Smart Heating Boiler De-Calcification & Legionella prevention Testimonial

Initial Requirement: Testing the effectiveness of using ultrasound to control legionella and calcification in an industrial boiler system.

Munchen StadtWerke (Municipal Service Company of Munich, Germany), maintains immersion heating systems on behalf of regional customers, including those in the Taufkirchen district of Munich.

These boiler systems (Fig. 1), typically comprise an arrangement where the secondary water for customer use, is heated by having a heat exchanger tube bundle (Fig. 2) immersed within it, through which the primary hot water is passed. The primary and secondary water circuits are kept separate from each other.

The main problem is the formation of pathogens, in particular Legionella bacteria, in the secondary water chamber, which is typically kept at a temperature of 55° C. To kill any germ formation, the boilers are traditionally heated up to a temperature of 80° C every night for an hour, which significantly increases energy use.

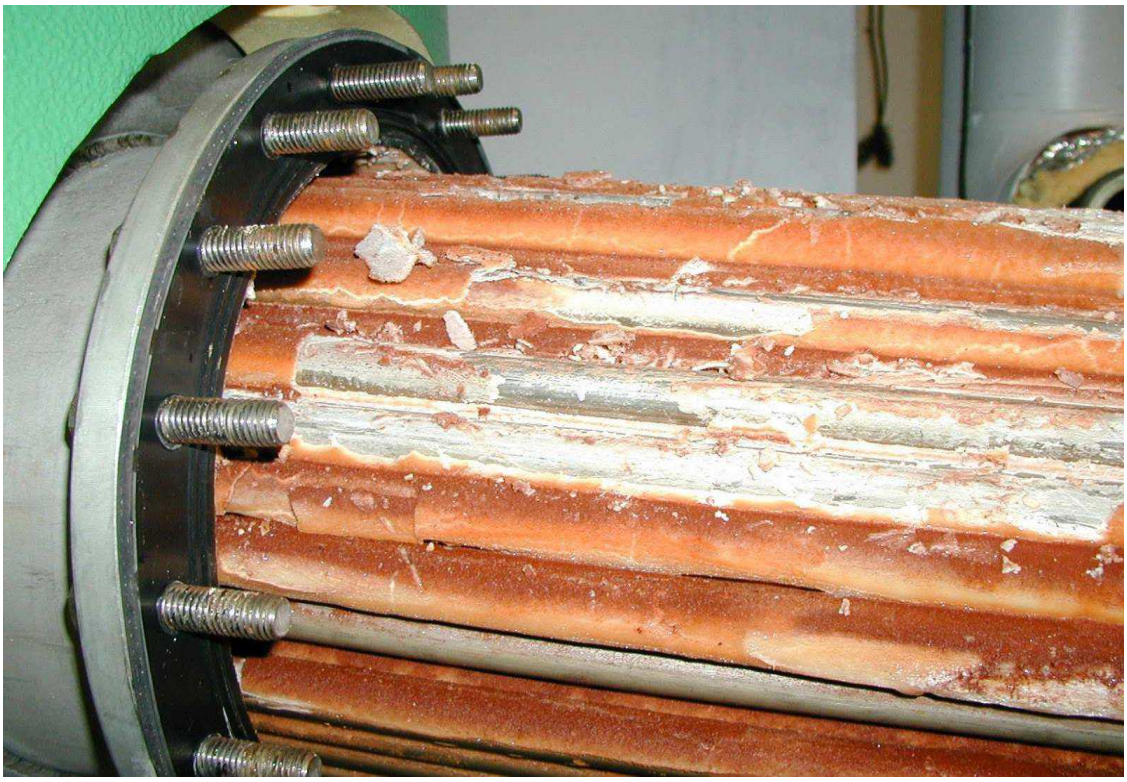
(Fig. 1)Warm Water Boiler 2000 L capacity

(Fig. 2) Internal Heat Exchanger tube bundle (cleaned)

Additionally, since the water in the region is very hard, lime-scale deposits become attached to the heat exchanger bundles after a period of use. (Fig. 3 and Fig. 4)

Once the heat exchanger becomes heavily calcified, heat transfer is significantly reduced and energy efficiency decreases, preventing a guaranteed permanent secondary water temperature of 55° C for customer use being achieved. Also, the preventative diurnal water heating cycle temperature of 80° C can-not be reached within the expected 1 hour time period, for the process of killing bacteria.

Consequently, the heat exchangers must be serviced and cleaned every 12 months by a special boiler descaling company, which cleans the bundle using an acid bath.



(Fig. 3) Calcification of the heat exchanger bundle after 12 months

(Fig. 4): The lime-scale is hardened and burned onto the pipes of the heat exchanger and must be dissolved with acid

Munchen StadtWerke, was searching for an economic but efficient alternative to fight the growth of pathogens in their warm water boiler systems. There was also the hope that a solution could also be found to counter the problem of lime-scale deposits inside the boilers; ideally by using the same system.

Was this just wishful thinking?

Could ultrasound be used to control both legionella and lime-scale deposits?

Both problems were effectively tackled by Efficient Sonics, who installed a „Smart Heating H 2000 L 2" ultrasonic device, into a hot water boiler with a nominal capacity of 2000 litres.

The ultrasonic devices of Efficient Sonics have been successfully used for many years in both domestic and industrial facilities, to control and reduce algae growth, reduce biofilm and biofouling, and dissolve lime-scale in ponds, cooling tower basins, and industrial process water systems.

The frequencies and signal profiles used by the ultrasound devices are specially tailored to suit the application.

It is well known that ultrasound in water has a cleaning effect on the surfaces it contacts. This cleaning effect also removes biofilm and biofouling.

Biofilm is the slimy layer which settles on the surfaces of basins and reservoirs, and provides a substrate for pathogens, like bacteria, to grow in.

If there is no biofilm present, there is correspondingly very little pathogen growth.

In addition, scientific research has shown that over a short distance, ultrasound signals can kill some pathogens like E-Coli bacteria for example.

The ultrasound signal also dismantles and removes calcification or other layers of encrusted deposits.

Test Method:

In the Taufkirchen district of Munich, there were housed in the cellar of a big apartment building, two identical warm water boilers. They were connected to a common output water pipe which provided the warm water feed to the tenant’s apartments. Consequently, both boilers were used equally and were individually heated by an internal heat exchanger bundle, using hot water from a central gas heating system.

In November, the leftmost of the two boilers had a Smart Heating 2000 L 2 installed, whilst the other boiler on the right was left alone, to act as a control for the experiment.

A single ultrasound transducer (speaker) was fitted using a flange, to the outer metal surface of the boiler and second transducer was fitted to the outside of the heat exchanger.

(Fig. 5): Flange for the ultrasound transducer

For these tests, a mounting flange was welded onto the casing of the boiler, as shown in Fig. 5 and Fig. 6.

However, a different mounting method is now used which does not require welding, considerably simplifying the installation process.

(Fig. 6) Flange with the Smart Sonic Heat transducer.
The boiler's thermal insulation jacket has been suitably cut out and the system is shown ready to run.

During the first three months of testing, both boilers were heated to 80° C at night, to kill any pathogens, like legionella.

An independent laboratory checked the water quality in both boilers once a week, analyzing and comparing the measured results. The outcome was no pathogens were found, either dead or alive.

During the subsequent three months, neither boiler was heated nightly to 80° C. Pathogen control relied entirely on the Smart Heatating system to do its job, which it performed admirably!

At the end of the test period, water in both boilers was tested for pathogens. Water in the boiler with the ultrasound device showed no germ or biofilm presence confirming that pathogens were not present inside that boiler. However, in the boiler without an ultrasound device, pathogens were found in alarming quantities.

After six months operation, both boilers were opened up for inspection to compare the amount of calcification present inside the boilers and on the heat exchanger bundles.

People were surprised to see that germ prevention in boilers, by using ultrasound, had been proven to work.

However, what about the un-expected positive side effect?

The cleaning power of ultrasound?

Could ultrasound be effective in reducing calcification of the boiler and heat exchanger bundle?

If our Smart Sonic Heat devices prevent the build-up of germs and pathogens, and also prevent or drastically reduce calcification inside a boiler or heat exchanger, the result could be considered a bit of a technical coup!

Also, the latest environmental protection regulations require keeping warm water boilers running at lower temperatures which could inadvertently increase the possibility of pathogen growth. There was previously no simple solution to this conflict.

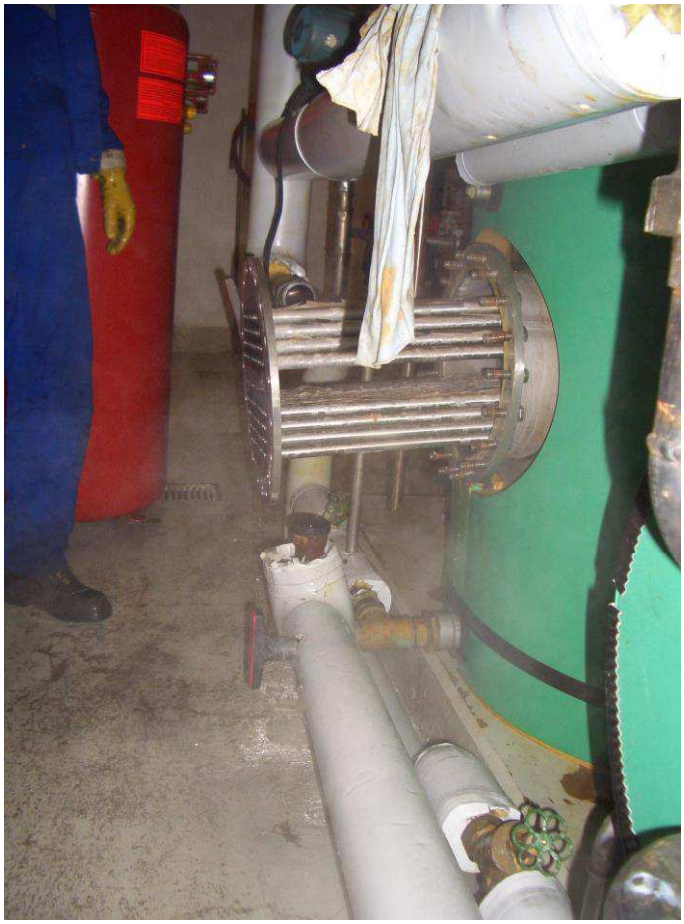
The result was astonishing!

(Fig. 7)
Service Engineers opening the boiler where the Smart Sonic Heat unit had been working for 6 months.

The second boiler, with no ultrasonic device installed, was also opened by the Service Engineers.

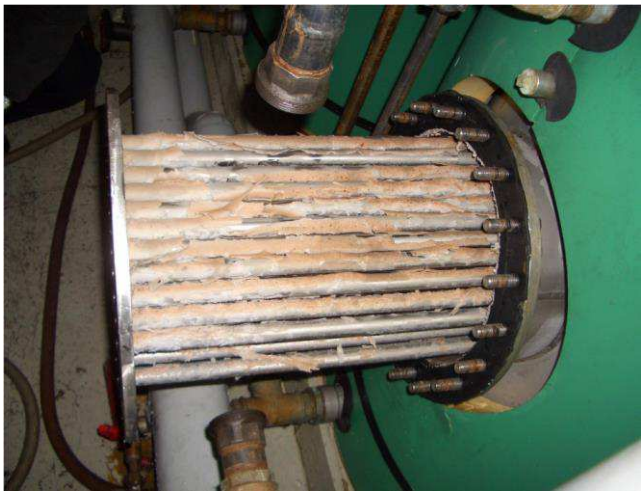
The Results were amazing, but make your own judgement!

With Smart Heating, by Efficient Sonics



(Fig. 8): The heat exchanger bundle is withdrawn from the boiler.
A bit of calcification is visible, but not as much as expected.

Without Ultrasound device



(Fig. 9): The bundle without ultrasonification has after six months, already developed a pretty thick and hard layer of calcium. Definitely much more than the other bundle.

What a difference, after 6 months only… see on next page.

With Smart Heating, by Efficient Sonics **Without Ultrasound**

(Fig. 11) Treated with Efficient Sonics Smart Heating

(Fig. 12): No ultrasound treatment

(Fig. 13) Comparing both bundles next to each other, showing approximately 2/3 less calcification!

And the boiler, how does is look?

With Smart Heating, by Efficient Sonics

(Fig.14) The boiler wall is very clean. Only on the bottom has a little bit of calcium / lime dust.

Without Ultrasound

(Fig. 15) Bottom of the boiler without ultrasound.
There is a lot of calcium / lime and it is brown and muddy.

(Fig.16) The boiler wall is totally clean and there is no biofilm visible. No wonder germs have no-where to grow here.

The wall, the bottom and even the inlet for the heat exchanger is very dirty, full of biofilm and calcium. A paradise if you want to breed germs.

Conclusion: There were no germs or pathogens growing and nearly no calcification in the boiler that was equipped with the Smart Heating device by Efficient Sonics. The process of heating up the boiler every night to prevent pathogen growth is no longer necessary. This saves considerable energy costs and the service interval to clean and de-calcify the boilers can be extended from 12 months to 48 months.

Immediate benefits include lower energy consumption and better energy efficiency.
However, the longer boiler service interval alone, saves at least 3000 GBP / per service!

By the way, Efficient Sonics Ltd. also offers an ultrasonic solution to protect your water pipes from limescale deposits.

Is that necessary you might ask?

Well, it is if you consider the enormous cost of re- plumbing the water pipe network in an apartment building!

This is how a typical water pipe in Munich looks after 21 years use!!! It is blocked up!