - 12
PHOTOGRAPHIC RECORD OF TEST COUPONS DURING THE TREATMENT PERIOD

FIGURE 10
Site: Pre-heating area (35°C)
Exposure time: 83 days, Corrosion rate = 2.95 mpy, Deposition rate = 0.85 mpy

FIGURE 11
Site: Pasteurization area (65°C)
Exposure time: 83 days, Corrosion rate = 3.05 mpy, Deposition rate = 0.95 mpy

FIGURE 12
Site: Cooling area (28°C)
Exposure time: 83 days, Corrosion rate = 2.49 mpy, Deposition rate = 0.35 mpy