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## The Effect of Natural Gas Clean Utilization on Air Pollution Control

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# Air Pollution Condition in China

## Air Pollution Condition in China

Air pollution has become one of the biggest challenges in the world due to the fast speed of urbanization and industrialization. China has witnessed four stages of air pollution and its control.

It is the fourth stage now. It is featured as huge amount of pollutants, “regional” and “complicated”. The pollutants for control are SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>. And PM<sub>2.5</sub> is the main one.

As we all know, China is suffering from the serious PM2.5 pollution. And the smog it caused has become the focus of environmental issue. In 2013, 96% of the 74 cities under air quality supervision are out of national level. Some key regions are the highly PM2.5 polluted regions. Its density in 27 days in January 2013 exceeded the standard level. Only 4 days are with fine weather.

According to the research, the cause of PM2.5 is very complex. About 50% is the primary particles caused by the direct emission of pollutants source. Another 50% is the secondary particles caused by the chemical reaction of gaseous pollutants from the emission source. The main sources are coal burning emissions, vehicle exhaust, biomass combustion emissions, agricultural production, cooking smoke & building decoration.

## Air Pollution Condition in China

Chinese government has issued series policies to fight against air pollution, including revising *Ambient Air Quality Standards*, issuing *Air Pollution Prevention and Control Action Plan*, and revising *Emission Standard of Air Pollutants*.

In 2012, PM<sub>2.5</sub> density limit is raised to measure air quality.

In September 2013, the state council issued this aim: By 2017, air pollutants should be greatly reduced. And air quality in key regions should be improved so that the air quality nationwide will reach a better level. For example, PM<sub>2.5</sub> density of Beijing in 2014 is about  $86 \mu\text{g}/\text{m}^3$  and it is aimed to be reduced to  $60 \mu\text{g}/\text{m}^3$ . The main measure is to adjust the energy structure and increase the clean energy supply.

## Air Pollution Condition in China

- In 2014, the national government revised the pollutant emission standard for boilers. For example, the emission limit of NO<sub>x</sub> for gas boilers is lowered to 200 mg/m<sup>3</sup> from 400 mg/m<sup>3</sup>. In key regions like Beijing-Tianjin-Hebei, the figure is adjusted from 400 mg/m<sup>3</sup> to 150 mg/m<sup>3</sup>.
- Beijing is revising for local emission standard for boilers, and the emission limit is proposed to be lowered to 30 mg/m<sup>3</sup> from 150 mg/m<sup>3</sup>.
- Chinese government is taking a series of activities to improve the environment by taking the final effect to appraise the working performance of different levels of the government.

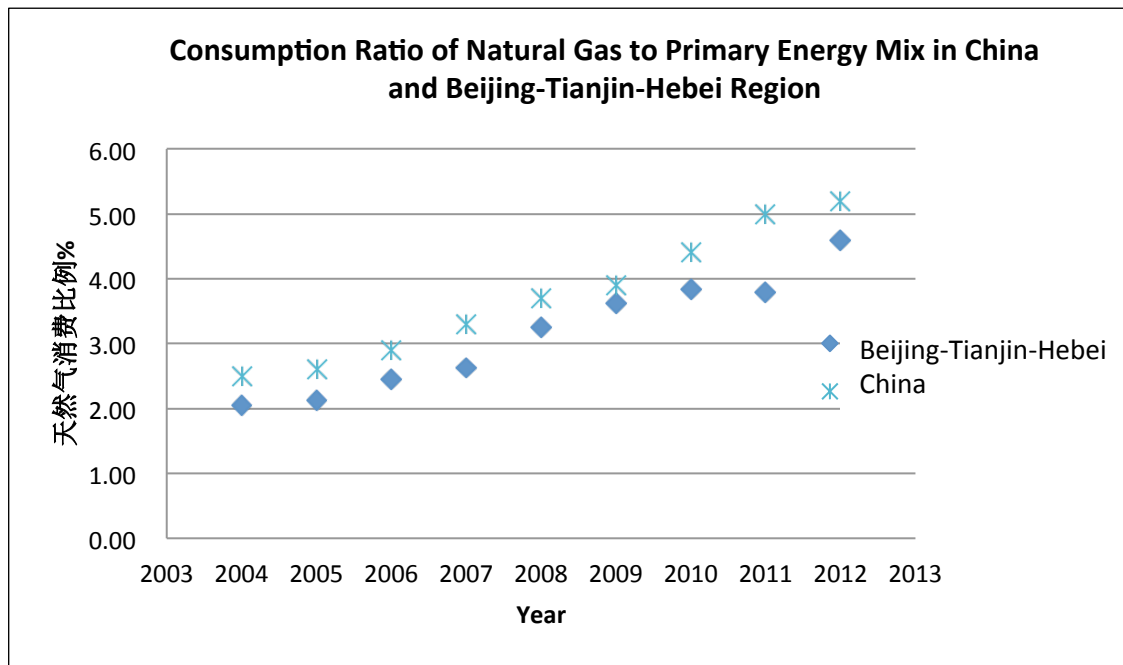
# The Clean Utilization of Natural Gas and Its Effect



# The Clean Utilization of Natural Gas and Its Effect

- Natural gas is the most ideal choice to replace coal and biomass. However, its reserve amount in China is not large. It takes a small share in the primary energy mix.
- It is 5.8% in 2013 and is estimated to be up to 9% by 2017, but it still falls behind the global 23.7% in 2013.

# The Clean Utilization of Natural Gas and Its Effect



This graph tells the consumption ratio. Even though it is rising, the share is still small.

The ratio of Beijing-Tianjin-Hebei region is even below national average. It is about 4.6% in 2012.

# The Clean Utilization of Natural Gas and Its Effect

- Faced with this limited storage, how to play its role as clean energy?
- China has conducted research on its utilization from various aspects.

## High-efficiency and Energy-saving Technology

- Exhaust Heat Utilization
- Oxygen Enriched Combustion
- High-efficiency Cooker for Chinese Cookery

## Low NOx Combustion Technology

- Low NOx Burner
- Chemical Looping Combustion

Some of them are already applied in the market and some are under the research process.

# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving

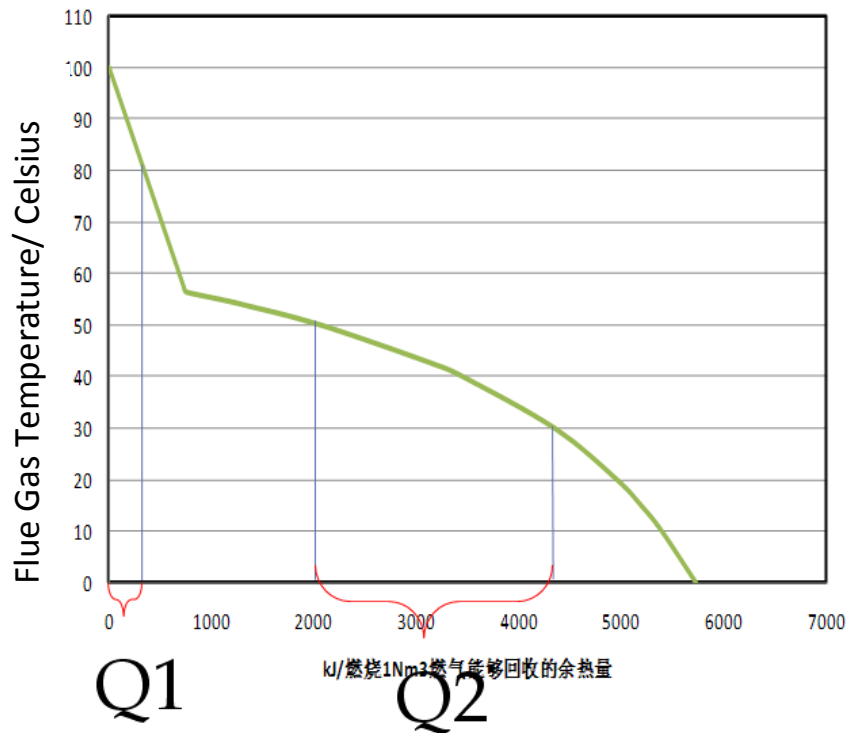
### Technology

#### Exhaust Heat Utilization

The flue gas emitted from gas boiler is normally above  $100^{\circ}\text{C}$ . From the graph we can see that when the temperature drops from  $100^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ , the heat amount of  $Q_1$  can be recollected between this  $20^{\circ}\text{C}$  difference.

When the temperature drops from  $50^{\circ}\text{C}$  to  $30^{\circ}\text{C}$ ,  $Q_2$  can be recollected between the same temperature difference, but we can see here  $Q_2$  is 5-6 times of  $Q_1$ .

Therefore, there is great potential for exhaust heat recollection in the low temperature section of flue gas.



# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving Technology

- However, the truth is that it is very difficult to recollect the heat, but our technology can solve this problem.

- The exhaust heat utilization technology can be applied to newly-built gas boiler or the boilers with the exhaust system upgraded. Take the 28 MW gas boiler as an example, the added 5 million RMB investment can be recovered within 3 years. Gas saving rate can exceed 10%. At the same time, it could effectively remove white smoke and save water.

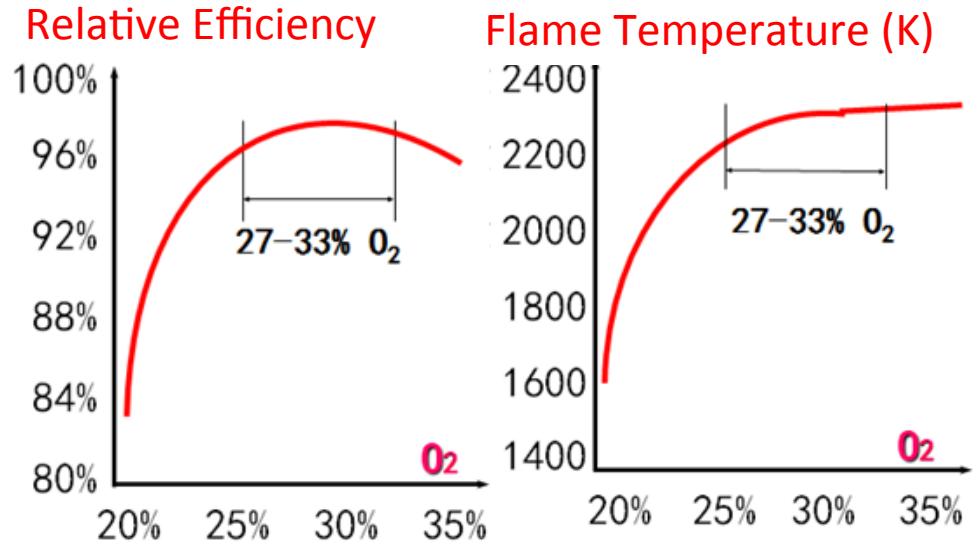


# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving Technology

### Oxygen Enriched Combustion

is also a maturely applied technology. It increases the flame temperature and reduces flue gas so that the heat efficiency will be improved. It will achieve the best comprehensive effect if the oxygen amount of the air can reach this rate range.



# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving Technology

### Oxygen Enriched Combustion

- It will increase the emission of NO<sub>x</sub> at the same time. Our technology reduces NO<sub>x</sub> by partially increasing the oxygen amount.
- The heat efficiency can be improved by 10%-30% and the NO<sub>x</sub> can drop 50% through oxygen enriched combustion.

# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving Technology

### High-efficiency Cooker for Chinese Cookery

“Stir-fry” in Chinese cookery requires high heat load, but the heat efficiency of current cookers is relatively low. For the products developed by the Research Institute for commercial use, the heat efficiency can be over 40%.





# The Clean Utilization of Natural Gas and Its Effect

## ---High-efficiency and Energy-saving Technology

- In summary, the popularization of high-efficiency & energy-saving technology will play an important role in air pollution control.
- By 2020, it is estimated that 23 billion m<sup>3</sup> natural gas will replace coal in Beijing-Tianjin-Hebei Region. Its utilization may save more than 10% natural gas, so that the emission of CO<sub>2</sub> and NO<sub>x</sub> will be relatively reduced. This will make a difference in air pollution control.

# Low NOx Burner

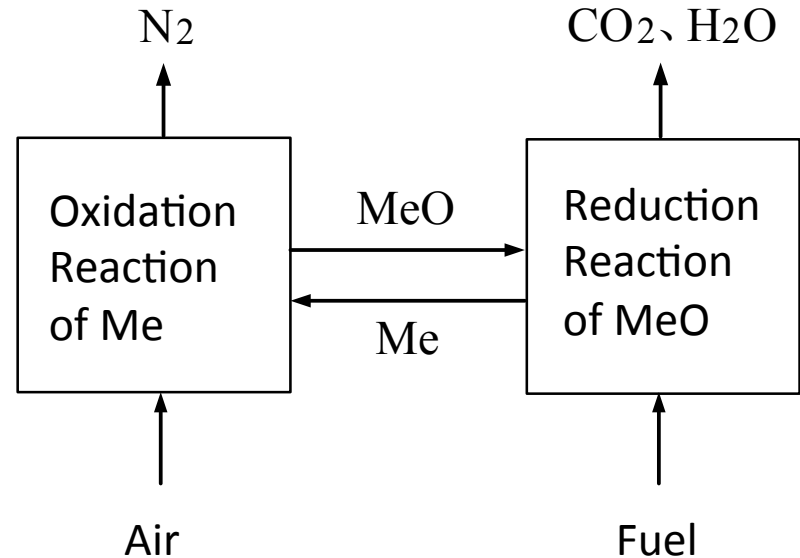
- The key lies in lowering the flame temperature to reduce the formation of NOx. With years of experience, the Research Institute has developed low NOx emission burners for different applications, which has become the pioneer for its development in China.
- NOx emission is under 40 mg/m<sup>3</sup> for the developed cooker for residential use and the figure is 20 mg/m<sup>3</sup> for commercial use. These products have been widely applied in Beijing.
- The ultra-low NOx burner for gas boiler under research is aiming to bring the emission down to 30 mg/m<sup>3</sup> and is planned to be applied as pilot project in 7MW gas boiler.

# The Clean Utilization of Natural Gas and Its Effect

## ---Low NOx Combustion Technology

### Chemical Looping Combustion (CLC)

- As for low NOx technologies, chemical looping combustion (CLC) technology is the one that can truly realize zero emission. The oxygen carrier separates oxygen and nitrogen in the air through oxidation reaction, so that nitrogen will not be involved in the reduction reaction with fuel. In this way, the zero emission of NOx can be realized.



# The Clean Utilization of Natural Gas and Its Effect

## ---Low NOx Combustion Technology

- Currently, the difficulty of CLC lies in the life span of the oxygen carrier. Normally, it can last about 200h, which cannot fulfill the requirement for its popularization in the market.
- The Research Institute is conducting a research on commercial oxygen carrier that can last more than 2000h, which will be tested through pilot project.

# The Clean Utilization of Natural Gas and Its Effect

## ---Low NOx Combustion Technology

- The application of NOx combustion technology enjoys a good future in the process of air pollution control and plays a key role in reducing PM2.5.
- In Beijing-Tianjin-Hebei region, it is estimated that 23 billion m<sup>3</sup> natural gas will replace coal. The combination of these two technologies will further reduce the emission of NOx and the density of PM2.5 in the air, which effectively improves air quality.

# Vision towards Air Pollution Control

## Vision towards Air Pollution Control

- Efficient utilization of natural gas resource and the promotion of these technologies will make a difference in air pollution control of China.
- Through our combined efforts, environmental condition in China will be greatly improved in the coming 5 to 10 years.

## Vision towards Air Pollution Control

- Beijing Gas Group Research Institute is the professional R&D center. Beijing consumes 10 billion m<sup>3</sup> gas last year as a single city. The Research Institute conquers series technical difficulties and provides technology support and guidance to its safety operation.
- We welcome gas friends from all over the world for technical visit and exchange. Look forward to communication and cooperation on gas application technologies!



