Legionella and Solar Water Heaters

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TC 312 - Thermal Solar Systems and Components -
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  – Involvement of TC312 and current situation

• Legionella and solar hot water systems
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  – How does Legionella dynamically behaves in solar systems

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  – How to control the risk of Legionella hazard
Introduction

• CEN TC 164 WG2: Technical report 16355
  “Recommendations for prevention of Legionella growth in installations inside buildings conveying water for human consumption”
  – Recommendations on hot water installations
  – Not explicit for solar hot water systems
  • Need for explicit rules for solar hot water systems

• TC 312 drafted a Code of practice
  – Focus on solar hot water systems
  – Building on the CEN TR 16355
  – TC 312 approved for a work item to make it a CEN TR
Introduction

• Project started in 2011/2012
  – Project team:
    • John Lee (UK)  Legionella ecology and control
    • Jean-Marc Sutter (CH)  Solar hot water systems & standardization
    • G. van Amerongen (NL)  Solar hot water systems & liaison TC164
    • Reporting and discussions within TC312

• Work done:
  – Background report (Legionella and solar water heaters)
    • Literature study
    • Mathematical study
  – Drafting of Code of Practice (Minimizing the risk of Legionella ...)

TC164/WG2 2013 Bonn
Legionella and solar water heaters

- Origin outbreaks Legionella < 10% from hot or cold water installations
  - or 20% of known cases
- Can originates from all parts of such installations
  - Piping, valves, devices, ...
    - also from solar thermal devices
  - No statistical data available on solar share in this
    - probably due to small penetration grade
- Legionella is to be taken serious in hot water installations
Reports on incidences in solar systems

- Three known outbreaks:
  - Brazil: cause unspecified
  - Antiqua: indirect relation
  - Turkey: mismanagement

- Reported incidences:
  - Athens: Legionella in 10% SHW and 69% oil fired systems
  - Germany: 4.2% of solar and 13% of others
  - Denmark: 0% of solar and 21% of others

- Legionella also in solar, but not more often than others
Legionella and solar thermal
- Dynamic process of stability, growth and dying -
Mathematical simulations

• Simulation by model calculation of development of Legionella

• Assumptions on the solar hot water system:
  – Typical solar system layouts
  – Different collector orientations and tilts, climate zones and heat demands
  – Hourly calculations for two successive years

• Assumptions on the Legionella development
  – 98% of Legionellae is on the tank surface
  – A defined maximum allowed concentration in the water
  – Assumed relation temperature and concentration development
Building categories and risk levels

• For interpretation of mathematical study
  – Categories based on SIA 3851/1 (CH)
  – Low risk (concentration < 5x10^5 cfu/l)
    • Housing units, restaurants, stores, ...
  – Medium risk (concentration < 5x10^3 cfu/l)
    • Residential buildings, schools, sports, ...
  – High risk (out of the scope of the report)
    • Hospitals, housing for elderly, ...
    • Out of scope: special Legionella management required
Results
- examples of results -

Stockholm, Sweden

Evora, Portugal

Introduction Literature study Mathematical study Code of practice TC164/WG2 2013 Bonn
Results / conclusions

- Legionellae growths and dies in a solar thermal system
  - Concentrations of Legionella depend on many factors:
    - systems design, climatic region and the operation of the system
  - Lessons can be learned to maintain a low risks
    - On system design in combination with type of application
    - and the TC164 wg2 TR16355
  - The lessons learned are used to draft the Code of Practice
Lessons learned

- Vulnerable situations
  - Solar collection without heat withdrawal (winter months!)
  - Only workday or weekend use
  - Over dimensioned tank volume related to design load
  - Sub-optimal collector orientation
    - Especially vertical mounted collector southern Europe
  - High ration $V_{sto}/A_{col}$

- Solar only systems:
  - More vulnerable due to lack of auxiliary heater
  - Less vulnerable due to higher throughput of tank
Applicable materials for containers of potable water
– E.g.: stainless steel, copper, enameled steel

Design of these containers
– E.g.: hygienic conditions

Controllers
– E.g.: tank temperature < 80 °C

Documentation
– E.g.: safeguards against improper use
Code of practice
- Design recommendations -

- 4 system layouts of solar and auxiliary
- Each a set of recommendations
Installation layout
- storage / storage -

- Risk evaluation:
  - Potential growth solar tank
  - Potential growth auxiliary tank

- Recommendations:
  - Auxiliary: > 55 °C whole day or >60 °C one hour (TR16355)
  - Solar device options (‘or’):
    - Design rules (dimensioning of components)
      - Aimed at $V_{sto} / A_{col}$
    - Thermal disinfection: 60°C/20m, 65°C/10m, 70°C/5m (TR16355)
      - Medium/low risk: weekly
      - High risk: daily
Installation layout
- storage / instantaneous -

- **Risk evaluation:**
  - Low risk of growth solar tank
  - Potential growth auxiliary tank

- **Recommendations:**
  - Auxiliary: > 55 °C whole day or >60 °C one hour (TR16355)
  - None for solar device
Installation layout
- instantaneous / instantaneous

• Risk evaluation:
  – Low risk of growth solar tank
  – Low risk of growth auxiliary tank

• Recommendations:
  – None
Installation layout
- instantaneous/ storage

• Risk evaluation:
  – Potential risk of growth solar tank
  – No disinfection in auxiliary tank

• Recommendations:
  – Solar device options (low risk):
    • Design rules (dimensioning of components), or
      – Aimed at $V_{sto} / A_{col}$
    • Thermal disinfection: 60°C/20m, 65°C/10m, 70°C/5m (TR16355)
      – Medium/low risk: weekly  High risk: daily
  • Solar device options (medium and high risk):
    – Above and Legionella safe design + sampling + maintenance manual
Conclusions

- Code of Practice is a valuable addition to the TR16355
  - Solar thermal systems are now more explicit
  - Guide to maintain the Legionella risk within acceptable ranges
    - Design and operation
- Legionella shows a dynamic development within a solar system
  - Stable population and growth and dying
  - Typical systems and operation show an intrinsic safeguard against Legionella hazards
    - However, bad design and operation conditions may prove harmful
- No indications reported of ‘above average’ risks related to solar thermal
recommendations

- Upgrade Code of Practice to a more formal status
  - CEN technical report (CEN approved)
  - Preferably with support from TC164 WG2
    - Common workgroup?
- More field studies
  - Hot water installations with renewable energy sources
  - Further research to determine more accurately the frequency of thermal disinfection (at 60 °C)
- Further mathematical studies
  - More system types and thermal stratification in tank