vA Consult

Legionella and Solar Water Heaters

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TC 312 - Thermal Solar Systems and Components -

Contents

- Introduction
  - Involvement of TC312 and current situation
- Legionella and solar hot water systems
  - Results from literature study
- Mathematical study
  - How does Legionella dynamically behaves in solar systems
- Code of practice
  - 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

  "Code of practice – The CEN/TR 16355 technical report of CEN/TC 164/WG 2 on Legionella applied to solar hot water systems"

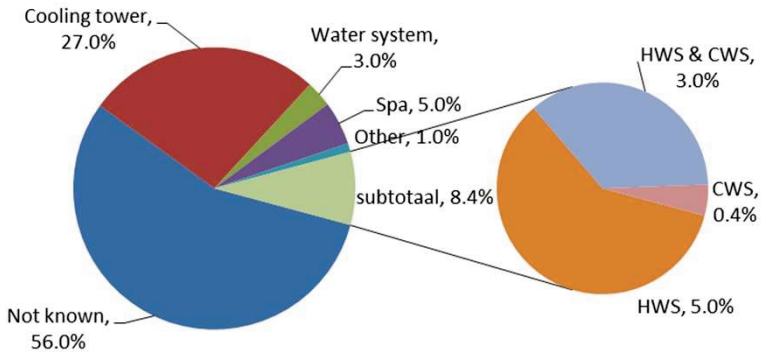
  - Focus on solar hot water systems
  - Building on the CEN TR 16355
  - TC 312 approved for a work item to make it a CEN TR

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 …)

Legionella and solar water heaters

- Origin outbreaks Legionella
  < 10% from hot or cold water installations
  - or 20% of known cases



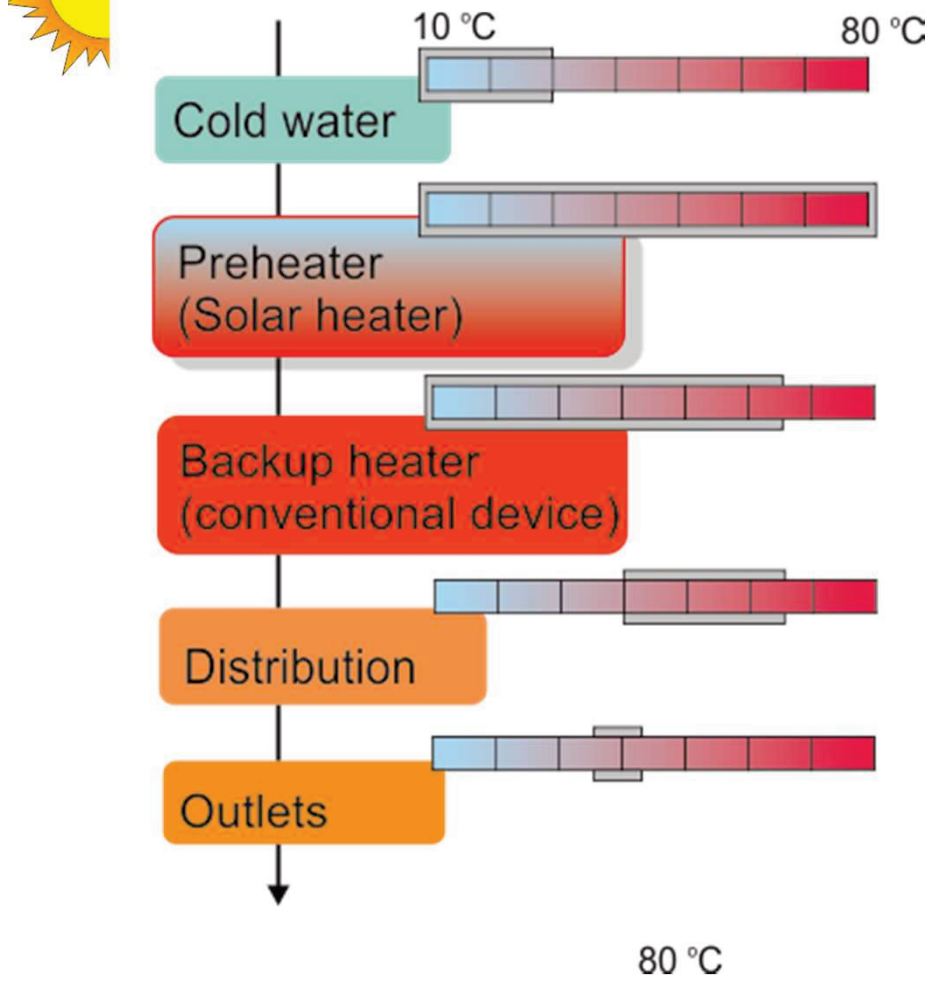
- Can originates from all parts of such installations
  - Piping, valves, devices, …
    - also from solar thermal devices
  - No statistical data available on solar share in this
    - probably due to small penetration grade
- Legionella is to be taken serious in hot water installations

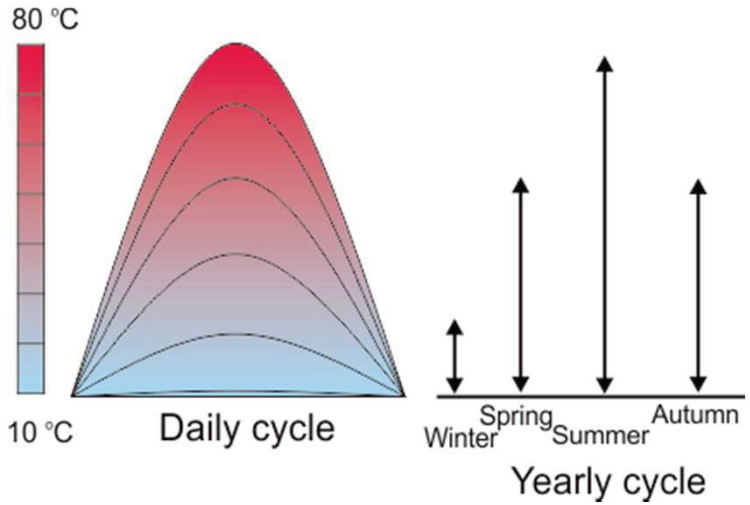
Reports on incidences in solar systems

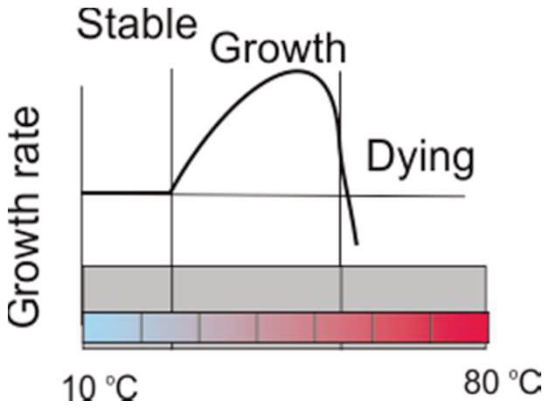
- Three known outbreaks:
  - Brazil: cause unspecified
  - Antiqua: indirect relation
  - Turkey: mismanagement
- Reported incidences:
  - Athens: Legionella in 10% SHW and 69% oil fired systems
  - Germany: 4,2% of solar and 13% of others
  - Denmark: 0% of solar and 21% of others
- Legionella also in solar, but not more often than others

Legionella and solar thermal

- Dynamic process of stability, growth and dying -







Mathematical simulations

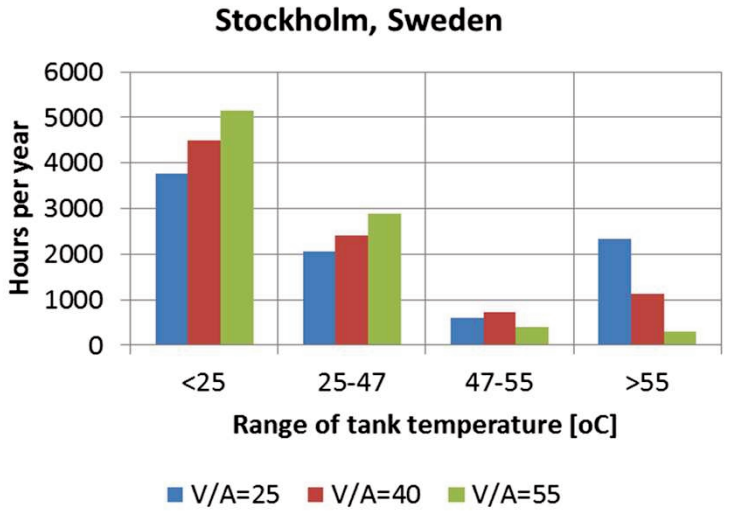
- Simulation by model calculation of development of Legionella
- Assumptions on the solar hot water system:
  - Typical solar system layouts
  - Different collector orientations and tilts, climate zones and heat demands
  - Hourly calculations for two successive years
- Assumptions on the Legionella development
  - 98% of Legionellae is on the tank surface
  - A defined maximum allowed concentration in the water
  - Assumed relation temperature and concentration development

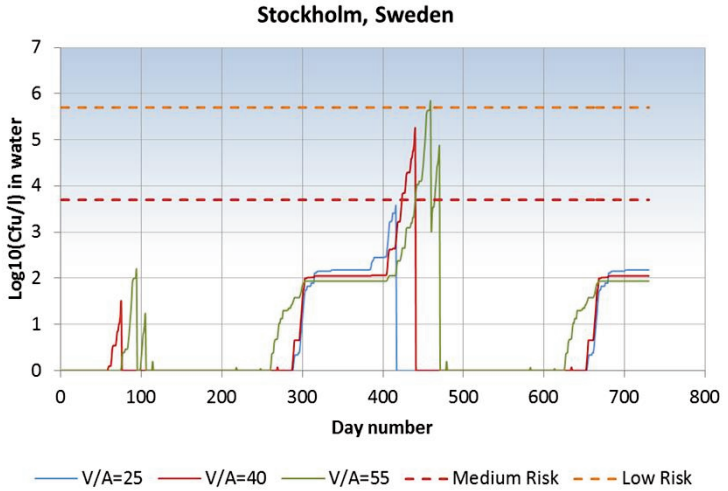
Building categories and risk levels

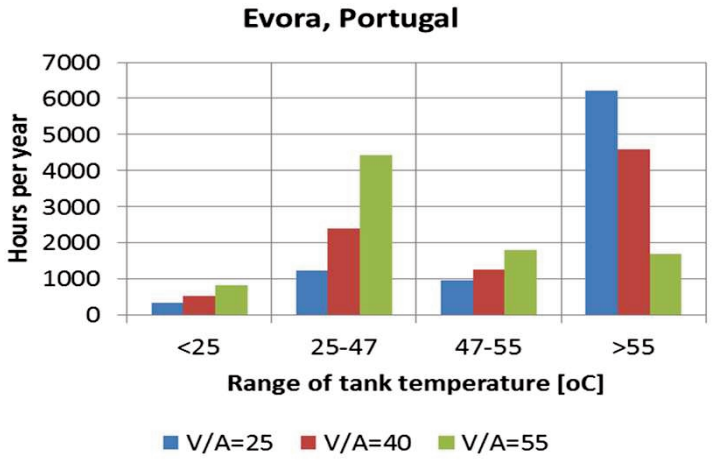
- For interpretation of mathematical study
  - Categories based on SIA 3851/1 (CH)
  - Low risk (concentration < $5x10^5$ cfu/l)
    - Housing units, restaurants, stores, …
  - Medium risk (concentration < $5x10^3$ cfu/l)
    - Residential buildings, schools, sports, …
  - High risk (out of the scope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

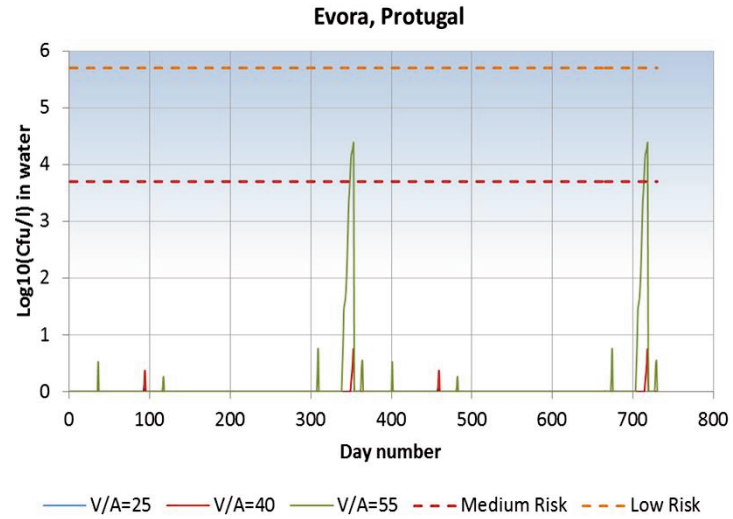
Results

- examples of results -









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

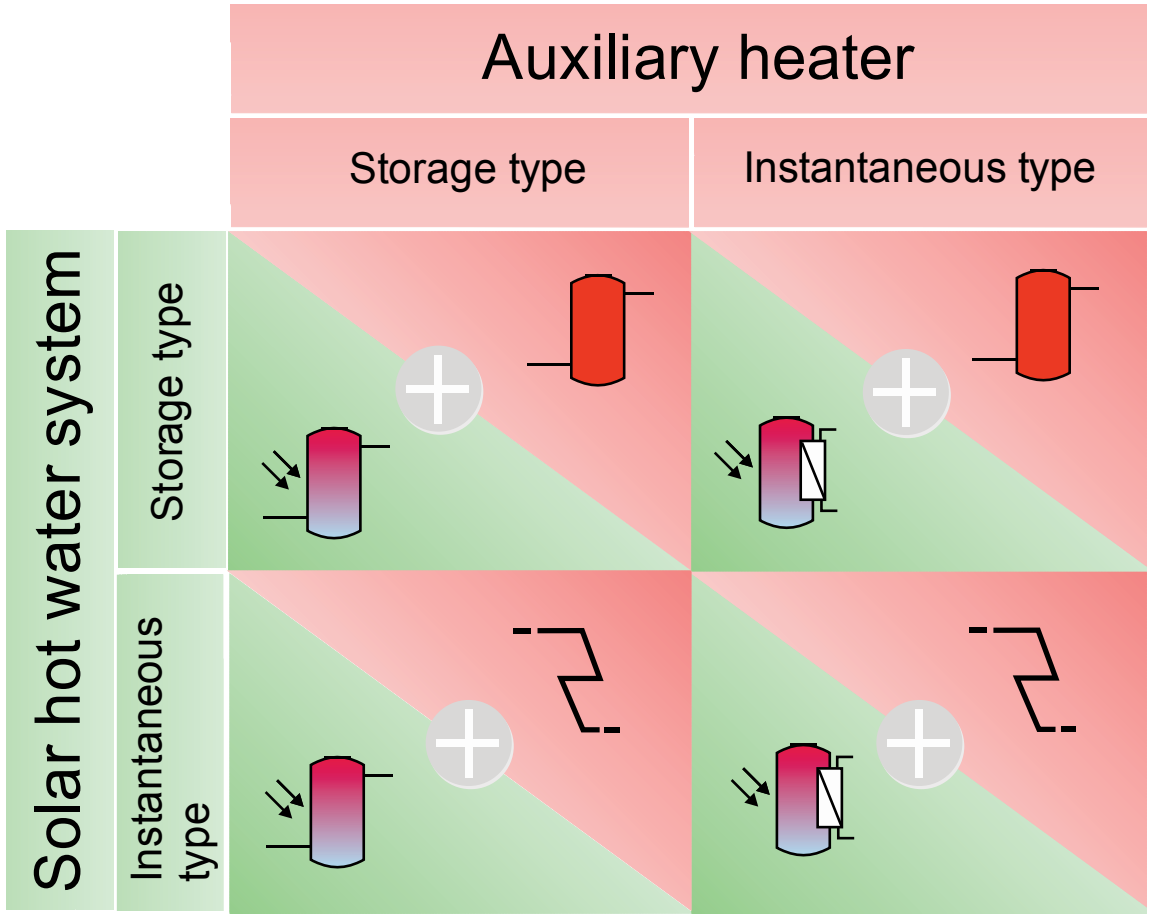
Code of practice

- Design considerations -

- 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

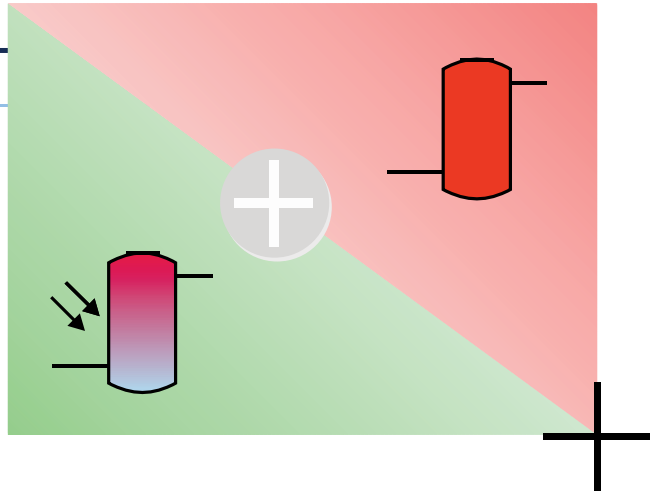
Code of practice
- Design recommendations -

- 4 system layouts of solar and auxiliary
- Each a set of recommendations



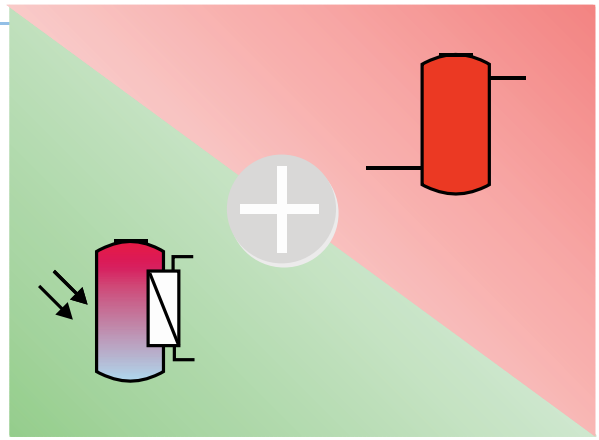
Installation layout

- storage / storage -



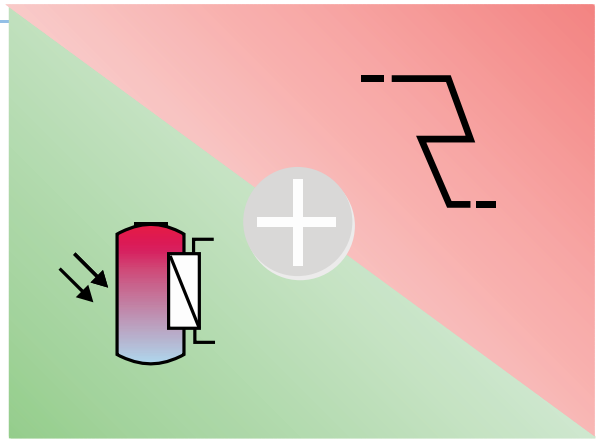
- Risk evaluation:
  - Potential growth solar tank
  - Potential growth auxiliary tank
- Recommendations:
  - Auxiliary: > 55 ^{o}C whole day or >60 ^{o}C one hour (TR16355)
  - Solar device options ('or'):
    - Design rules (dimensioning of components)
      - Aimed at V_{sto} / A_{col}
    - Thermal disinfection: 60^{o}C/20m, 65^{o}C/10m, 70^{o}C/5m(TR16355)
      - Medium/low risk: weekly High risk: daily

Installation layout
- storage / instantaneous -



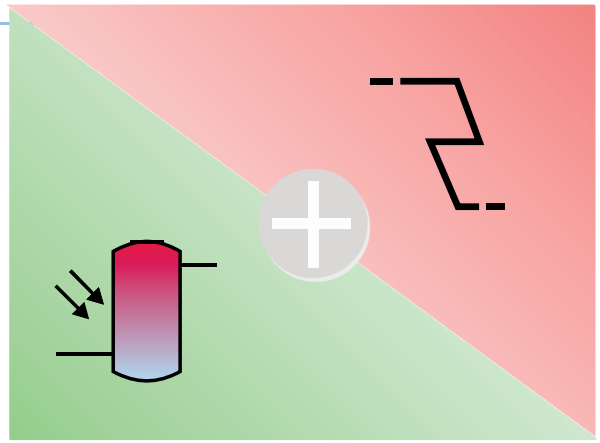
- Risk evaluation:
  - Low risk of growth solar tank
  - Potential growth auxiliary tank
- Recommendations:
  - Auxiliary: > 55 °C whole day or >60 °C one hour (TR16355)
  - None for solar device

Installation layout
- instantaneous / instantaneous



- Risk evaluation:
  - Low risk of growth solar tank
  - Low risk of growth auxiliary tank
- Recommendations:
  - None

Installation layout - instantaneous/ storage

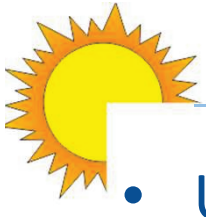


- Risk evaluation:
  - Potential risk of growth solar tank
  - No disinfection in auxiliary tank
- Recommendations:
  - Solar device options (low risk):
    - Design rules (dimensioning of components), or
      - Aimed at V_{sto} / A_{col}
    - Thermal disinfection: 60°C/20m, 65°C/10m, 70°C/5m(TR16355)
      - 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 ^{o}C)
- Further mathematical studies
  - More system types and thermal stratification in tank