The Analysis and Assessment on Heating Energy Consumption of SAT

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Abstract: The article introduced the fuel-energy consumption and outdoor temperatures of three heating terms from year 1999 to 2002 of SAT's fuel-boiler heating system. It demonstrated the relationship between the consumption and the temperatures by using the regression analysis method. It also calculated the economization of the fuel, introduced the methods of economizing fuel and, made an assessment on it.

Key words: the daily average temperature, the highest average temperature, the lowest average temperature, the daily consumption of fuel

0. INTRODUCTION

According to the environment protection request from the Beijing government, from 1996, all fuel-boilers in Beijing have to use clean fuel.

I has been in charge of the design and retrofit of SAT's fuel-boiler since 1997, during this time, I kept trying to improve the efficiency and got quite a satisfied result. And I got quite some achievement on the fuel-boiler's energy saving. Now I would make a comparison basing on the weather, fuel consumption and other data of three heating terms from year 1999 to 2002, in hope of discovering the fuel saving rules of such heating systems.

1. SYSTEM COMPOSITION AND CONTROL PRINCIPLE

1.1 Beijing government prescribe that the heating term dates from November 15th to March 15th. That is 121 days in total. The actual heating term is determined by the climate. (For more details, see Tab.1.

Tab.1 The Heating Term & The Fuel Consumption

year	Heating term	Total fuel consumption	Daily fuel consumption
99-00	142	353.70	2.4908
00-01	151	339.98	2.2515
01-02	150	252.21	1.6814

1.2 Total heating area is 60,000m^2 , among it the SAT buildings' area is 31,000m^2 ,the other buildings' area is 29,000m^2 .

1.3 The heating plant includes 4 constant pressure heat water boilers, whose rated power is 1.75NW, made in 1997. The total power of plant is 7 NW.

1.4 The fuel-boiler heating system use computers to control and adjust the facilities' operation, records, feed back and alarm automatically. Such way of control significantly reduced the influence from man, and fulfilled the annual request from Beijing government: "Heating for 24 hours".

1.5 In order to ensure the civilians' holiday, engage bad climate such as sudden temperature drop, we will sometimes need to enhance the supply/return water temperature, and make the indoor temperature 2 or 3^oC higher than regulated. Fuel consumptions for such purpose were not count in the Statistic.

2. FUEL CONSUMPTION AND CLIMATE PARAMETER

2.1 Fuel consumption of the heating system.

1) After the summary of the fuel consumption, the variety of the fuel changed from multi-grade to the grade of -20#, high quality diesel oil for light vehicles.

2) The measuring instruments is the LL-800T type flow meter, the measuring method is daily measuring.

3) The fuel consumption can see from Tab.1.

From Tab.1 we can see that: fuel consumption in the heating term of 01~02 are significant less than the two former heating terms.

2.2 The outdoor temperature calculated in the heating terms.

About the calculation:

1) The outdoor temperature is based on the weather forecast from Beijing Weather Bureau.

2) The calculation method of the daily temperature is the "Check list of daily temperature to the supply/return water temperature" given by the Beijing heating office.

a. T Average Highest temperature = ∑Highest temperature /total days

b. T Average Lowest temperature = ∑Lowest temperature /total days

c. Calculation methods of Average temperature of the day:

Average temperature of the day = (Highest temperature of the day + Lowest temperature of the day) / 2.

3) See calculation result in Tab. 2.

Tab. 2 The outdoor air temperature calculated in heating terms

Year	Highest temperature of the day/℃	Lowest temperature of the day/℃	Average temperature /℃
99-00	6.45	-4.00	1.23
00-01	4.75	-4.56	0.10
01-02	8.22	-2.46	2.88

2.3 The analysis on the relationship between fuel consumption and outdoor temperature.

1) Average temperature and average fuel consumption in the month.

According to the method introduced above, we can see results in Tab. 3.

Comparison of the three heating terms: During the heating term in 01~02, the average temperature in November is close to the former two years, so there isn't much difference on fuel consumption .In December ,the average temperature is a little bit lower than the former two years, so its fuel consumption increased. From January to March, the average temperature is much higher than the former two year, so the fuel consumption dropped dramatically.

From the comparison, we can see that: Average temperature in the year has direct influence to the fuel consumption. So we must set the climate factor at the same condition when we analyze them, in order to get a more accurate value of the fuel consumption and fuel saved.

2) The calculation analysis on relationship between the average temperature and the average fuel consumption.

Tab. 3 Average temperature and average fuel consumption in the month

Month	year	Average Temperature T/℃	Average fuel Consumption Q/t/d
11	1999	5.17	1.51
	2000	2.60	1.51
	2001	5.72	1.32
12	1999	−0.53	2.61
	2000	−0.10	2.28
	2001	−2.70	2.84
1	2000	−4.05	3.89
	2001	−5.70	3.76
	2002	−0.50	2.04
2	2000	−0.76	2.76
	2001	−1.40	2.87
	2002	2.50	1.57
3	2000	7.80	1.03
	2001	5.60	1.90
	2002	8.71	0.74

3) The calculation analysis on relationship between the average temperature and the average fuel consumption.

a. Purpose:

Find out the relationship between the average fuel consumption and average temperature, confirm that the climate factor influences the fuel consumption at the same level, and then make comparison:

- The comparison of the same facility's energy consumption trend at different time and condition.
- The comparison of the same heating unit's energy consumption under the same situation in different years.
- The comparison of the different facility's energy consumption.
- The comparison and calculation of the cost control of the same heating unit.

b. Calculation and the data based on:

In the relationship between average temperature and fuel consumption, we assume that the independent variable (average temperature) and the dependent variable (fuel consumption) have a linear relationship. So we use the common monistic linear regression.

According to the climate data from the Beijing weather Bureau in 01~02, we can calculate the

average temperature and the daily fuel consumption (holiday, Saturday, Sunday not included). Basing on the average temperature and daily fuel consumption, we can set up a monistic linear regression model; the calculation result will be as the following Tab. 4.

Tab. 4 Regression Statistic

Related Coefficient R	0.915969
Re-measure Coefficient	0.839000
Standard Error	0.41
Observation Value	112

All Coefficients:

Related coefficient R: It is used for weighing the relationship between the variable value T (Average temperature for each day) and Q (Oil consumed quantity), here R is 0.915969, which shows the height relation between them;

Re-measured coefficient: it is used for explaining the relation degree between the independent variable and dependent variable for measuring the fitting effects of dependent variable Q. The coefficient here is 0.8390, which show the varied difference of independent variable can be explained 89.3% of dependent variable, resulting from the varied average temperature for each day.

Standard error: it is used for weighing the fitting size, if the value is smaller; it shows the better fitting result. The estimated standard error here is 0.41, if the value is smaller than this one, it show s the better fitting result;

Through analyses, it verifies the effective regression model, and the hypothesis between the day average temperature and oil consumed quantity comes into existence.

Observation Value: it is used for estimating data numbers of the regression equation (sample). Here it shows the total heat supplying date for statistic.

- Regression Parameters

Regression parameters Tab. 5.

Tab. 5 Regression Parameters Table

	Coefficient	Standard Error	Lower 95%	Upper 95%
Intercept	2.3298	0.04759	2.2355	2.4241
Slope	-0.161	0.00672	-0.174	-0.148

The line 2 and Line 3 respectively show the intercept and slope value; can get the regression equation based on it; then to get the 95% upper and lower level of intercept and slope.

Includes: intercept 2.33; slope -0.161; measured coefficient 0.839067485.

- Regression Equation:

We can get the regression equation as following:

$$Y=2.33-0.1611X$$

It shows that when the day average temperature rises 1℃ corresponding to the oil consuming 0.1611 ton decreasing .

3. FUEL CONSUMPTION ANALYSES AND ASSESSMENT

3.1 Oil Saving Accounting Ways

The equation shows the relationship between the effective quantity on heating supply season and oil saving among 41-02 and 00-01

$$Q = 339.98-252.21-0.1611\times(2.88-0.10)\times 150$$
$$=87.77-67.18$$
$$=20.59\ (t)$$

It verifies that the value will be reduced 67.18t due to the effect of heating supply season, the actual fuel saving is 20.59t than last heating supply season.

Using the formula above, we can get 61.62t fuel saving on year 01-02 than year 99-00.

3.2 Measurement of Fuel Saving

1) Choosing the oil accordingly: we will choose -20#diesel oil, which has the advantage of low adhesive degree, easer to burn, high heat value and high firepower. It will greatly increase the burning quality, reducing the stockpile of smoke and carbon and increasing the heat producing efficiency. Under the condition, it will save the oil and fuel consumption. In addition, the -20$^{\#}$ diesel oil has the advantage of low sulfur containing; it is good for environment protection. It will lowly erode the bronze, which will extend the using longevity of the equipments

2) Through technology implementation and assign the heat energy according, whether we can reach the regulated indoor temperature, on the condition that the structure and terminal device are decided, the height of indoor temperature will depend on the heat supply and return water. But the return water temperature control is concerned with the type

of the terminated exchanged. On the other hand, the aim is to achieve the same indoor temperature, if have the different exchanger, so it will deserve the different requirement for boiler water supply temperature and return water temperature. But one set heat supply system on heat producing and output will be with only one water supply temperature. Due to the complication of the heat supply system of the State Administration of Taxation, it will supply two types heat supply devices, such as the fan duct used for the office area and the common hot air pipe used for the residence area. It will cause the waste. Additionally, the dynamic of hot load of each heat supply system will cause the maladjustment of water power; which also will cause the waste if we will not adjust them on time. Therefore, we install the electrical hot power distribution device on the return pipe of heat supply distribution at the non-heat supply season, in accordance with the load change, to adjust the heat power by manual and reduce the unnecessary waste. And it will reduce the boiler operation temperature and oil consumption.

3) Increasing the operation management and enhancing the boiler efficiency: it is a big task for the equipment operation management to make the heat supply control, and the key point is to save the fuel. The saving concept mentioned here does not equal to the decreasing of the oil consuming absolute magnitude, the aim is to enhance the energy exchanging efficiency with ensuring the heat quality. During the practical operation, we will adopt different measurement in view of different situation, for example:

Due to easier to control the fire burning of the boiler, we can get optimized operation situation and highest efficiency in accordance with the different load to set the operation equipment quantity and equipment fully operating;

Minding the change of the fume exhausting of the boiler for mastering the exchange case; if the fume exhausting temperature rising, it indicates that heat volume of the burn pit is defended during passing the water supply, surplus heat increasing , the efficiency decreasing , the heat will be discharged outside. And we need to find out the reason and manage to eliminate this issue;

Inspecting the nozzle situation normally, adjusting the fan intake and oil pressure, keeping it at the optimized situation for creating the optimal burning condition;

To strictly disposal the boiler water for defending eroding

Must clear up the burning room and fume and burning pipe during the season transferring for reducing the exchanging resistance.

3.3 Assessment

In a word, to adopt the technology implementation for the heat supply system and increase the adjustment of the heat power equipment operation. To set operation procedure reasonable and the adjustment of the water power balance of the heat supply system. We can reduce the oil consumption in continuously three years and get the obvious the energy saving effects eliminating the effect of the weather. During the comparable analysis, as to the relationship between the outdoor temperature and oil consumption, the statistic method of regression analysis has been used, and has demonstrated the linear relation between them. It will make the oil saving analysis more practical and scientific.

4. CONCLUSION

The oil burning boiler system of the State Administration of Taxation can achieve a good oil saving result after completing the technique implementation project and continuously to accumulate the related experience.

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