Legionella pneumophila in cooling towers and evaporative condensers

MARIA JOÃO ALVES 78570

Instituto Superior Técnico, Industrial Safety and Health
Introduction

→ Legionella is a public and an occupational health issue

→ The World Health Organization (WHO) provides guidance on Legionella risk assessment and management in three principal documents:
  - Guidelines for Drinking-water Quality (WHO, 2004)

→ In most European countries, risks from Legionella are covered by laws, decrees based on Directive 2000/54/EC
Legionella pneumophila

→ Gram- negative;
→ Coccobacillus;
→ Multiple strategies to adapt to stressful environment conditions;

Sources:
→ Cooling towers and evaporative condensers
→ Health – care facilities
→ Hotels and ships
→ Natural spas, hot tubs and swimming pools

Conditions:
T < 20 °C → no proliferation
T: 20 - 45 °C → growth
T > 60 °C → Can’t survive

Fig 1: Legionella pneumophila
**Legionella in Portugal: Outbreak in 2014**

---

**Fig 3:** Outbreak of *Legionella* in 2014 in a factory in Vila Franca de Xira

- **Duration**: 12 October - 4 December
- **Source**: cooling tower of a fertilizer company (ADP fertilizantes)
- **Cases**: 375
- **Deaths**: 12
Evaporative Cooling: Cooling Towers and Evaporative Condensers

Fig 4: Configuration of a typical cooling tower

Fig 5: Configuration of a typical evaporative condenser

→ In the system water is stored or re-circulated;
→ Water temperature between 20–45 °C;
→ There are deposits that can support bacterial growth;
→ Production of water droplets;

Right environmental conditions for *Legionella* growth and spread

Develop a strategy to minimize the risks of *Legionella* proliferation
How to minimize the risks of *Legionella* proliferation in cooling towers and evaporative condensers?

**Health – Based Targets**

**Public health context and health outcome**

**Water Safety Plans**

- System Assessment
- Monitoring
- Management and Communication

**Surveillance**

*Fig 6: Legionella pneumophila*
2. Water Safety Plans

→ Comprehensive risk assessment and risk management approach that encompasses all steps in water supply.

Benefits:

• Systematic and detailed assessment and prioritization of hazards;
• The operational monitoring of barriers and control measures;
2.1 System Assessment

→ Develop and implement effective strategies for controlling hazards

Assemble the team
Document and describe the system
Assess hazards and prioritize risks
Assess the system

Example:

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Water Source</th>
<th>Heat Exchanger</th>
<th>Distribution</th>
<th>Cooling Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess hazards and prioritize risks</td>
<td>High level of nutrients and microbial load</td>
<td>High temperature and level of nutrients in biofilm</td>
<td>Stagnant water in dead legs in the pipework</td>
<td>Excessive drift loss from the tower exhaust</td>
</tr>
</tbody>
</table>

Fig 7: Example of a deadleg in piping
2.2 Monitoring

→ Identification and monitoring of control measures used to ensure water safety

- Identify control measures
- Monitor control measures
- Validate effectiveness of WSP

Fig 8: Total colony count of *Legionella*
Control measures for Legionella

- Control *Legionella* and other microbial activity, corrosion, scale formation and fouling, and include appropriate measures, such as regular physical cleaning and disinfection, to maintain the system’s cleanliness.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature Control</strong></td>
<td>T at the upper or lower limits of the <em>Legionella</em> multiplication range</td>
</tr>
<tr>
<td><strong>Microbial Control</strong></td>
<td>Biocides: oxidizing (chlorine; bromine) and non-oxidizing</td>
</tr>
<tr>
<td><strong>Corrosion Control</strong></td>
<td>Corrosion inhibitors</td>
</tr>
<tr>
<td><strong>Scale Control</strong></td>
<td>Scale inhibitors</td>
</tr>
<tr>
<td><strong>Fouling Control</strong></td>
<td>Dispersant chemicals; filtration</td>
</tr>
<tr>
<td><strong>Pre-treatment</strong></td>
<td>Filtration; Clarification; Biocides; Reverse osmosis; Water softening</td>
</tr>
<tr>
<td><strong>Drift Control</strong></td>
<td>Use drift eliminators</td>
</tr>
</tbody>
</table>

**Fig 9:** Example of a drift eliminator
2.3 Management and Communication

→ To document the system assessment and monitoring, and describe actions to be taken during normal operation and after incidents, including documentation and communication.

Fig 10: Cooling Towers
Conclusions

→ Well design process and strict control measures are very effective controlling *Legionella* in cooling towers and evaporative condensers;

→ Nowadays some outbreaks result from lack of maintenance;

→ The development of new techniques and the discovery of new information will reduce the probability of outbreaks occur;
References

• Legionnaires’ disease: Technical guidance. Health and Safety Executive.