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## Expert report

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### Boiler insulation technology

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Most steam and hot water boilers are often in use for more than 8,000 hours a year, and during this time they emit heat into the surrounding atmosphere, depending on the technology they use. These losses from heat radiation and conduction are the same at every boiler load level. However, they differ completely for each manufacturer, depending on the design, the number and form of thermal bridges and the insulation technology applied.

The boiler designs from Bosch Industriekessel, which have been tried and tested for decades, use the best possible thermal technology and have a far better surface/performance ratio than other designs because of the heating gas conduits, geometry and layout of the combustion chamber and convection heating surfaces. In spite of this excellent starting point for keeping heat radiation losses low, we have also made use of further opportunities to minimise losses.

#### The insulation

##### Insulating mats without spacers

With the insulating technology used, no spacers are placed between the boiler body and the cylindrical insulating cladding, thus preventing thermal bridges.

There is no conduction of heat from the hot boiler drum to the insulating cladding, which means that the thermal insulation of the insulating mat is effective all over.

### Insulated inspection openings

The interiors of steam and hot water boilers have to be inspected regularly by the competent supervisory authorities. This requires inspection openings with special locks in the boiler body, for which openings have to be made in the insulating cladding. These openings are insulated and closed with screw-down insulating coverings. The inspection and cleaning openings in waste gas collection chambers and economiser housings are sealed using the same insulating technology, so that no increased radiation heat is lost through inspection openings. Marker labels are affixed over the inspection openings.

### Minimal thermal bridges

Thermal bridges at boiler stools and platform consoles are reduced to a minimum using structural measures. Boiler feet, boiler stools and platform consoles, which only adjoin the boiler body at the weld connection, reduce the thermal bridge effect. Elements used to improve structural loading and rigidity are underneath the insulation and do not conduct heat to the insulating cladding.

### Positioning of connections

Space conditions are often limited in already existing boiler houses. If necessary, individual adaptations can be made, e.g. lateral flue gas connection or free-standing economizer.

### More usable heat through innovative insulation materials

Boiler systems with front doors in contact with heating gas or built-on front reversing chambers use insulating materials that provide up to 30 % better thermal insulation values than standard insulating materials.

### Compact and surface-minimised

We have achieved this aim of increased customer benefits with virtually all our series of boilers. These boiler systems are fitted with fully integrated economizers for flue gas heat recovery without any appreciable increase in surface size. Separate housings insulated on all sides are only used for economizers that are retrofitted onto existing boiler systems.

### Insulation thickness

Bosch boilers are isolated with 100 mm thick mineral wool as standard. On the customers' request and in extremely cold boiler houses or regions, insulations of up to 150 or 200 mm are possible. By increasing the insulation thickness surface temperatures and heat losses can be reduced.

The challenge is to decide for a reasonable, economic optimization since the doubling of the insulation thickness does not mean that the heat losses from the insulating surface are halved (Figure 2).



Figure 1: ULS boiler with textured aluminium plate and insulated inspection openings

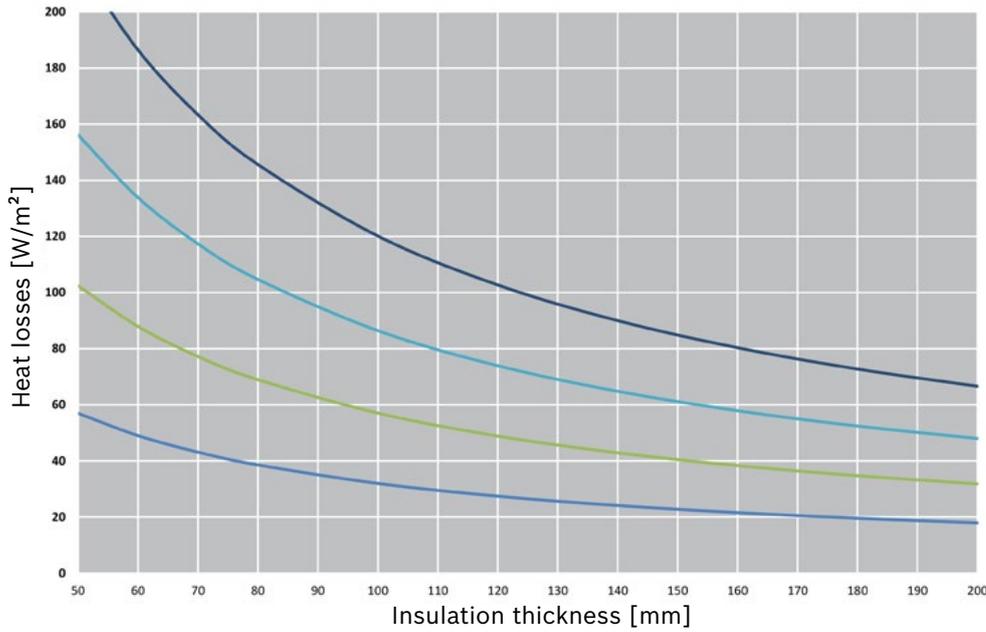


Figure 2: Heat losses via the isolated areas of the vessel or boiler surface

- Medium temperature 100 °C
- Medium temperature 150 °C
- Medium temperature 200 °C
- Medium temperature 250 °C

**Boiler insulation technology in practice test**

Not only hot spots with higher temperature losses but every temperature level can be detected with a thermal imaging camera, as seen in figures 3 and 4. Thermographic measurements on the boiler during operation clearly show the high level of thermal insulation by Bosch. The insulated areas show an even temperature distribution without visible, increased hot spots

which is proven by the examples indicated below. The red areas in the thermal images indicate the highest temperature losses. These often result from uninsulated valves and piping. In many cases even in new buildings, there is still no insulation of valves and flanges due to installation or financial reasons or sometimes simply because of different supply limits.

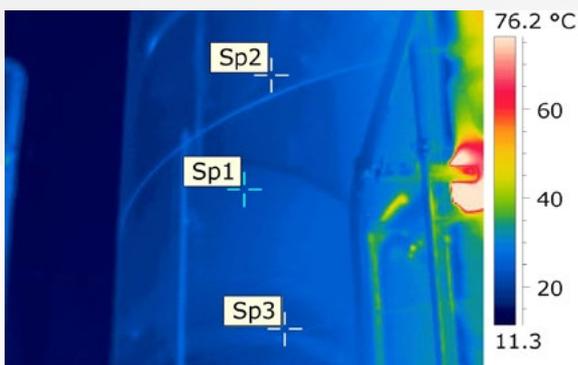


Figure 3: The picture on the right-hand side shows the position of the thermal camera. The measuring point Sp1 has a temperature of 21.7 °C, the measuring point Sp2 shows 21.2 °C and measuring point Sp3 22.8 °C.



Figure 4: The picture on the right-hand side shows the position of the thermal camera. The measuring point Sp1 has a temperature of 23.2 °C, the measuring point Sp2 shows 28.3 °C and measuring point Sp3 26.9 °C.

Unisolated valves can also be found in already existing plants. It is highly recommended to install the insulation subsequently to reduce the high heat losses at unisolated connections.

Besides the more complex examination with a thermal imaging camera it is mostly possible to detect and eliminate the hot spots with the highest heat losses even by sensing hot areas, visual inspection of the insulation or by means of a surface or radiation thermometer.

The surface temperature can only be taken as a measure for heat losses conditionally. This applies in particular when different surface materials are compared as a lower surface temperature sometimes indicates higher heat losses. Reason for that is the radiation coefficient of the insulation surface. A high coefficient results in increased heat losses but reduced surface temperatures at the same time. Therefore, the use of a material with a low emission coefficient is beneficial, as for example aluminium sheet.

**Bosch boilers with outstanding thermal balances**

In an examination of various manufacturers’ boiler surfaces isolated with insulating mats and cladding designed for a particular performance, it is clear that very different quantities of fuel are required to cover thermal losses, depending on the manufacturer. In the case of the boilers compared here, (A = Bosch and B), the Bosch boiler has a smaller surface area, thus saving thousands of litres/cubic metres of fuel oil/gas (Figure 5).

**Commercially outstanding, environmentally compatible**

Calculations have shown that the insulation technology used by Bosch Industriekessel gives far more savings than any other insulation of the same thickness which is not in line with the latest technological developments. Figure 5 also shows that insulating mats more than 150 mm thick do not make sense economically. We have squeezed out every last drop of benefit, commercially and environmentally, with all boiler systems through our design measures and through the use of our insulation technology. Mineral fibre mats, as used in house building, and biodegradable ceramic insulating mats are used, showing our total environmental awareness. The thermal insulation materials employed can simply be disposed of after use.

**Individual features\* – even at the design**

Industrial boilers by Bosch are produced according to the customers’ project-related requirements. Even colour, external design and the positioning of the connections can be adapted customer-specifically.

**The external cladding**

Bosch boilers can be equipped with three different surface materials as standard – depending on the installation location and surroundings. Customer specific requirements are verified upon request.

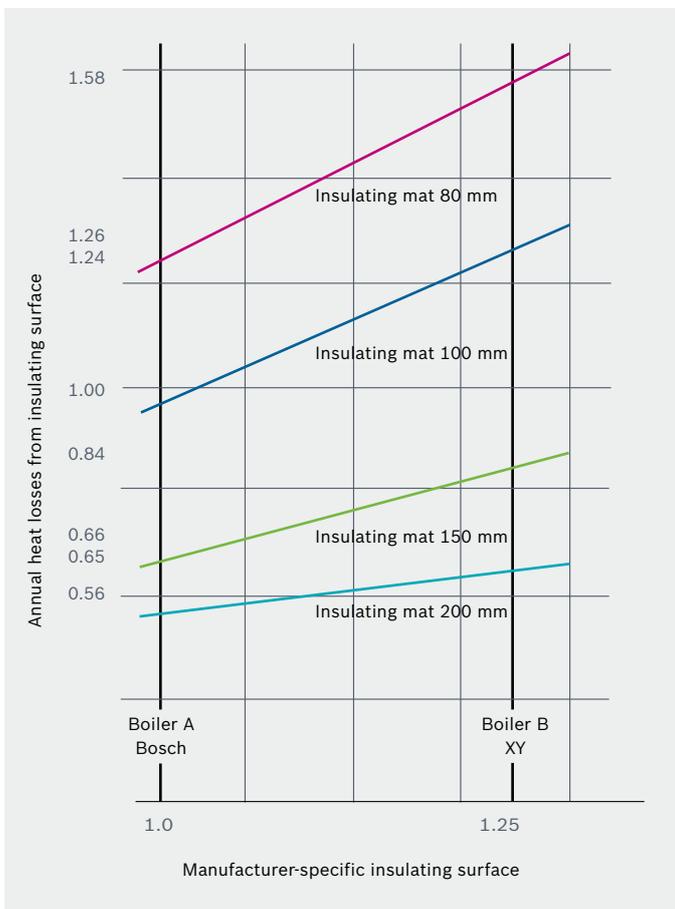


Figure 5: Trend of heat loss from two boilers with the same steam output with different insulating surfaces and thickness

\* Design adaptable according to customers’ requirements, partly with additional costs



Figure 6: External cladding with a textured aluminium sheet

The textured aluminium sheet, so called Alu-Stucco, that we use is extremely solid and resistant. Furthermore the material is cost-effective by means of purchase and a possible replacement after long-time use.

The emission coefficient, which indicates the heat losses, is very low. Therefore only little heat losses to the environment occur and the efficiency of the boiler is increased.

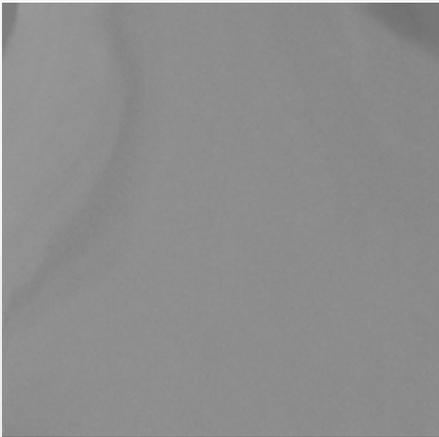


Figure 7: External cladding stainless steel

Polished stainless steel, as an option, has high optical qualities. It is more demanding in use, unevenness of the surface is easier to detect.

Often it is applied in boiler houses that are open to customers, e.g. for factory tours. Also in hygienically sensible areas as in the food and pharma industry or in hospitals or central sterilizations it is used.



Figure 8: External cladding galvanized steel

In case, no boiler house is available or the boiler is planned for outdoor installation for another reason, a special external cladding made from galvanized steel is required. It is weather resistant, all transitions and overlaps are sealed in addition.

As the surrounding temperatures are often below the ones in a boiler house, an efficient insulation is of utmost importance.

### For the installation in the boiler house

When the boiler is installed inside a boiler house, it is delivered as standard with a surface made of textured aluminium sheet, so called Alu-Stucco, which is free of heavy metals. It is solid, non-corrosive and forgives little carelessness in the boiler house (Figure 10).

Special demands require a particularly fine boiler cladding made of polished stainless steel (Figure 9). This is especially the case in hygienically challenging sectors, as for example in the food or pharma industry. Even modules, such as the control cabinet, can be delivered in stainless steel (Figure 12).

### For the outdoor installation

Bosch boilers for outdoor installation are designed in galvanized steel (Figure 11). Specific circumstances regarding weather conditions are considered in the finishing of the external insulation. All overlaps are sealed weather-proof and resistant materials are used in aggressive atmospheres, such as seawater-resistant aluminium.

### The colouring

All self-produced steel parts are delivered in anthracite and Bosch red as standard. Customer-specific colouring with company colours or different colours according to the customers' wishes can be applied (Figures 13 and 14).



Figure 9: Boiler with polished stainless steel

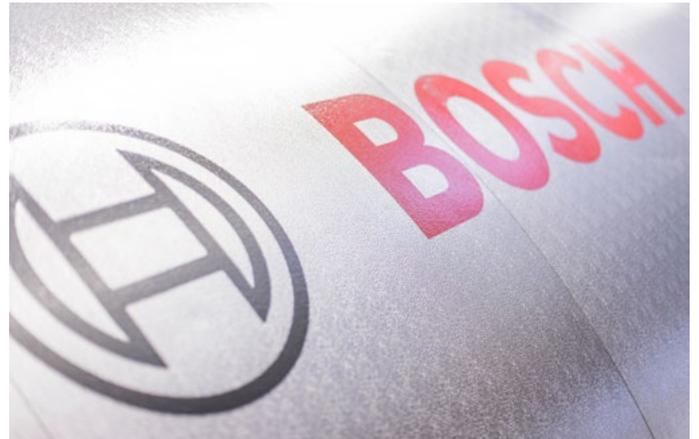


Figure 10: Standard boiler cladding in Alu-Stucco



Figure 11: Weather-resistant insulation for the outdoor installation



Figure 12: Bosch control cabinet in brushed stainless steel



Figure 13: Customer-specific colouring in the company logo's blue of Gaffel-Koelsch from Cologne, Germany.



Figure 14: Vivid red decorates the Bosch boilers at the Peter Wiersma heating plant in the Netherlands

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