Data sheet

Domestic Hot Water Circulation System - Background information


TVM-W


MTCV


CCR

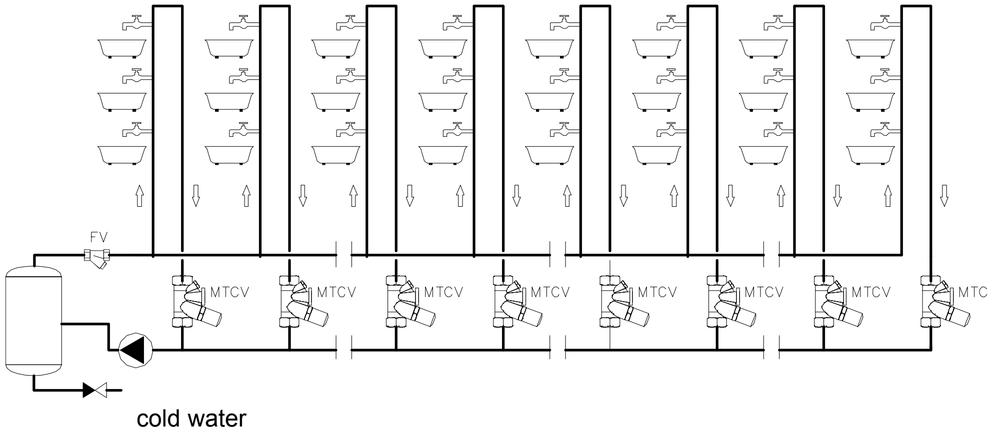

ESMB


ABN

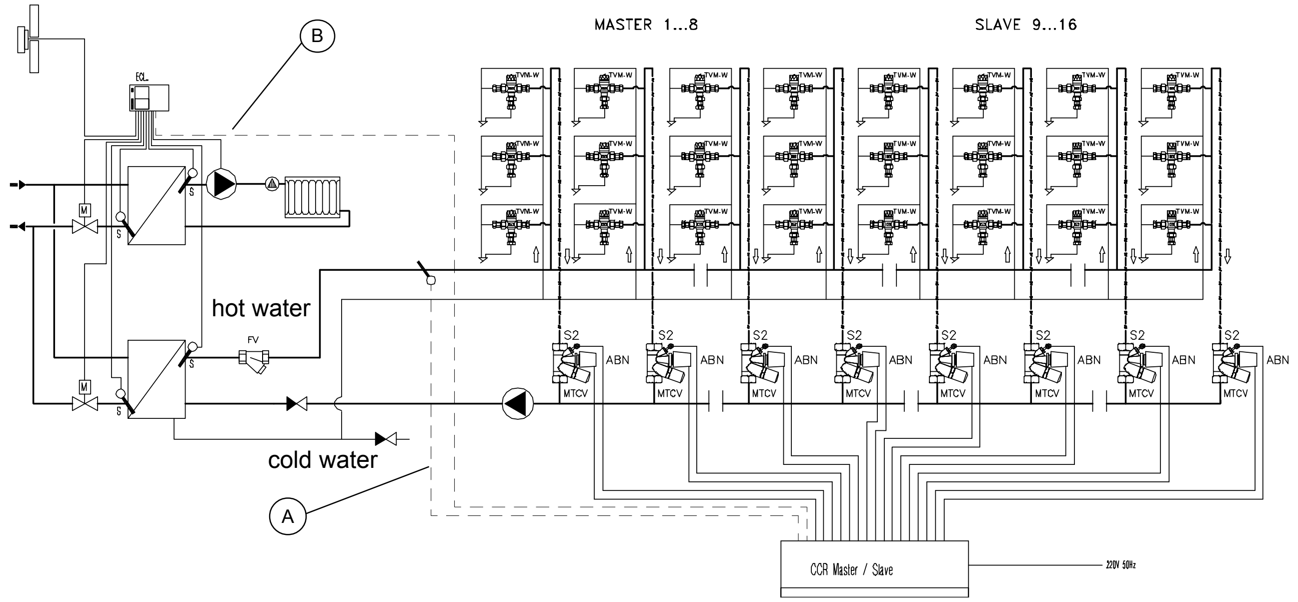

ESMC

Design principle

Recommended scheme of hot water installation with circulation



Example of MTCV / basic version / placement in domestic hot water system



A) Indirect heating connection with parallel instantaneous system for domestic hot water production
- independent CCR system
B) Indirect heating connection with parallel instantaneous system for domestic hot water production
- dependent CCR system

Background

Domestic hot water systems have developed over the last few years. These developments have been stimulated by new factors and trends like:

- Increasing cost of domestic hot water production
- Increasing cost of water
- Required high level of reliability of the hot water supply
- Quality and hygiene of water i.e. legionnaire contamination

Danfoss has developed a universal and comprehensive solution for the regulation of hot water systems, providing the following advantages for users:

- Reduction of the domestic hot water production costs.
- Reduction of water consumption - no need to wait for running water to achieve the right temperature at the tapping point
- Thermal balancing - equal temperature of hot water at all tapping points
- Possibility of thermal disinfection of the hot water system against Legionnaire. This can be done automatically by protecting the installation against calcium sedimentation and corrosion
- Reducing scalding risk during the disinfection process
- Possibility of monitoring and controlling the hot water temperature during the disinfection process.

Thermal Balance Sizing methods

A. **Traditional sizing methods** common in the seventies and eighties, calculated the required circulation flow in whole hot water system i.e. from heat loss through the pipes through the nominal temperature drop from the heat station to the last tapping point and nominal water consumption.

The disadvantage of this sizing method is that circulation flow in an individual riser is proportional to nominal water consumption from all tapping points of the riser. The same flow will be calculated in the nearest and farthest riser from the heat exchanger (in case of risers with the same number of tapping points, e.g. in multi-family houses). It is obvious that heat losses are biggest at the farthest riser and the water will be at its lowest temperature there.

The traditional sizing method does not compensate for this fact and as a result the water temperature will be different at different points in the installation. Fig. 2 and 3 illustrate sizing results for a typical installation in a 10 storey building with 12 hot water risers. The temperature distribution graph (fig. 2) illustrates that temperature varies from 52 °C to 47 °C in the farthest riser.

B. **The sizing method currently** being used compensates for heat losses through the pipes. Heat losses are calculated, taking into consideration thermal insulation of the pipes and the difference between the ambient temperature and water temperature. Due to heat losses, the temperature drop is assumed to be in the range of between 5 to 10 K, depending on the hot water nominal temperature.

This method allows for an equal water temperature in all the risers and at the same time a different circulation flow in individual risers, (fig. 2 and 3).

Below are basic assumptions and formulas used in the calculations:

Water flow in installation is in relation to temperature drop, where:

$$\dot m = \frac{\sum \dot Q}{c_w\, \Delta t_{hw}}\ [kg/s]\ or\ \dot V = \frac{\sum \dot Q}{\rho\, c_w\, \Delta t_{hw}}\ [l/s] \qquad (1)$$

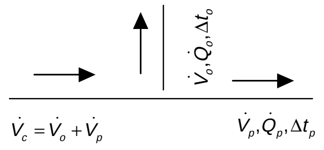
$\sum\dot Q$ - heat losses in installation [kW]
ρ - water density [kg/m3]
c_w - specific heat of water, [kJ / (kg K)]
Δt_{hw} - temperature drop of hot water (assumed to be between 5 and 10 K)

Heat losses are calculated from the formula:

$$\dot Q = K_j\, l_{hw}\, \Delta T = l_{hw} q \qquad (2)$$

q - unit heat loss through hot water pipes [W/m],
K_j - heat transfer coefficient for pipes and thermal insulation [W/(mK)],
l_{hw} - pipe length [m]
Δt - difference between ambient temperature and hot water temperature [K]

Calculation of the circulation flow in the individual risers is made on the basis of incoming and outgoing flow to the specific node.



Calculation scheme of the hot water installation node

Thermal Balance Sizing methods

When calculating flow values in the individual risers, it is assumed that the temperature drop in the first riser (from the heat station to the last tap on the riser) is the same as in the remaining part of the hot water system. Flow in the whole system is a sum of flow in its parts, thus:

$$\left\{\begin{array}{ll} \dot{V}_c = \dot{V}_o + \dot{V}_p & (3a) \\ \dot{V}_o = \dfrac{\dot{Q}_o}{\rho \times c_w \times \Delta t_o} & (3b) \\ \dot{V}_p = \dfrac{\dot{Q}_p}{\rho \times c_w \times \Delta t_p} & (3c) \\ \Delta t_o = \Delta t_p & (3d) \end{array}\right.$$

Substituting (3b) and (3c) to (3a) and dividing this new formula by (3b), the following formula appears:

$$\frac{\dot{V}_o}{\dot{V}_c} = \frac{\dot{Q}_o}{\dot{Q}_o + \dot{Q}_p} \quad \text{thus:} \quad \dot{V}_o = \dot{V}_c \times \frac{\dot{Q}_o}{\dot{Q}_o + \dot{Q}_p} \ \text{[l/s]} \qquad (4)$$

where:

$\dot{V}_o$ - nominal water flow in the riser (branch flow) [l/s],

$\dot{Q}_o$ - nominal heat loss in the riser [W],

$\dot{V}_c$ - nominal total flow in the hot water system (incoming flow from water heater) [l/s],

$\dot{V}_p$ - nominal flow in the circulation header (passing flow) [l/s],

$\dot{Q}_p$ - nominal heat loss in the circulation header (in remaining part) [W].

Passing flow in the circulation header is calculated from the formula:

$$\dot{V}_p = \dot{V}_c - \dot{V}_o \ \text{[l/s]} \qquad (5)$$

The flow in the other branches is then calculated using formulas (4) and (5).
The calculated flow in branches and recommended water velocity determine the sizing of the pipes.
The recommended water velocity vma , varies from 0,2 ¸ 0, 5 m/s, and must not exceed 1 m/s.
It is not recommended to use steel pipes smaller than DN 15 due to risk of scaling.

Having sized the pipe diameters, hydraulic losses and consequently flow can be calculated in all branches of the system. Hydraulic losses are a sum of linear and local losses, (it can be assumed that local losses are between 20 - 40% of linear losses, depending on the system configuration) and losses on the valves and other equipment mounted in the system.

The following formula is used for calculating the pressure losses (hydraulic losses):

$$\Delta p_p = (1{,}2 \div 1{,}4) \times (\Sigma\, l \times R) + \Delta p_R + \Delta p_w \ \text{[Pa]} \qquad (6)$$

where:

Δp_p - total pressure losses in hot water and circulation system to size the circulation pump, [Pa],

$1{,}2 \div 1{,}4$ - 20 - 40% reserve for local pressure losses in hot water system with circulation

l - lengths of the branch, [m];

R - unit linear pressure loss, [Pa/m],

Δp_R - local pressure loss on valve (controller, equipment), [Pa],

Δp_w - local pressure loss on water heater (boiler, heat exchanger), [Pa].

Thermal Balance Balancing methods

When the pressure losses have been calculated, the hot water system must be balanced. There are 2 basic methods of balancing:

1. **STATIC METHOD - Hydraulic balancing**
   Should excessive pressure be reduced in a certain node of the system, we can size the throttling (regulating) devices. This type of balancing does not secure an equal temperature in all points of the system due to:

- Changing hydraulic (pressure) losses while the scaling process in the pipes occurs (higher friction of the pipes walls)
- A change from nominal consumption of hot water (influence on flow and water temperature)
- A different than assumed result in the calculation of ambient temperature (different from the calculated heat losses)
- Different conditions than assumed in calculations for parts of the installation located close to external walls, ventilation shaft, etc. This is especially the case in larger systems.
- The dynamic nature of hot water consumption, when nominal conditions are rare.

2. **DYNAMIC METHOD - Thermal balancing**
   The method is based on the usage of thermostatic balancing valves (circulation valves), which secures a constant temperature in all the circulation risers of the system, irrespective of changing operating conditions.
   Regulation is made simply by setting the required temperature on the valve.
   Complicated hydraulic calculations to balance pressures in all nodes of the system are no longer needed. The thermostatic balancing valve automatically allows minimum circulation flow in order to maintain the set temperature.

In the example mentioned below, the calculation results are illustrated for the 2 sizing methods (authors: PhD W. Szaflik, MSc A. Malysa, Szczecin Technical University, Poland).

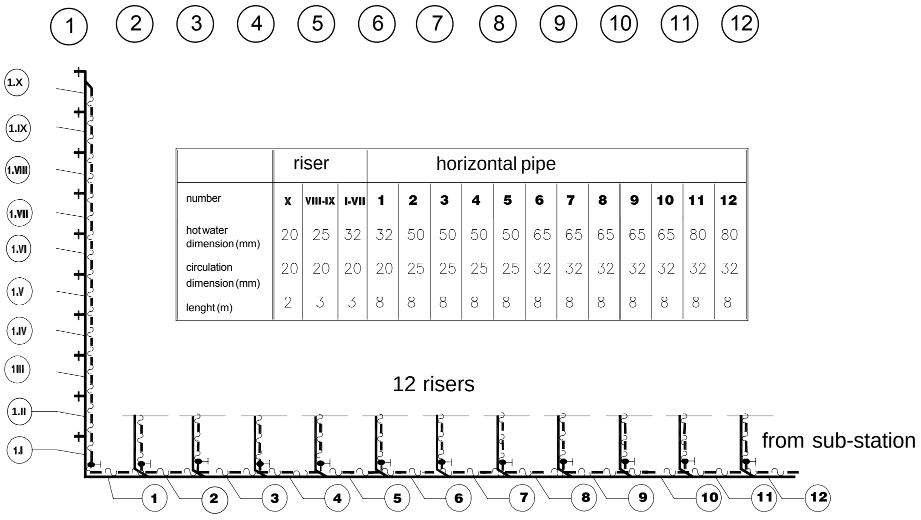
A - sizing method of determining circulation flow proportional to sum of nominal flow of all tapping points on the riser

Thermal Balance
(continuous)

B - sizing method of determining circulation flow proportional to heat losses in each part of hot water system and circulation

Example:

- 10 storey building, 12 hot water risers with circulation
- nominal inlet temperature of hot water T_{cwu} = 55 °C,
- nominal temperature drop = 5 K
- heat transfer coefficient for uninsulated steel pipes K = 12 W/(m²K),
- pipes diameters are stated in table fig. 1
- nominal ambient temperature:
  - T_o = + 5 °C for cellars
  - T_1 = + 25 °C for installation and ventilation shafts



	riser			horizontal pipe											
number	**X**	**VIII-IX**	**I-VII**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
hot water dimension (mm)	20	25	32	32	50	50	50	50	65	65	65	65	65	80	80
circulation dimension (mm)	20	20	20	20	25	25	25	25	32	32	32	32	32	32	32
lenght (m)	2	3	3	8	8	8	8	8	8	8	8	8	8	8	8

Fig. 1 Scheme of hot water system with 12 risers and circulation, in 10-storey building.

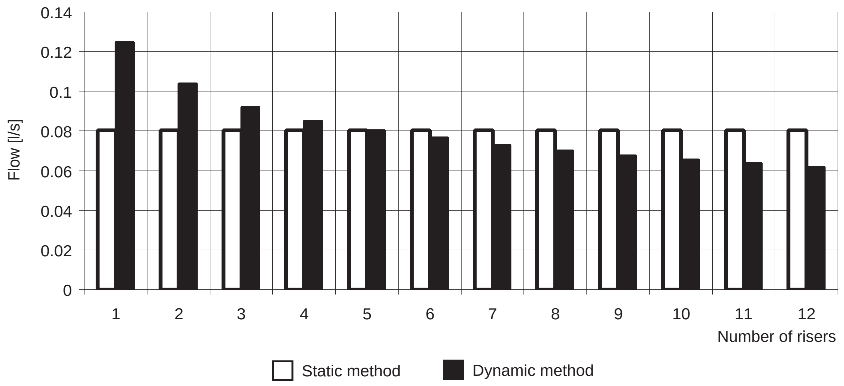


Fig.2 Circulation flow in 12 insulated risers of hot water system.

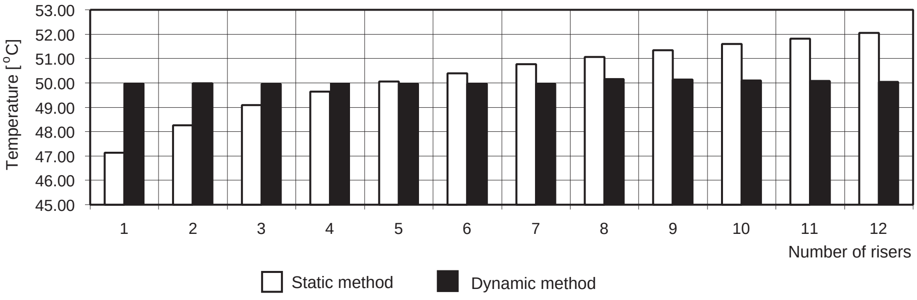


Fig.3 Temperature in last tapping points of 12 risers of hot water system.

Legionella pneumophila - a threat to health

During the last few years there has been a growing interest from the public media, and focus from sanitary and epidemic institutions on the hygienic quality of water, especially secondary bacteriological contamination of water. The reason for this is the discovery of the legionella bacteria, which grows in:

- Domestic hot water systems
- Cooling towers
- Evaporative condensers
- Large air-conditioning systems
- Hot whirlpools
- Respiratory equipment
- Small portable humidifiers

Below follows an outline of the main findings and conclusions from the research that has been done in relation to legionella.

The first information about legionella dates back to 1968. Regular investigation of bacterium, however, was not started until as recently as 1977 after illness caused twenty-nine deaths among American Legion members who were attending a convention in a Philadelphia hotel in 1976.

Legionella covers app. 50 classified species, of which as many as 18 can cause serious disease. These are types like: L. pneumophila, L. bozemani, L. micdadei and others.

Legionnaire is an infection caused by the bacterium Legionella pneumphila (app.90%).

The disease has two distinct forms:
- Legionnaires’ disease, the more severe of the infections, that includes pneumonia, and
- Pontiac fever, which is a milder illness.

Due to the fact that the infection is transmitted when inhaling aerosolized, contaminated water into the lungs, the presence of bacteria in water systems creates a risk wherever there are aerosol-producing devices.

The perfect conditions for transmission of the infection exist in water tanks and water installations in dwelling buildings, commercial buildings and public buildings, like: hotels, hospitals, sanatoriums, etc.
Typical examples are showers, whirlpool spas, humidifiers and decorative fountains where water-air aerosol is the ideal „transportation" of the bacteria into the lungs.

What are the usual symptoms of legionallosis?
Patients with Legionnaires' disease usually have fever, chills and cough, which may be dry or may produce sputum. Some patients also have muscle aches, headache, tiredness, loss of appetite, and occasionally diarrhoea. Laboratory tests may show a decreased functioning of the kidneys. Chest X-rays often show pneumonia. As it is difficult to distinguish Legionnaires' disease from other types of pneumonia by symptoms alone, other diagnostic tests are required.

Who gets Legionnaires' disease?
People of any age can get Legionnaires' disease, but the illness most often affects middle aged and older people, particularly those who smoke cigarettes or have chronic diseases. People whose immune system is suppressed by diseases as cancer, kidney failure, which requires dialysis, diabetes or AIDS are also at increased risk. People who take drugs that suppress the immune system are also at higher risk.

In the Europe alone, over 5.000 to 10.000 cases of legionnaires’ disease are reported each year. About 5% of known cases of legionnaires’ disease have been fatal.

What is the treatment for Legionnaires' disease?
Erythromycin is the antibiotic currently recommended for treating people with Legionnaires' disease. In severe cases a second drug, rifampin, may be used in addition. Pontiac fever requires no specific treatment.

What are the best conditions for the bacterium to breed?
Legionella bacteria are most commonly found in natural and man-made aquatic environments.
The bacterium breeds easily at temperatures between 22 - 43 °C and the optimal temperature for their growth is 36 $^{+}/_{-}$ 1°C. The time of regeneration of cells at this temperature is 6-8 hours.

Bacteria breeding in biofilms and microbes can still occur at a temperature of 67 °C. The growth of bacteria is possible within pH 5,5 - 9,2 and the optimal pH is 6,8 - 7,0. Scale, sediment, biofilms and presence of amoeba are also favourable conditions for the multiplying of bacteria.

Bacteria are eliminated at a temperature above 46 °C. The graph below illustrates the empiric dependency (dependency of Brundrett), of bacteria on their ability to multiply at different temperatures. The axis of ordinates in a logarithmic scale (vertical), represent concentration of bacteria in water and the axis of abscissa (horizontal) - time.

Dependence between bacteria concentration and time is linear at a constant temperature (in chosen logarithmic scale). We can thus read directly from the graph that at 50 °C, 2.3 hours are needed to reduce bacteria concentration from 1000 units to 100 units. The pasteurization process is much faster at a high temperature. The graph illustrates that in order to achieve legionella-free water at a temperature of 50 °C, a pasteurization time of 7 hours is needed, while at a temperature of 54 °C only 1.3 hour is needed. At a temperature of 48 °C, the pasteurization process must continue for as long as 30 hours.

Legionella pneumophila - a threat to health

It is also interesting to study the dependency of bacteria concentration in a changing water temperature (author: PhD J. Wollerstrand, Lund Institute of Technology, Sweden). The dependency is shown on the lined curve. At first there are 100 units of bacteria colonies in the water. The colonies are amplifying in a temperature up to 40 °C, after that they start to decrease at a temperature of 50 °C, after which, on further temperature increase, they start to grow again.

The conclusion is that a periodical increase of temperature (without control over pasteurization time) will reduce the concentration of bacteria, but will not eliminate them completely. A similar phenomenon can occur in a hot water system, or parts of it, which are rarely used.

It is important to mention that the bacteria grow not in the water itself, but in the biofilms, which always cover surfaces which are in contact with the water.

A recently discovered form of bacteria growth are colonies inside amoeba and other microbes that are living in water and are a specific “umbrella" for bacteria. In this case the required pasteurization temperature may be up to 70 °C. In such a high temperature, the scalding risk is very high and has to be considered as well as the risk of pipe scaling and corrosion.

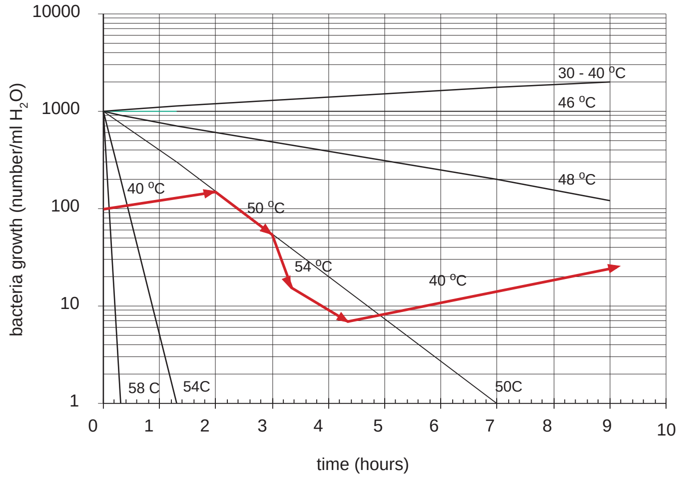


Fig. 4 Legionella growing process depending on temperature

What is being done to prevent legionellosis?

We can use several methods,which have been the subject of research, to control legionella in portable water systems. They include the chemical methods:

- **Chlorination**
  In this method doses of Cl_2/l are regularly added to water heaters and water installations and the concentration of Cl_2 is kept at a level of 2-3 mg/l.
  The use of chlorine and its compounds is effective, but requires constant monitoring due to the risk of creating cancerous chemical compounds. Furthermore, chlorination increases corrosion of the pipes.

- **Ozoning**
  The use of ozone O_3 - a strong oxidizer, results in the reduction of bacteria concentration in the water by 99 % in only 5 min. Unfortunately, the side effects of using ozone, limits its application in hot water systems. Also the fact that oxidizers can undergo a chemical reaction with materials in the water will reduce their effectiveness.

The above-described chemical methods have the following common disadvantages:

- Practical difficulties in dosing of chemical additives and constant control of their concentration in water
- Negative influence on water quality
- Increased corrosion

The physical methods developed to eliminate bacteria in water systems are:

- **Ultraviolet Light**
  The devices used emit ultraviolet radiation UV of 254 nm and at an intensity of 2.04 mW-s/cm^2, which results in the reduction of bacteria by 90 %. The effectiveness of this method is, however, influenced by the turbidity and the colour of the water and temperature. Scale and sediment in water will significantly decrease the effectiveness of a.m. method.

- **Thermal disinfection**
  The recommended physical method of bacteria pasteurization is thermal disinfection. The thermal disinfection takes place when heating up water to the "disinfection temperature" and maintaining this temperature for the specific "disinfection time".

Legionella pneumophila - a threat to health
(continuous)

Thermal disinfection must be regularly repeated, depending on the measures of the legionella contamination and the installation type. Thermal disinfection methodology including ”disinfection parameters" is subject to specific regulations in individual countries.

Comments:
Legionella pneumophila in hot water systems can pose a severe threat to health.
Currently known pasteurization methods can contribute to a significant reduction of this risk. Thermal disinfection is the most effective, easiest and at the same time cheapest method. The full thermal disinfection system by Danfoss (MTCV + TVM-W + CCR) will provide the possibility to lower the risk of legionnaire and at the same time help protect the installation against excessive scale (CCR) and the user from scalding (TVM-W).

Given that the research in the area of legionella as accounted for above is accurate, Danfoss offers a solution that can control a temporary increase in temperature in order to facilitate a disinfection process.

All this can be achieved at a low cost (MTCV). The following guidelines must be observed when designing, installing and maintaining water installations:

- Keep the temperature of the drinking water supply below 20 °C and in the hot water system at a temperature of 55 - 60 °C.
- Insulate hot and cold water pipe to maintain the recommended temperature.
- Avoid ”dead ends" in the installation when designing the circulation.
- Keep the system clean and free of sediment, deposits of solids, scale and corrosion.
- Regularly perform thermal disinfection at a temperature of up to 70 °C.

The above-mentioned directions will contribute to lowering the risk of infection caused by Legionella pneumophila.

(Corrosion and fur) lime problems

Installations for domestic hot water is subject to two independent processes:

- Corrosion
- Precipitation of sediments

The operating durability of domestic hot water installations are affected by these processes' speed of evolvement and the concentration ratio of chemicals dissolved in water, the existence of colloids and suspensions, the water flow speed and its temperature. However, the most important role is played by the chemical content and temperature.

Corrosion
The phenomenon occurs mainly in installations made of zinc-plated steel pipes, which commonly were used in apartment housing in the 70s and 80s. Replacing this material with others (copper, plastic) effectively decreases the risk of corrosion occurring. However, we must remember the already existing installations, and the fact that steel is still accessed and used in new installations for domestic hot water (e.g. distributing horizontal pipe).

Installations are supplied by water, which is required to fulfil sanitary norms. The treatment of the water is carried out with consideration to these norms. However, ingredients included in water, even if they are neutral or even favourable from a health point of view, can provide water with strong corrosion features.

The first factor, which the speed of corrosion depends on, is the ratio of protective ingredients (as acid carbonates, hydroxides, ions of calcium) and corrosive ingredients (as chlorine, chlorides, nitrates, oxygen and carbon dioxide) included in the water.

The second factor is the water temperature, which has influence on the change of composition and structure of arising products from the zinc corrosion and thus on the protective features of these products. Whereas in cold water products of corrosion create a tight and protective coat which sticks well to the basis, they become grainy and loosely connected with metal at a temperature 40 - 80 °C. The maximum for zinc corrosions occurs at a temperature of 65 °C - the speed of corrosion in this environment is e.g. 10 times higher than at a temperature of 55 °C!

An additional unfavourable factor is temperature fluctuations. This phenomenon causes a pole reversal of the zinc-iron arrangement, which significantly accelerates corrosion. As a result of the perforation of the zinc coating (increase of temperature above 65 °C) a pole reversal of the zinc-iron arrangement and a sudden steel corrosion occurs through the simultaneous restraining of the zinc corrosion.

Precipitation of sediments
As a result of the physical - chemical changes and under influence of the heating of the water sediments occur, which are the reason for faulty functions in the domestic hot water installation ("overgrowing" of pipelines, increased roughness of the surface of the pipelines) and has influence on hydraulics of the system.

Damaging chemicals included in water cause the evolvement of sediments (commonly called scale sediments). It can be e.g. calcium, magnesium, iron and manganese bicarbonates. However, the main ingredient of fur in domestic hot water is calcium bicarbonate in form of crystals of calcite or/ and aragonite.

(Corrosion and fur) lime problems
(continuous)

Calcium creates so-called carbonate hardness. It occurs in water as well as soluble calcium bicarbonate ($Ca(HCO_3)_2$) in balance with hard soluble calcium carbonate ($CaCO_3$). The balance is described as follows:

$CaCO_3 + H_2O + CO_2$ « $Ca(HCO_3)_2$

The condition of maintaining well soluble bicarbonate in the water is the existence of carbon dioxide in the system. This minimal content of carbon dioxide is balance dioxide. Unfortunately, during heating up the removal of CO_2 that causes the removal of the balance into direction of hardly soluble calcium carbonate is a consequence.

In similar ways magnesium, manganese and iron bicarbonates are created (it should be noticed that $Mg(HCO_3)_2$ is characterised by much higher solubility, which decreases during increase of the temperature, t_{water} >75°C).

Many factors influence the rate of carbonate sediments arising. The most important are:

- Water temperature
- The initial concentration of bicarbonates in water
- Period and way of heating

The high hardness of the water and the high temperature increase the rate of decomposition of calcium bicarbonate, which may be the reason for the accelerated process of precipitation of calcium sediments. During analysing the above-mentioned process you may state that the increase of the temperature from 45 °C to 60 °C causes a four-time increase of the decomposition rate of $Ca(HCO_3)_2$ - the main element of fur. This fact explains the frequent occurrence of problems with "overgrowing" in domestic hot water installations.

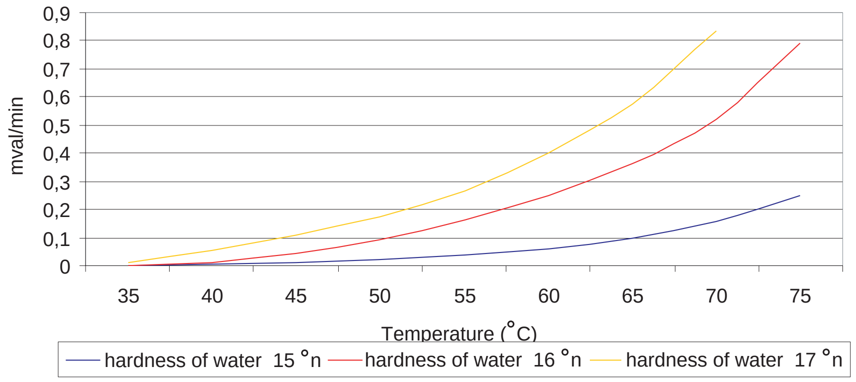


Fig. 5 The rate of thermal decomposition of calcium bicarbonate in the first minute of heating.

Thus inspection of an adequate water quality and temperature guarantees that the installation works properly. For the user of the installations supplied with very hard water this indicates the strict obligation of maintaining proper temperatures. Otherwise the installation may become totally "overgrown" even after a few years' operation. In case installations are supplied with soft water, even at a temperature of 65°C, it does not present a problem (for concentrations below 10 °n - almost nine-times decreasing of decomposition of bicarbonates).

In order to understand the process of fur arising it should be noticed that thermal decomposition is not identical - in a direct way - to this arising. After decomposition precipitation follows which depends on several factors both accelerating and inhibiting. You may number among them:

- The material which installation is made of (brass, copper have strongly anti-chemosorptive features which inhibits crystallisation i.e. precipitating of sediments;
- The way the water is heated;
- The heat load of the heating surface of domestic hot water heaters;
- The flow speed of the water.

Conditions for the arising of bicarbonate sediment:

Carbonate hardness of water (°n)	Period of beginning of sedimentation (hours)				
	30 °C	40 °C	50 °C	60 °C	70 °C
7	120	48	24	immediately	
10	120	24	5		
15	120	24	2		
16	120	24	1		
17	120	24	1		

Based on the quoted data you may generally state that: higher temperature, longer heating period and higher concentration of bicarbonate means faster arising of sediment. From the presented table you can read that the critical temperature for the initiation of fur arising depends on carbonate hardness (carbonate hardness is caused by the content of calcium and magnesium bicarbonate).

(Corrosion and fur) lime problems
(continuous)

Thus the temperature is already critical when T_{kryt}= 50 °C at a hardness higher than 15 °n, where the initiation of sedimentation arising follows after one hour. For the same temperature T_{kryt} = 50 °C and at a hardness lower then 7 °n , the initiation of sedimentation arising follows after "only" 24 hours.

Summary
The problem connected with fur precipitation and corrosion in domestic hot water installations may be limited to a minimum under the following conditions:

- Knowledge of quality parameters of the installation water (obedience to quality standards)
- Maintenance of a proper constant temperature in domestic hot water installations and circulation installations
- Limiting the temperature fluctuations to an essential minimum (controlled overheats of installation in function of time and temperature)
- Assurance of proper flow speeds and selection of proper plumbing materials.

Scalding problems

Besides comfort hot water serves a vital role in maintaining a good health. To serve this role the hot water must be produced at **an appropriate temperature**.

What does an appropriate temperature of hot water mean?

An appropriate temperature is a temperature, which will:

- Reduce the risk of a Legionella infection to a minimum
- Reduce the risk of scalding and cutaneous burns to a minimum
- Reduce problems of precipitation to a minimum

This document is intended to give a clear guidance, but does not supersede any current legislation or standard.

The owner of a residential building has the duty of care and must ensure that the tenants can use the building and its facilities safely. On one hand the risk of Legionella contamination requires the maintenance of a high temperature (around 55 - 60 °C, sometimes even more!). On the other hand this high temperature can cause serious injuries.

Thousands of children, elderly and disabled persons are severely scalded, burned and disfigured because of dangerous and unsafe domestic hot water systems. Almost 30% of all burn injuries are related to hot water. The majority of these injuries involve elderly and children under the age of five. Studies of thermal injuries presented on the below graph, show the relative importance of time and surface temperature in the causation of cutaneous burns (authors: Dr. Moritz AR, Dr. Henriques FC - American Journal of Pathology). According to this data severe, full-thickness scalding that causes irreversible second and third-degree burns can occur in 1 to 30 seconds at a temperature between 54 - 70 °C. At 63 °C, first-degree burns can occur in less than 2 seconds, but with a water temperature of 49 °C it would take much longer - approximately 5 minutes.

Since infants, young children and elderly may not be ably to respond quickly to a situation involving contact with hot water - a constant safe water temperature is essential for preventing scalds by tap water.

When reducing the temperature in order to prevent scalding you reach a temperature, which is ideal for Legionella bacteria to grow in the water system. A temperature high enough to kill the bacteria will scald users of the hot water and increase the risk of precipitation lime deposit. Only effective systems can be used to minimize the risks for scalding, Legionella and lime deposits. However, in many cases a high hot water temperature reduces either one of these risks and increases the potential risk from the other.

Scalding problems
(continuous)

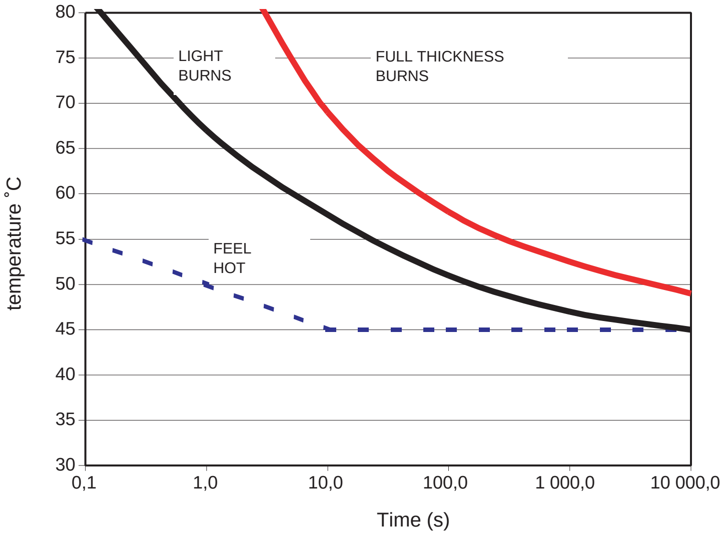


Fig. 6

Comments

The Danfoss solution based on electronic controls of valves installed in the circulation system (MTCV and CCR) and individual for each flat - thermostatic mixing valve for water (TVM-W) reduces all of the above-mentioned risks and provides the possibility to achieve individual regulation in a wide range.
A TVM-W - thermostatic mixing valve - tempers the water temperature in such a way that the temperature will not exceed the level at which the thermostat is set.
The MTCV and the CCR allow the maintenance of an appropriate circulation temperature in the systems simultaneously with recognizing thermal disinfection in minimum time and reducing the scalding and precipitation of deposit problem - providing maximum guarantee of thermal disinfection.

Local legislation in many countries e.g.: CBRF - Community Based Residential Facilities, ASSE - American Society of sanitary Engineering, CPSC - Consumer Product Safety Commission requires a safe pre-set temperature. The Danfoss solution can be adapted to this and thereby provides maximum satisfaction for both the owner of the building and the end-users.

References

- Brundrett, G.W.: Legionella and Building Services, Butterworth-Heinemann Ltd. 1992.”
- Chudzicki J. Bakterie Legionella w instalacjach sanitarnych, Politechnika, Warszawska, 1997
- Evans, C.C.: Clinical Aspects of Legionnaires Disease. Health Estate Journal, June 1993
- Makin, T. Legionnaires Disease Infection Control. Health Estate Journal, June 1993
- Seminar. Bakteriefrit varmt brugsvand - hvordan ? Odense Congress Center, Februar 2001
- Walker, J.T. & C.V. Keevi: The influence of plumbing tube materials, water chemistry and temperature on bio fouling of plumbing circuits with particular reference to colonisation of Legionella pneumophila ICA Project 437 C. International Copper Association Ltd., New York, 1994
- Wollerstrand J., Lund Institute of Technology, Sweden, Cyrkulacja Cieplej wody Użytkowej w świetle nowych wymagań temperaturowych i sanitarnych, Międzyzdroje 1999,
- Yu, V.L.: Resolving and Controversy on Environmental Cultures for Legionella - a modest proposal, Disinfection Control and Hospital Epidemiology, 1998, vol. 19, No. 12, pp. 893-897.

Please note that Danfoss does not assume responsibility for the research that has been performed with regards to legionella. Danfoss offers a product to fulfil the requirements of the research results.

Danfoss A/S
Sales Department
Building Controls Division
Hydronic Balancing
DK-6340 Nordborg
Denmark
Tel.: +45 7488 2222
Fax: + 45 7449 0394

http://www.hydronicbalancing.com

Danfoss Trata d.o.o.
Jožeta Jame 16, P.O.B. 4820
1210 Ljubljana - Šentvid
Slovenia
Tel.: +386 1/58 20 200
Fax: + 386 1/51 99 824

http://www.danfoss-trata.si