

Striving for More Environmentally Friendly Boilers

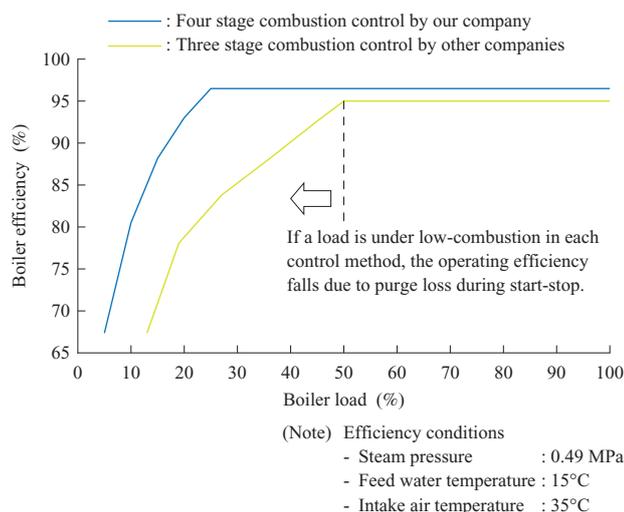
Small once-through boilers developed in the pursuit of energy saving and usability

Introduction to our state-of-the-art control technology and the newest model for each fuel type

Small once-through boilers, which require no official license for operation, are becoming the most common type of general industrial boiler. In the midst of many manufacturers doing their best to make advancements in this field, we introduce our patented combustion load control method for gas-fired boilers and state-of-the-art small once-through oil-fired boilers that reduce purge loss during start-stop.



Gas-fired small once-through boiler K-SEI series



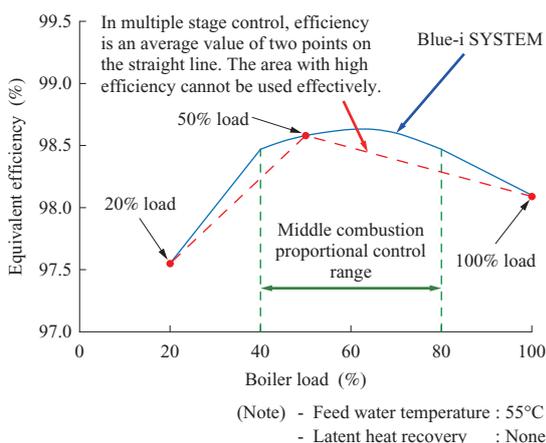
Superiority of four stage combustion control

Small once-through boilers require no official license for operation and a rapidly increasing number of such boilers are installed in the general industrial fields. Although such boilers can be used alone, they can substitute for large boilers (water tube boilers and fire tube boilers) by installing several boilers together and such demand is developing. In such circumstances, larger capacity and higher efficiency are required of small once-through boilers in order to reduce the cost of equipment and installation space and to save energy. We will present the characteristics of each combustion load control method for small oil-fired and gas-fired once-through boilers and the products based on them, from the view point of energy saving.

Control technology for oil-fired small once-through boilers

Multi stage combustion control, such as three stage combustion control (OFF-50%-100%) and four stage combustion control

(OFF-20%-60%-100%), are the mainstream for small once-through boilers. Four stage combustion control, which started from a technology patented by IHI PACKAGED BOILER CO., LTD. (IBK), is gaining popularity among gas-fired small once-through boilers due to its effectiveness. However, three stage combustion control is still the most common type of oil-fired small once-through boiler. Only IBK uses four stage combustion control. In three stage combustion control, if the heat load is lower than the minimum combustion load (50%), 50%-OFF is repeated and heat loss accompanying furnace purge at boiler start-stop occurs, causing the actual operating efficiency to drop drastically. In addition, since small once-through boilers hold only a small quantity of water and cannot supply steam by self-evaporation, the pressure drops soon after the combustion stops. Therefore, it is important to continue combustion in order to maintain steam pressure. In order to deal with these issues, IBK developed



Comparison of boiler efficiency by control methods

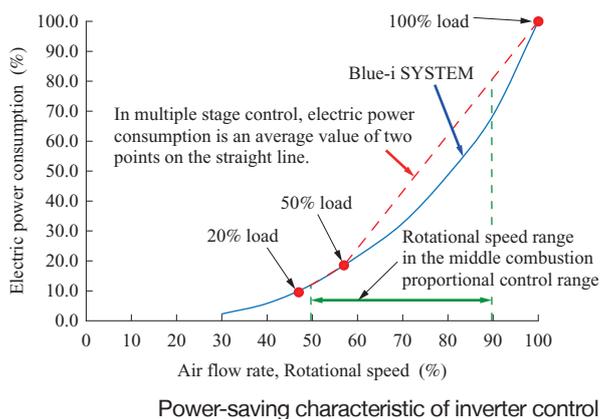
four stage combustion control, which can decrease the minimum combustion load by introducing a medium load, and made efforts to reduce this load further (improvement in the characteristics of combustion with low loads) and to improve the boiler efficiency. The oil-fired X series, which was put into production in 2014 (developed models from 1.6 to 2.5 t/h with equivalent evaporation), improves the rated efficiency to 96.5% and reduces the low combustion load to 25% by using newly developed burners (The best values in the industry were achieved for both rated efficiency and minimum load. Erosion at low temperatures by oil fuel was taken into consideration for rated efficiency. For minimum combustion loads, the drop in exhaust gas temperature is suppressed by partially bypassing the economizer water supply).

Control technology of gas-fired small once-through boilers

While four stage combustion control is becoming the mainstream in the gas-fired small once-through boiler market, IBK developed a new control method by using the controllability of gas fuel that makes the most of the efficiency characteristics of boilers. From the experience made in four stage combustion control over the years, it has been confirmed that boiler efficiency is better in the middle combustion stage than in high or low combustion of the sensible heat region. The new control method is a combustion of the middle combustion stage (40-80%), which is controlled by PI (Proportion and Integration), and the fixed high combustion (100%) and low combustion (20%) stages. It improves boiler efficiency in practical operations, prevents steam pressure change, achieves smooth response to sudden load change, and saves on electric power used by fans. The above control method is registered as a Japanese Patent No. 5399427, and is called the Blue-i SYSTEM.

Its characteristics are as follows.

- Effective utilization of the high efficiency region
As mentioned above, the performance characteristics of boiler efficiency show an inverted U-shaped curve in



Power-saving characteristic of inverter control

the sensible heat region. However, in stage control, as combustion is carried out at fixed points, efficiency moves along the straight line between two fixed loads. For example, in four stage control, efficiency in the middle load range (40-80% load) moves along the straight line connecting the fixed points of 20%-50%-100% loads. However, in the Blue-i SYSTEM, it moves along the original performance characteristic curve of boilers (an inverted U-shaped curve with a peak in the middle combustion stage). Therefore, even boilers with the same performance may show different operation efficiencies due to the differences in the control methods. Although the difference is small for one boiler, if several units are installed, the total difference for the all units is not negligible if the number of years of operation is considered.

- Effect on saving electric power
Four stage control and the Blue-i SYSTEM are different in electric power consumption in the same way as for boiler efficiency.

In addition, the new method has other characteristics such as improvement in smooth response to sudden load change, prevention of steam pressure change, and adaptability to existing systems. IBK accomplished the combination of Blue-i SYSTEM and high efficiency models to achieve 98% boiler efficiency. The system has already developed as the SEI series and includes models with 1.6 to 3 t/h equivalent evaporation.

IBK developed the optimal control method for both gas fuel and oil fuel. While it is expected that more energy saving measures will be taken in factories, IBK wishes to contribute to energy saving in general industry fields with products that realize high efficiency operation in a wide range of loads.

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