Legionella development in sanitary heat exchangers

B. Bleys (1), K. Dinne (2), M. Guarini (3), M. Roger (4)

(1) bart.bleys@bbri.be
(2) karla.dinne@bbri.be
(3) michel.guarini@bbri.be
(4) marilyn.roger@bbri.be

(1), (2), (3), (4) Belgian Building Research Institute (BBRI), Belgium.

Abstract

Legionella development in sanitary installations is often thought to be a storage problem. In order to determine whether specific measures are necessary to prevent Legionella development in instantaneous domestic hot water (DHW) production at low DHW production temperatures, a test setup with a small plate heat exchanger was built. *Legionella spp.* was cultivated in a separate water tank and used for the initial contamination of the heat exchanger. Once the biofilm was formed, the test setup was connected to uncontaminated drinking water and the DHW production temperature in the heat exchanger was set at 45°C, whilst the exchanger was continuously maintained at this temperature. Flushes at different flow rates and thermal shocks were implemented in order to reach *Legionella spp.* concentrations beneath 1000 cfu/l. Flushing proved to be ineffective at all flow rates tested. Shocks at 60°C, and even weekly shocks of 10 and 30 minutes at 65°C didn't suffice. Although increasing the DHW production temperature to 60°C reduced the *Legionella spp.* concentrations significantly, values above 1000 cfu/l were still obtained.

Keywords

Legionella development; sanitary heat exchangers, flushing, thermal shocks, hygienic water quality, LT district heating

1 Introduction

Most previous studies on Legionella development in sanitary DHW installations have focussed on installations with storage tanks [1,2,3]. Since the bottom of a storage tank is a known risk point for Legionella development, this is a logic choice, but it has lead part of the industry to believe that Legionella development is a storage problem. Even if a biofilm should form in a plate heat exchanger, during periods of stagnation, it would automatically flush out once the installation would be used again.

In order to determine whether specific measures are necessary to prevent Legionella development in instantaneous domestic hot water (DHW) production a test setup with a small plate heat exchanger was built.

As reducing the energy use for DHW production, whilst maintaining the desired comfort level for the building occupants, is becoming increasingly important, we focused on low DHW production temperatures (45°C). This production temperature is also very relevant for low-temperature (LT) district heating and LT heat networks within buildings [4].

2 Test setup

2.1 General description

The test setup, shown in Figure 1, is composed of an electrical boiler and a small plate heat exchanger with a content of 112 ml. As Legionella development in DHW distribution systems has already been studied intensively [1,2,3], the test setup was limited to the DHW production.

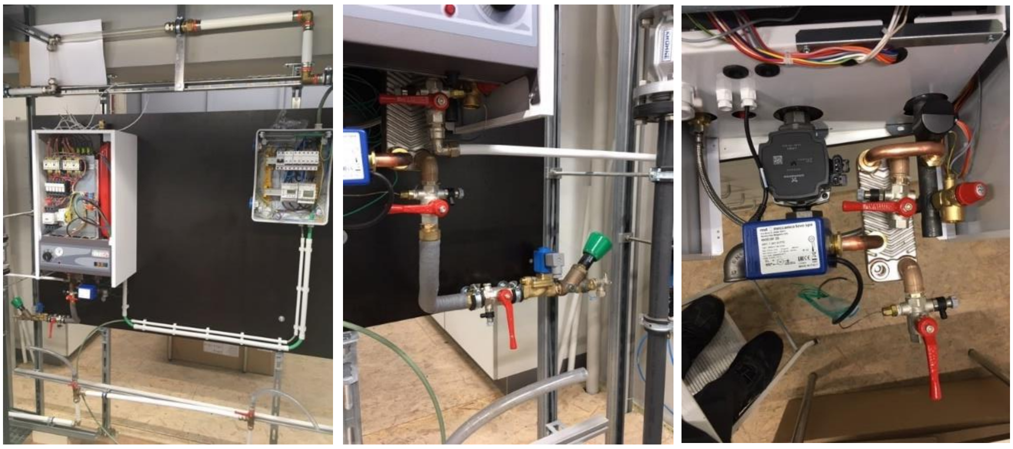

Figure 1 - Global view of the test setup.

Legionella spp. was cultivated in a separate water tank and used for the initial contamination of the heat exchanger. Once the biofilm formed, the test setup was connected to uncontaminated drinking water and the DHW production temperature in the heat exchanger was set at 45°C, whilst the exchanger was continuously maintained at this temperature.

2.2 Tapping profile

During the complete duration of the tests a tapping profile of approximately 160 l/day, typical for a 4 person-family was applied. The tapping profile was based on the one used in previous studies [2,3], but the tapping durations were converted, based on the applied flow rate, to obtain 160 l/day.

2.3 Flushes and thermal shocks

A series of different flushes and thermal shocks were implemented at a DHW production temperature of 45°C in order to try to reach stable *Legionella spp.* concentrations below

1000 cfu/l[1]. Table 1 gives an overview. After these tests, the DHW production temperature was increased to 60°C.

Dates	**T prod.** (°C)	**Flow rate** (l/min)	**T shock** (°C)	**Duration shock** (min)	**Freq. shock**
9/07/2020 – 14/08/2020	45	2	/	/	/
15/08/2020 – 31/08/2020	45	4	/	/	/
1/09/2020 – 21/10/2020	45	9	/	/	/
22/10/2020 – 11/11/2020	45	4	60	10	1x/week
12/11/2020 – 10/12/2020	45	4	60	30	1x/week
11/12/2020 – 27/01/2021	45	4	60	60	1x/week
28/02/2021 – 11/02/2021	45	4	60	10	1x/day
12/02/2021 – 24/02/2021	45	4	60	30	1x/day
25/02/2021- 11/03/2021	45	4	60	60	1x/day
12/03/2021 – 27/04/2021[2]	45	4	65	10	1x/week
28/04/2021 – 11/05/2021	45	4	65	30	1x/week
12/05/2021 – 15/06/2021	60	4	/	/	/

Table 1: Implemented flushes and thermal shocks

2.4 Measurements of Legionella concentration

Legionella concentrations were determined by culture method (ISO 11731: 2017 [5]) by our accredited lab.

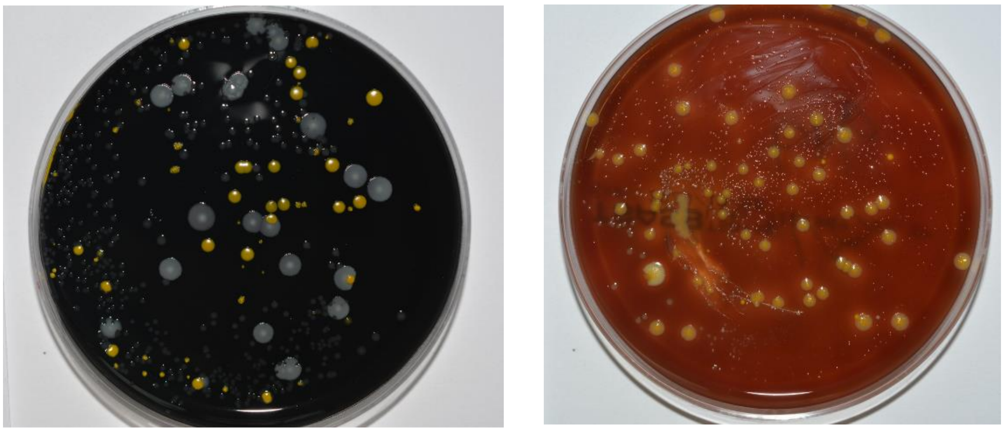

Figure 3 – Measurement of *Legionella spp.* concentration

[1] The advisory report from the Superior Health Council of Belgium for Health Care Premises, advises a maximum level of 1000 cfu/l *Legionella spp.* bacteria in order to minimise the risk of infections.

[2] Due to an accidental manupulation, de temperature of the thermal shock reached almost 80°C during appoximatively 1 minute on 26/03/2021

3 Results

Figure 3 shows the Legionella spp. concentrations at the outlet of the heat exchanger throughout the study

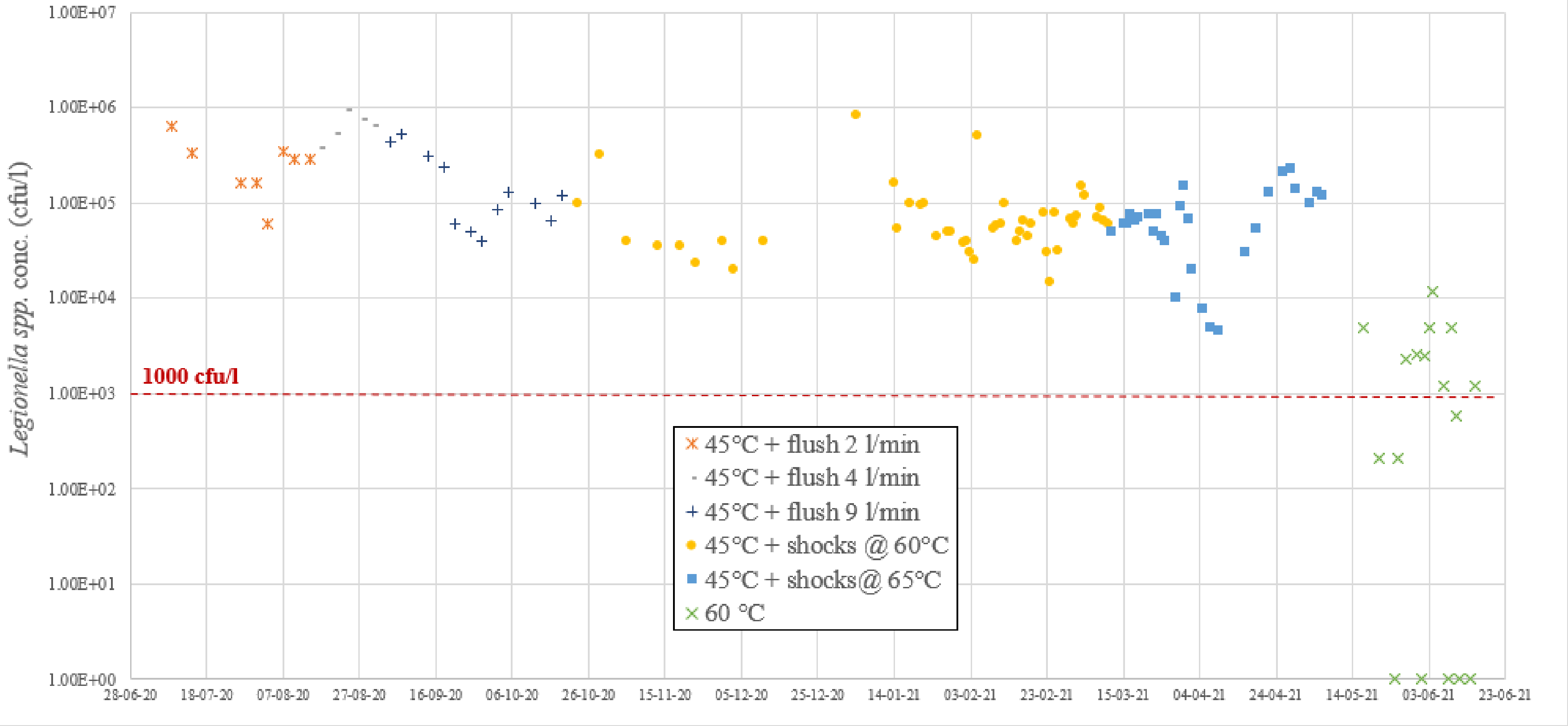

Figure 3 – *Legionella spp.* concentrations at the outlet of the heat exchanger throughout the study.

4 Conclusions

Although Legionella development in sanitary installations is often thought to be a storage problem, it has also proven to be important in instantaneous DHW production at low DHW production temperatures. At a continuous DHW production temperature of 45°C, flushes at different flow rates and thermal shocks were implemented in order to reach stable *Legionella spp.* concentrations beneath 1000 cfu/l. Flushing proved to be ineffective at all flow rates tested. Various types of shocks at 60°C, and even weekly shocks of 10 and 30 minutes at 65°C didn't suffice. Although increasing the DHW production temperature to 60°C reduced the *Legionella spp.* concentrations significantly, values above 1000 cfu/l were still obtained.

5 Acknowledgement

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6 References

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7 Presentation of Author(s)

Bart Bleys is bioengineer and head of the laboratory water technologies of the Belgian Building Research Institute (BBRI).	
Karla Dinne is biochemical engineer and head of the laboratory Microbiology and Microparticles of the Belgian Building Research Institute (BBRI).	
Michel Guarini is technician of the laboratories Energy and Hydrothermal Characteristics of the Belgian Building Research Institute (BBRI).	
Marylin Roger is technical responsible of the laboratory Microbiology and Microparticles of the Belgian Building Research Institute (BBRI).