4th International Conference on Smart Energy Systems and 4th Generation District Heating
Aalborg, 13-14 November 2018

Solutions and regulations to deal with legionella problems in district heating systems

Kerstin Sernhed (Lund University), 13th of November, 2018

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4th International Conference on Smart Energy Systems and 4th Generation District Heating 2018
#SES4DH2018

4DH
4th Generation District Heating Technologies and Systems

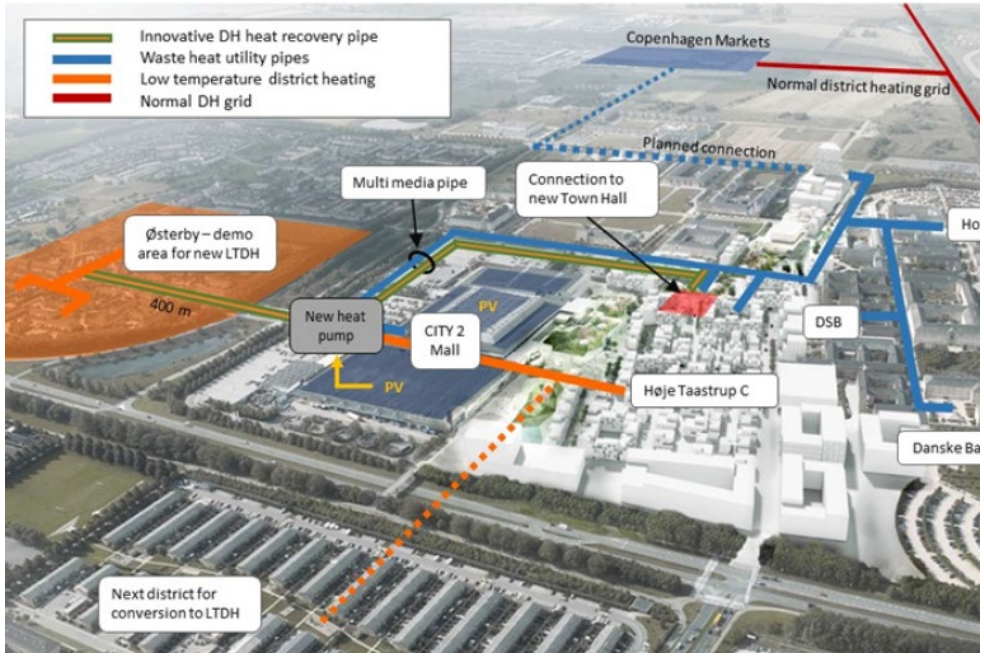
COOL DH – an EU-project with two demonstration sites with low temperature district heating

Brunnshög, Lund (Sweden)

THE WORLD'S LARGEST LTDH

- 4,4 km
- 65^{0}C / 35^{0}C
- Construction start 2017
- First delivery 2019

Höje Taastrup, (Denmark)



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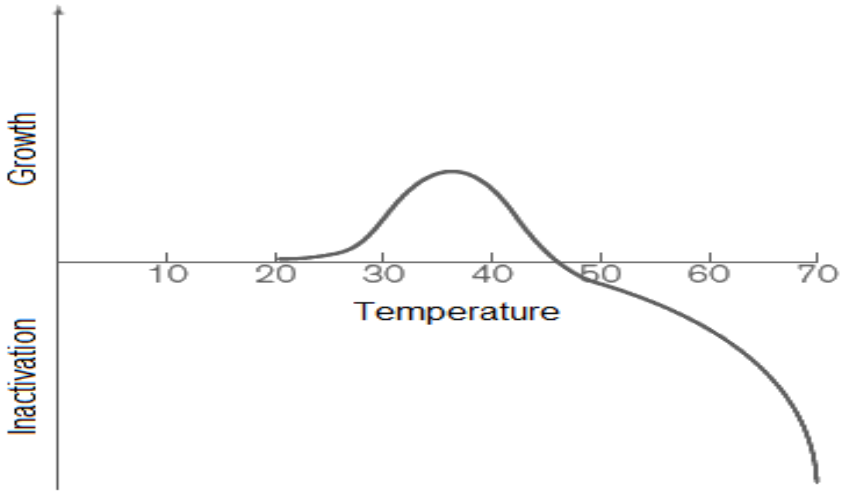
Legionella bacteria

- *Legionellae* are common bacteria in freshwaters, seawater and soils
- Causes Legionnaires disease and Pontiac fever
- The bacteria thrives in:
  - Temperature levels of 32-42 °C
  - Stagnant water
  - Presence of biofilm and protozoa



Source: Stålbom & Kling (2002)

Purpose of study

1. What is the legislation associated with legionella in domestic hot water systems? (In Sweden, Denmark, Finland, Norway, France and Germany)
2. What is the incidence of Legionnaires disease in the six included countries? How does this comply with the legislation?
3. What techniques could be used for legionella prevention in DHW systems?
4. How do the techniques comply with the legislation and the use of low temperature district heating?

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Legislation

European union

No specific law concerning legionella!

- Water quality is mentioned in several directives:
  - Directive 2000/54/EC: Directive regarding biological agents at work
  - Council Directive 98/83/EC: Directive on the quality of water intended for human consumption
  - ...But no specific requirements on legionella control

European working group for Legionella infections (EWGLI) – Technical specifications

1. Parts of the system should be **kept at a temperature that does not promote microbial growth**
2. The system should be designed in such a way that **water stagnation does not occur**
3. The components should be **made in materials that do not promote microbial growth** (e.g by limiting the growth of biofilm)

EWGLI recommends that:

- hot water should be **stored at a temperature no less than 60°C**
- circulating water should be at a temperature that **allows at least 50°C at the tap** within one minute of opening the tap

Regulations of DHW system temperatures in six countries related to legionella

Country	Min. system T	Min. tank T	Min. tap T	Max. tap T
Sweden 	50 °C	60 °C	50 °C	60 °C/ 38 °C*
Denmark 	55 °C (45 °C)**	55 °C (up to 60)		
Norway 	65 °C (circulating)			55 °C/38 °C*
Finland 			55 °C	65 °C
Germany 	50 °C, unless small system	60 °C		
France 	50 °C, unless V < 3 liters	55 °C		

* Only for locations with increased risk of scalding

** Exceptions of temperature requirements are made at peak hours

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Incidence

Incidence of Legionellosis in the six countries

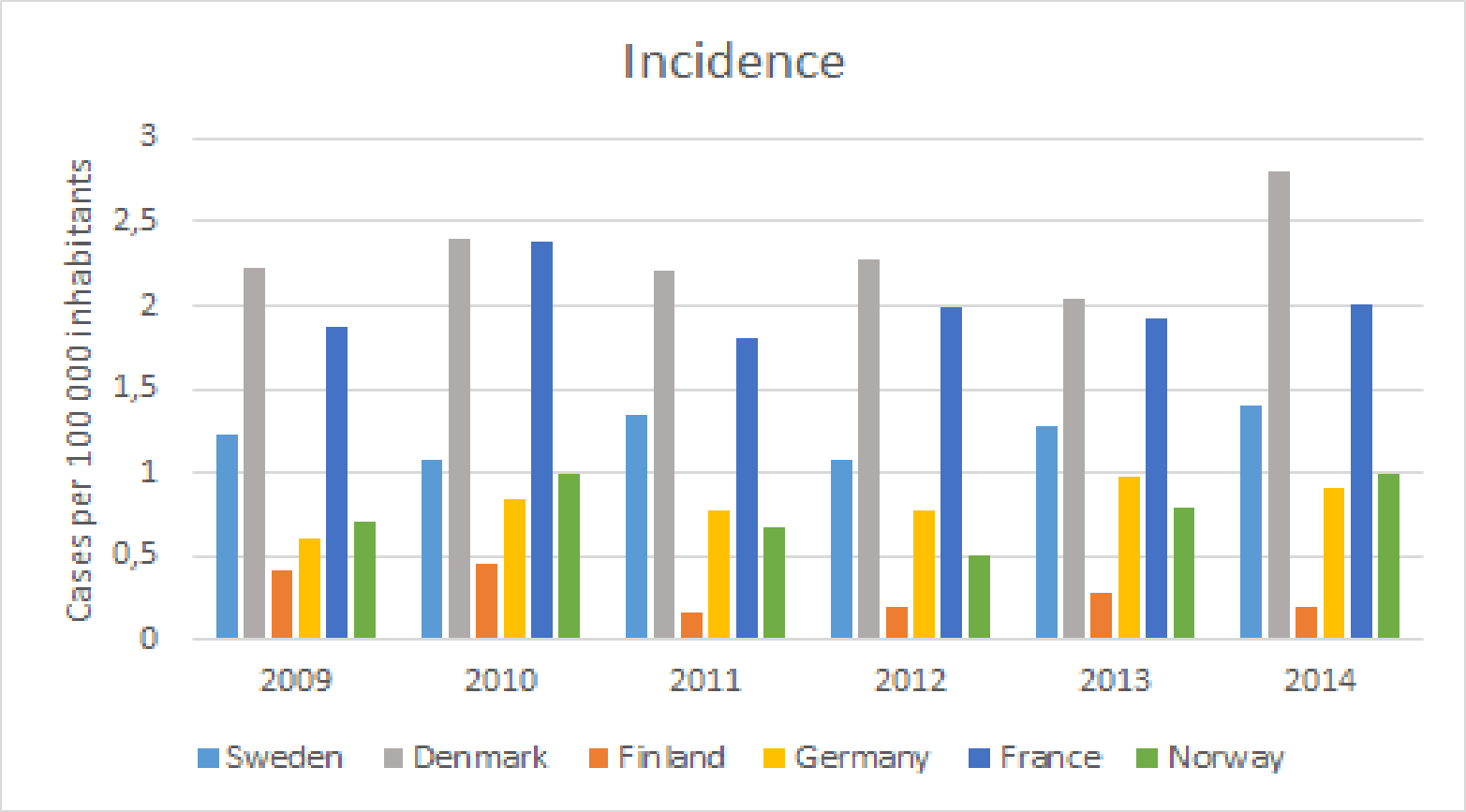


Diagram compiled from data obtained from ECDC (European Centre for Disease Prevention and Control, 2016).

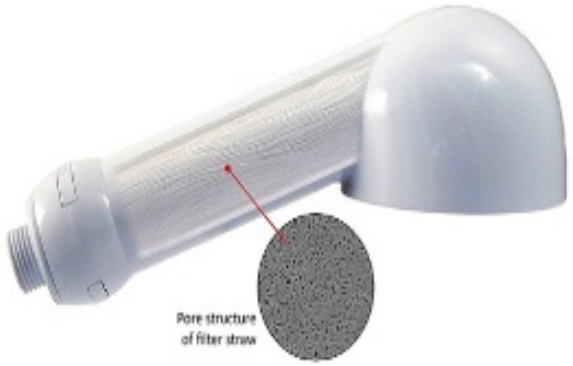
Source: Karlsson & Ottosson, *Overcoming issues with Legionella in DHW in LTDH systems*

Techniques in DHW systems to prevent legionella

1. Mechanical treatment
2. Sterilization
3. Alternative system design

Mechanical treatment

Technique	Advantages	Disadvantages	Fulfils temperature requirements in regulations?
Filters	• Instant effect • Very effective	• Short lifetime; frequent maintenance required • High cost • Local effect, not residual	No



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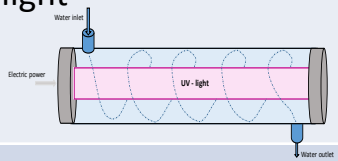
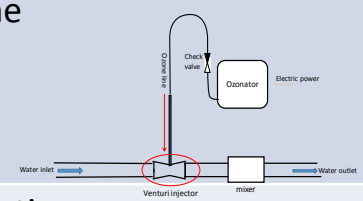
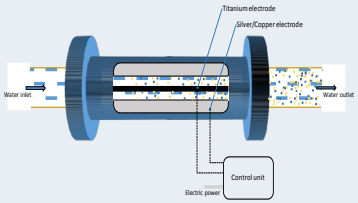
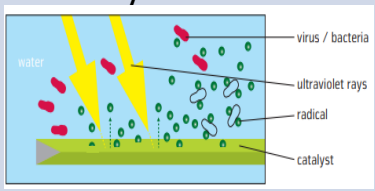
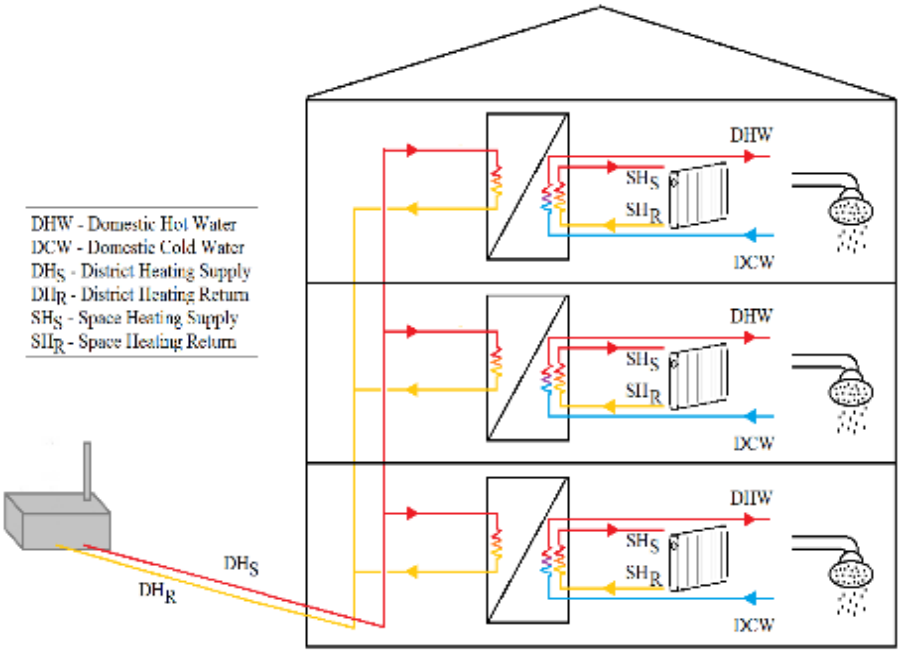
Sterilization

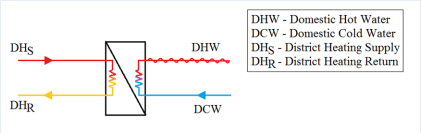
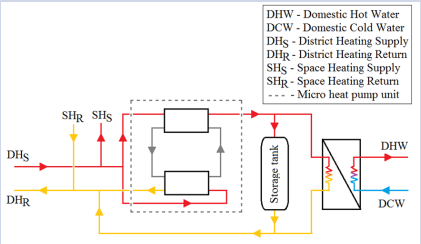
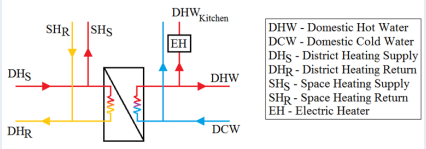
Technique	Advantages	Disadvantages	Fulfils temperature requirements in regulations?
Chlorination  	• Mature technology • Residual control	• Less effective on protozoa • Local legislation • Potential health hazard, chemicals added • Can be corrosive for pipes	No
UV-light 	• Instant effect • Mature technology	• Not sufficient on its own • Less effective on protozoa • Local effect, not residual	No
Ozone 	• Highly oxidizing, effective in low concentrations	• Corrosive: pipe maintenance required • Local effect, partly residual	No
Ionization 	• High efficiency • Mature technology	• Can be prohibited by national legislation because of potential health hazard • Copper and Silver ions added	No
Photocatalysis 	• Pilot studies show high efficiency	• Not commercialized for residential properties • Local effect, not residual	No

Alternative system design

Technique	Advantages	Disadvantages	Fulfils temperature requirements in regulations?
Decentralized substations	• No need for DHW circulation: reduces heat losses	• Investment cost	No



Alternative system design

Technique	Advantages	Disadvantages	Fulfils temperature requirements in regulations?
Auxiliary heating devices:			
Electric heat tracing 	• No need for DHW circulation: reduces heat losses	• Only partly commercialized for residential properties	**Yes**
Micro heat pump 	• Energy efficient	• Higher investment costs	**Yes**
Instantaneous electric heater 	• Compact installation	• High electric effect required at peak times: may need upgrade of main fuse	**Yes**

Conclusions

- Legislation: Temperature requirements not bacterial level
- Different temperature requirements in different countries
    - Norway - 65 °C
    - Germany and France – 3-litre rule
    - Denmark - Exception for peak flows where a temperature of 45 °C at the tap is acceptable.
- In case of ULTDH:
    - Steralization techniques and filters are not possible to use as single methods
    - Decentralized substations only where 3-litre rule is applied

Conclusions

- Countries with higher temperature requirements also showed fewer cases of Legionella.
  - Causal relationship is not possible to establish in this study
  - Other factors could play a role: climate, number of detected cases, aging population, pattern of smoking and drinking

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