



Development of high efficiency gas burners for industrial use.

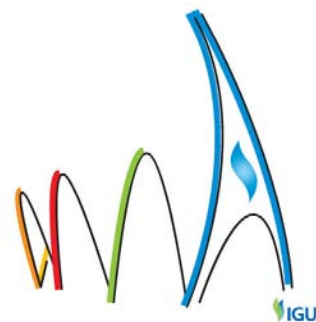
Yuki Shibata

Yoshihiro Kokura

Energy Engineering Dept., Osaka Gas Co., Ltd.

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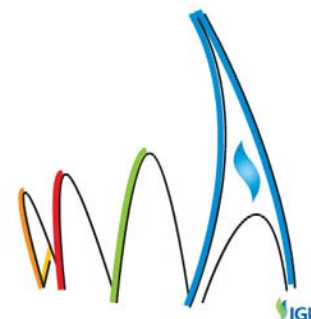
WORLD GAS CONFERENCE
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Background

In the Japanese industrial market, energy-saving industrial heating systems are required in terms of high energy price and green environment. Table 1-1 shows energy prices in some countries, it suggests energy price in Japan is higher than most of these countries. We, Osaka gas, have developed various high efficiency gas combustors, such as heat exchanger, recuperative burner and regenerative burner, and we have met our customer's requests for energy-saving by introducing these equipments. Recently, these demands are getting higher for various equipments and categories of industry. So we had to accelerate our development of high-efficiency gas burners for our customers' demands.

	Heavy fuel oil for industry (\$ /MWh)	Natural Gas for industry (\$ /MWh)
Austria	67.40	58.00
Belgium	61.57	35.99
Canada	61.00	11.90
Czech Republic	47.42	48.82
Denmark	77.50	92.00
Finland	...	45.75
France	63.80	51.14
Germany	60.18	51.04
Italy	74.28	68.00
Japan	80.51	92.05
Korea	77.80	64.80
Netherlands	57.90	38.62
Poland	66.70	43.96
Portugal	92.68	52.70
Slovenia	...	64.38
Spain	63.66	43.97
Sweden	124.80	63.32
Switzerland	62.30	71.71
Turkey	104.10	41.15
United Kingdom	77.90	38.45
United States	58.66	12.74

Source: "Key World energy Statistic 2013" etc

Table 1-1 : Energy prices in the main countries

Aims

The typical high efficiency gas burner, 'Regenerative burner', performs at high heating efficiency over 80%. It provides high energy-saving rate by heat exchanger which exchanges the heat energy between the furnace's exhaust gas and the combustion air via the heat storage material. Recently, we tried to improve our low capacity and compact 'Insert type Regenerative Burner (IREG) ' so that we can meet our customers' requests.

We have also developed exhaust heat recovering type gas burners. They can be introduced at lower initial cost while their heating efficiency is inferior to the regenerative burners. In order to increase our lineup of these gas burners, we have newly developed two kinds of gas burners, one is low capacity and compact 'High-efficiency Recuperative Burner (58kW)', the other is 'High-efficiency Single Ended Radiant Tube Burner (20kW)'.

Methods

1. New IREG (Insert type Regenerative Burner)

The structure of this burner is shown in Fig. 3-1. The features of this burner are as follows:

- High speed of combustion
- Heat storage ceramics set in the furnace wall (compactly set)
- Tapered ceramic case for heat storage body instead of burner tile (high durability, reduction in size and weight)
- Doughnut shaped heat storage ceramics made of SiC ceramics (Fig.3-1)

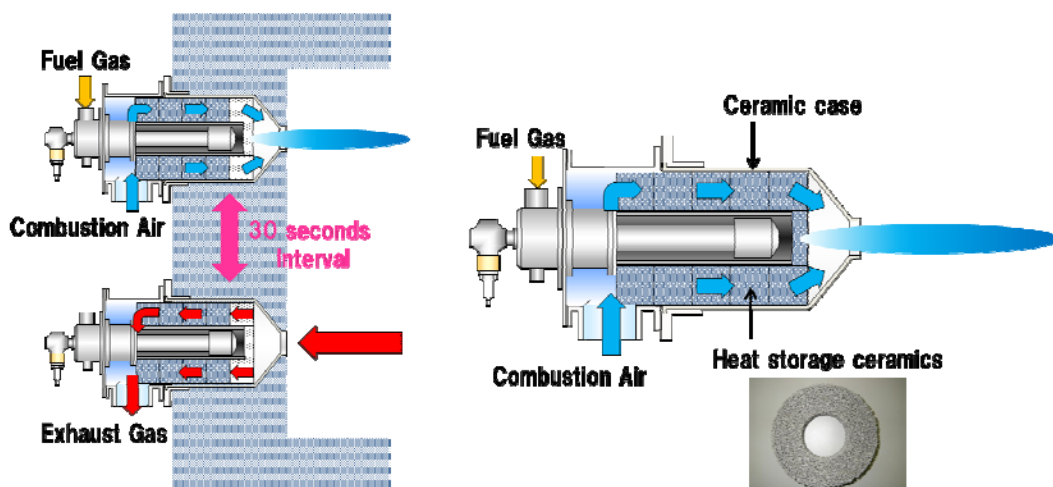


Fig. 3-1 : Structure of IREG



2. High-efficiency Recuperative Burner

The structure of this burner is shown in Fig. 3-2. The features of this burner are as follows:

- ① Doughnut-shaped heat exchanger with many fins on both inner side and outer side (increased area of heat exchange, increased current speed in the heat exchanger)
- ② Heat exchanger set in the furnace wall (compactly set)
- ③ High speed combustion air (low NO_x)
- ④ Air ejector installed in the exhaust stack (compactly set due to suction-blower-less)

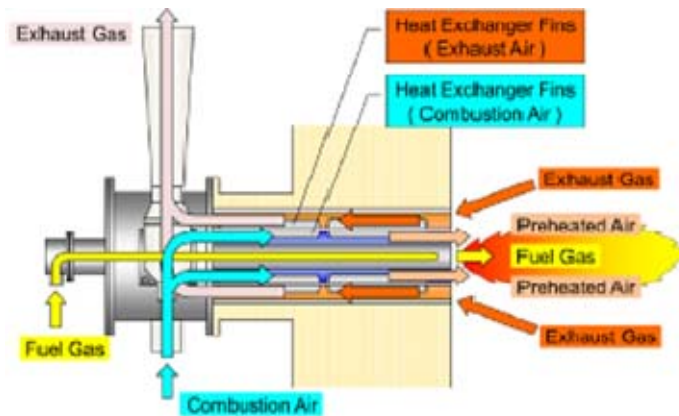


Fig. 3-2 : Structure of High-efficiency Recuperative burner

3. High-efficiency Single Ended Radiant Tube Burner

The structure of this burner is shown in Fig. 3-3. The features of this burner are as follows:

- ① Heat exchanger built in the burner body (increased amount of heat exchange)
- ② Exhaust gas recirculation for low NO_x

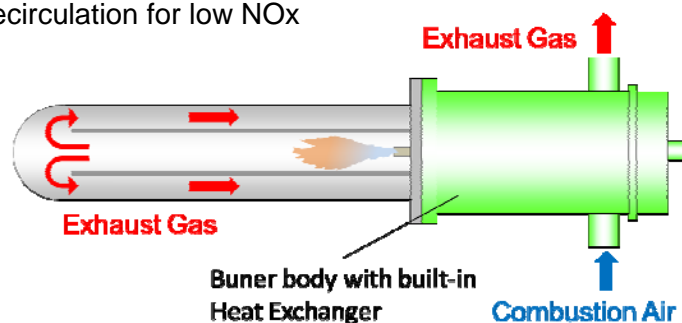


Fig. 3-3 : Structure of High-efficiency Single Ended Radiant Tube Burner



Results

1. New IREG (Insert type Regenerative Burner)

The performance of this burner is shown in Table 4-1-1. We achieved downsizing and high durability of regenerative burner while it offers high heating efficiency as the conventional type. The main advantages of this burner are as follows:

- ① Small installation space (heat storage ceramics set in the furnace wall, tile-less)
- ② High durability (no tile breakage)
- ③ Easy to handle (Fig. 4-1-2, reduction of weight and downsizing due to tile-less)
- ④ Low NOx (unique gas nozzle)

Table 4-1-1 : Performance of New IREG

Input	100kW
Heating Efficiency	84% (at 1150°C)
NOx	149ppm (O ₂ = 11%)
Max. temperature	1150°C

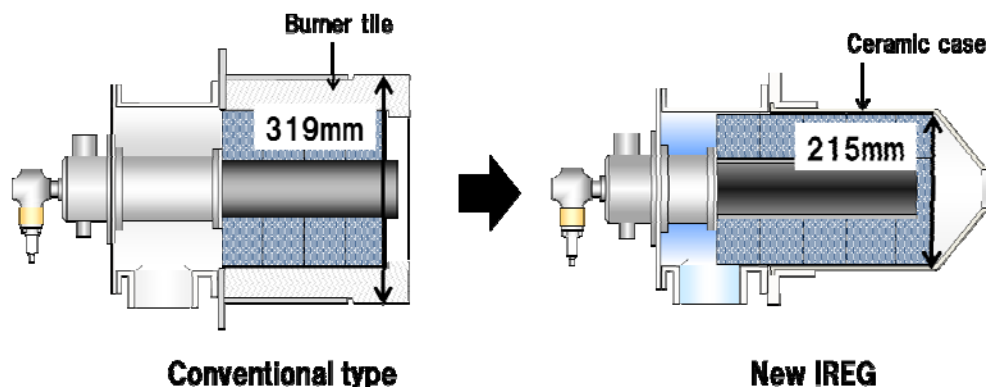


Fig. 4-1-2 : Comparison of structures of conventional type and new IREG



2. High-efficiency Recuperative Burner

The performance of this burner is shown in Table 4-2-1, and the comparison of heating efficiency between this burner and conventional one is shown in Fig. 4-2-2. This burner achieved high heating efficiency at 68% and low NOx as the recuperative burner. The main advantages of this burner are as follows:

- ① High efficiency
- ② 1/2 initial cost compared to regenerative burners
- ③ Low NOx (self EGR by high speed preheated air)
- ④ No suction blower (due to the ejector)

Table 4-2-1 : Performance of High-efficiency Recuperative Burner

Input	58kW
Heating Efficiency	68% (at 1000°C)
NOx	50ppm (O ₂ = 11%)
Speed of preheated air	90m/s
Max. temperature	1000°C

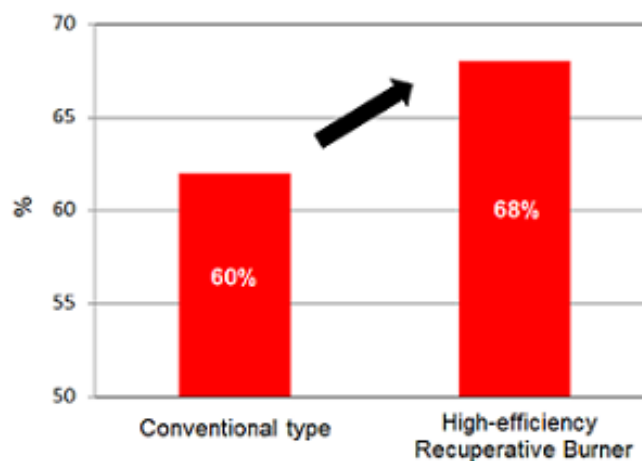


Fig. 4-2-2 : Comparison of heating efficiency



3. High-efficiency Single Ended Radiant Tube Burner

The performance of this burner is shown in Table 4-3-1, and the comparison of heating efficiency between this burner and conventional one is shown in Fig. 4-3-2. The heating efficiency of this burner achieved the highest level of 75%. The main advantages of this burner are as follows:

- ① High efficiency (exhaust heat recovery by built-in heat exchanger)
- ② Low NOx (unique gas nozzle and EGR)

Table 4-3-1 : Performance of High-efficiency Single Ended Radiant Tube Burner

Input	20kW
Heating Efficiency	75% (at 950°C)
NOx	148ppm (O ₂ = 11%)
Max. temperature	950°C

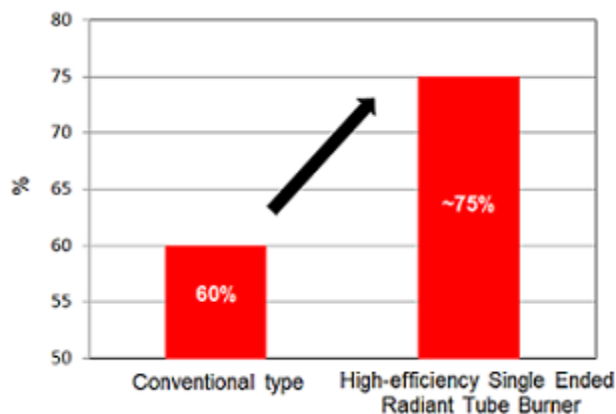


Fig. 4-3-2 : Comparison of heating efficiency

Summary

In order to facilitate energy-saving in our customers' equipment, newly we developed three types of high-efficiency gas burners. They are each superior to the conventional ones at efficiency, durability and initial cost. It enables us to offer our customers best –matched energy-saving solution from the wide lineup of energy-saving equipment, such as heat exchanger, recuperative burner and regenerative burner. In the future, we'll facilitate energy-saving for our customers by supporting their fuel conversion from the oil, LPG and electricity.