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Investigation and Research on the Treatment of Air Pollution by Heating Boiler of Beijing University of Chemical Technology

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Abstract: On June 10, 2015, Beijing Municipal Environmental Protection Bureau issued “Boiler Atmospheric Pollutant Emission Standard” DB11/139-2015. Starting from April 1, 2017, NO_x emissions from newly built boilers must be below 30mg/m³ and from in-use boilers must be below 80mg /m³. For implementing the emission reduction work in Beijing, according to current situation of boiler room in Beijing University of Chemical Technology, the school authorities do a series of work, including visits, market research and data analysis, attend academic conferences. On how to deal with the problem of air pollutant discharge standard of boilers in our university, we analyse the relevant emission standards at home and abroad, pollution prevention and control technology, low-nitrogen combustion principle of gas-fired industrial boilers and its technical development status, and put forward three solutions[1][2]. Through the comparison of advantages and disadvantages, the optimal solution is obtained.

1. Introduction

From April 1, 2017, the “Emission standard of air pollutants for boilers” (DB11/139-2015) [3], based on the national pollutant discharge standard and in combination with the current situation of Beijing, controls the pollutant discharge limit more strictly. The implementation of the new Standard further demonstrates the country's determination to control the discharge of pollutants.

2. Necessity of reforming the heating boiler room

2.1. Boiler status

There are eight boilers in three boiler rooms on the East campus, the West campus and the dormitory area of Beijing University of Chemical Technology, with a total heating area of about 458,000 m². The heating area is scattered and the management cost is high. The following Table shows the specific parameters of the 8 boilers.

Table 1. Status of gas boiler rooms

Boiler room	Boiler type	Quantity	Date of commissioning	Status Overhaul	Current heating area
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East Campus	WNS5.6-1.0/95/70-QT Shuang Liang	Four	2001.07	Replacement of all smoke pipes, pull bars in 2013	About 332200 m ² An increase of 25,000 m ² is projected
dormitory area	WNS2.8-1.0/95/70-YQ Shuang Liang	Two	1999.02	Replacement of all smoke pipes, pull bars in 2013	About 40,500 m ²
West Campus	WNS4.2-1.0/115/70-Q Fuzhou	One	2000.02	Replacement of all smoke pipes, pull bars in 2013	About 95,100 m ²
	WNS7.0-1.0/95/70-Q Shuang Liang	One	2007.09	Replacement of all smoke pipes, pull bars in 2013	

2.2. Emission status of pollutants

In 2015-2016, the pollutant emission of boilers in the three boiler rooms of University of Chemical Technology is shown in table 2. After the implementation of the new standard, the emission of pollutants exceeds the standard and does not conform to the policy of energy conservation and emission reduction.

Table 2. Pollutant discharge

pollutant boiler	oxygen content in flue gas	Average concentration of sulfur dioxide emissions / mg/m ³	Converted emission concentration of sulfur dioxide / mg/m ³	Average NO _x emission concentration / mg/m ³	Converted emission concentration of NO _x / mg/m ³	NO _x emission rate /kg/h
No.1 boiler in east Campus	5.5	2	2	128	145	0.78
No.2 boiler in east Campus	1.7	3	3	163	148	0.89
No.3 boiler in east Campus	4.7	2	2	128	137	0.46
No.4 boiler in east Campus	5.0	2	2	127	139	1.3
No.1 boiler in west dormitory area	4.3	2	2	126	132	0.27
No.2 boiler in west dormitory area	2.3	3	3	125	117	0.23
No.1 boiler in west Campus	3.3	2	2	108	109	0.48
No.2 boiler in west Campus	3.4	2	2	143	142	0.7

2.3. Comparison of standards

According to the “Emission standard of air pollutants for boilers” GB13271-2014[4], NO_x emission standard of newly-built boiler is 200 mg/m³. After the new standards issued, the Beijing local standards specified that the NO_x emission standard for boilers which built before the March 31, 2017 is 80 mg/m³, and the NO_x emission standard for boilers which built after April, 1st, 2017 is 30 mg/m³.

Under the pressure of environmental air quality improvement, Southern California in the United States was the first to raise NO_x emission standard to 18mg/m³. As can be seen from the figure below, the new standard of Beijing is also very strict compared with the international level.

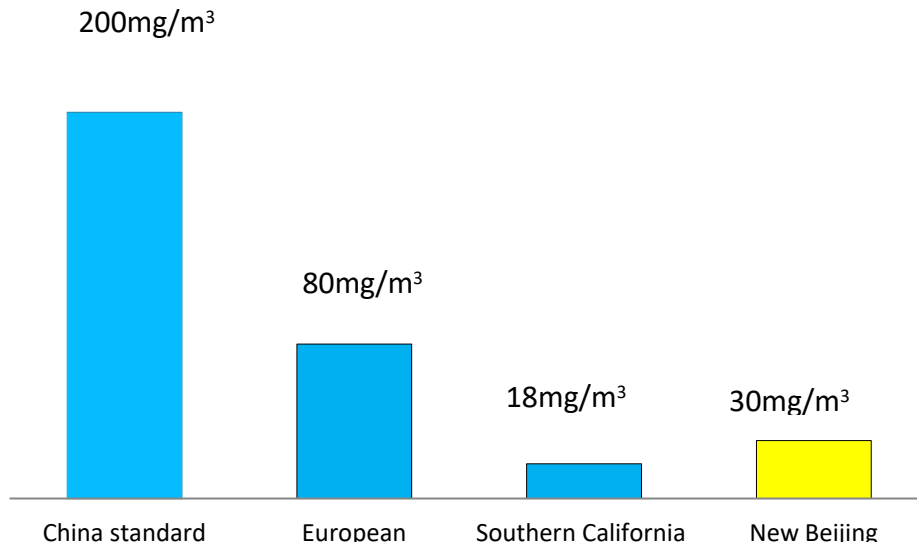


Figure 1. Comparison of pollutant emission standards in different countries

2.4. Incentive Scheme

For the implementation of the new standard, the Beijing finance bureau, the Beijing municipal environmental protection bureau, the Beijing municipal commission of economy and information technology, the Beijing municipal development and reform commission issued the “Measures for the administration of incentive Funds for Technical Renovation Projects of Air Pollution Prevention and Control”.

Chapter III(“ funding standard ”),Article 5 of this Measures pointed out that:“ With advanced pollution prevention and control technology, if the emission concentration of the treated objects (pollutants) after the transformation is lower than 50% (including) of the current environmental protection standard limit, and the pollutant removal efficiency is greater than 20%, the fund will be awarded according to 30% of the total investment of the project to encourage the majority of enterprises to carry out energy conservation and emission reduction work.”

Thus, it can be seen that the 10-ton boilers in the West Campus have been in use for nearly 10 years, and the other 7 boilers have been in use for about 16 years which with a long service life. It is an important content of future work to reasonably solve the problem of excessive pollutant discharge and longer boiler service life.

3. Scheme and analysis of pollutant emission control

3.1. Comparison of schemes

Option 1: Replace burner (NO_x <80 mg/Nm³)

The original size of the burners in the three boiler rooms meets the replacing requirements. The imported low-nitrogen burners can be replaced without changing the boiler body. Meanwhile, a flue gas condenser can be installed at the back end of the boiler body for waste heat recovery. NO_x emissions are less than 80mg/Nm³. The investment estimates are shown in table 3.

Table 3. Investment estimation for Option 1

Boiler room	The boiler model	Quantity (unit)	The total price (ten thousand yuan)	Estimate government subsidies (ten thousand yuan)
East Campus	WNS5.6-1.0/95/70-QT (8 tons)	4	251	42
West Campus	WNS4.2-1.0/115/70-Q (6 tons)	1	55.5	8.5
	WNS7.0-1.0/95/70-Q (10 tons)	1	83.5	12.5
west and east dormitory area	WNS2.8-1.0/95/70-YQ (4 tons)	2	94	12.6
total		8	484	75.6

Note: removal installation fee is included in the total price.

Option 2: Replace Boiler (NO_x <30 mg/Nm³)

All 8 heating boilers in the three boiler rooms will be replaced with flue gas condensers. Considering the heating over measure, the original four 8-ton boilers in the East campus are replaced with two 8-ton boilers and two 10-ton boilers. Two 4-ton boilers are equipped in the dormitory area; The west campus is equipped with two 6-ton boilers. NO_x emissions are less than 30mg/Nm³. The investment estimates are shown in table 4.

Table 4. Investment estimation for Option 2

Boiler room	The boiler model	Quantity (unit)	The total price (ten thousand yuan)	Estimate government subsidies (ten thousand yuan)
East Campus	WNS5.6-1.0/95/70-QT(8 tons)	2	220	56
	WNS7.0-1.0/95/70-Q(10 tons)	2	260	56
dormitory area	WNS2.8-1.0/95/70-YQ(4 tons)	2	140	34.8
West Campus	WNS4.2-1.0/115/70-Q(6 tons)	2	160	46
The demolition and installation fee			130	
total	56 tons	8	910	192.8

Option 3: Replace boilers in East and West Campus and outsource boiler rooms in dormitory area

Since the project of changing coal into gas completed in boiler houses of dormitory area, the energy consumption of per square meter. has been maintained at a high level. The mean reason is the heating areas are all old residential buildings. Except for the renovation of external wall insulation of two buildings of the No. 3 printing Plant in 2015, the other buildings remain as they are and the building consumes a lot of energy. The boiler room in dormitory area can be handed over to the social professional organization, then it will reduce a lot of burden. The investment estimates are shown in

table 5.

Table 5. Investment estimation for Option 3

Boiler room	The boiler model	Quantity (unit)	The total price (ten thousand yuan)	Estimate government subsidies (ten thousand yuan)
East Campus	WNS5.6-1.0/95/70-QT(8 tons)	2	220	56
	WNS7.0-1.0/95/70-Q(10 tons)	2	260	56
dormitory area	WNS2.8-1.0/95/70-YQ(4 tons)	outsource	--	--
West Campus	WNS4.2-1.0/115/70-Q(6 tons)	2	160	46
The demolition and installation fee			130	
total	56 tons	8	770	158

3.2. Scheme analysis

The advantages and disadvantages of different schemes are shown in the table below.

Table 6. Comparison of advantages and disadvantages

	advantages	disadvantages	fee
Option 1	a. Low cost, convenient construction	a. The problem of mismatching between burner and existing boiler body is easy to occur; b. The secondary matching problem when the boiler body is replaced again;	low cost
Option 2	a. Meet the emission standard at one time without any secondary matching problem; b. heating over measure of East campus;	a. high cost;	high cost
Option 3	a. Meet the emission standard at one time without any secondary matching problem; b. heating over measure of East campus; c. outsource boiler rooms in dormitory area, reduce a part of capital and management pressure	a. high cost; b. difficult to sign and manage the outsourcing contract;	Medium cost

4. Conclusion

The problems such as long service life of boiler in Beijing University of Chemical Technology, aging boiler body, small heating area and high energy consumption in the boiler room in the dormitory area are the disadvantageous factors affecting the boiler room reconstruction. Considering the pollutant emission index, the influence of energy efficiency, safety control, input and operation cost and the

complexity of operation and supervision, all boilers should be replaced in three campuses to reduce the pollutant emission to 30mg/m³, which is the best solution to solve the problems such as high energy consumption and pollution emission limitation. After the renovation was completed in October 2017, the boiler room was put into use and operated well, with pollutant emissions meeting the new standards.

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