The influence of PM2.5 coal power plant emissions on environment PM2.5 in Jilin Province, China

Ye Sun 1, Zhi Li 1, Dan Zhang 2, He Zhang 13 and Huafei Zhang 1

1 Jilin Electric Power Company Limited Electric Power Research Institute, People Street 4433, Changchun, Jilin, China;
2 Jilin Province Electric Power Research Institute Limited Company, People Street 4433, Changchun, Jilin, China.

3 13037833@qq.com

Abstract. In recent years, in the Northeast of China, the heating period comes with large range of haze weather. All the units of coal power plants in Jilin Province have completed the cogeneration reformation; they provide local city heat energy. Many people believe that coal power plants heating caused the heavy haze. In is paper, by compared concentration of PM2.5 in environment in heating period and non-heating period, meanwhile the capacity of local coal power plants, conclude that the PM2.5 emission of coal power plants not directly cause the heavy haze in Changchun and Jilin in the end of October and early November. In addition, the water-soluble iron composition of PM2.5 coal power plant emissions is compared with environment, which further proves that the heating supply in coal power plants is not the cause of high concentration of PM2.5 in Jilin province.

1. Introduction

Jilin province encountered heavy haze from the middle of October to the middle of November yearly in the past ten years. Researchers analyze the composition of PM2.5 in the local area at this time, the hazy is caused by coal using. In this period, coal is using for heating, most of coal is consumed by coal power plants, so the conclusion that the huge amount of gas discharged from cogeneration coal power plants, cogeneration coal power plants provide heat may be the reason of haze[1]. In the paper, for proving the influence of PM2.5 coal power plant emissions on environment PM2.5 in Jilin Province, PM2.5 which is from coal power plants is compared to environment PM2.5 and soluble ions are compared by seasonal.

2. Comparison of local operation capacity and the concentration of environment PM2.5

2.1. The comparison of power generation capacity of coal power plant and the concentration of PM2.5 in Changchun and Jilin area

Changchun is located in the northern middle zone of the northern hemisphere, in the Northeast Songliao plain, belongs to the north temperate continental semi humid monsoon climate zone, cold and dry in winter, high temperature and rainy in summer. The temperature decreases from east to west, precipitation decreased from east to west. At present, there is a large cogeneration coal power plant in the built-up area of Changchun City, and another four large coal power plants provide heat source for Changchun city (one of which is expected to be heating in 2018), which is far away from the main city.
Jilin City is located in the northeast of Changchun, located in the Changbai Mountain area to the Songliao plain over the area, surrounded by mountains, three sides of the water, and is a temperate continental monsoon climate, rich water resources. In 2013, Jilin registered 106 coal units, of which more than 35 t boilers 67 units. There are three large coal power plants in Jilin.

In Jilin Province, heating period begins in the end of October when coal power plant units get ready for heating. Using cogeneration unit heating, the period is divided into three parts. From the end of October to the beginning November is the first period. In this period, the weather is warm in Jilin Province, there is no need to increase load. Waste heat can meet the demand of heating. So the consumption of coal does not increase. When the temperature drops gradually in December, for satisfying the demand of heating, stream is extract from IP. As the consumption of coal increasing, the concentration of PM2.5 coal power plant emissions remains constantly. Winter heating operation will not increase the PM2.5 emission concentration of coal power plants. In February, the weather turns to be warm, heating period to the end, the heat demand dropped, and units shut down.

![Figure 1](image)

**Figure 1.** The comparison of power generation capacity of coal power plant in Changchun and the concentration of environment PM2.5 in the year of 2016[5].

Yearly, at the beginning of the heating period, combustion of coal leads to a sharp increase the concentration of PM2.5 in Changchun and Jilin[2,3]. At the same time, coal power plants only use the waste heat of unit, and no more coal is need. In the whole period, the emission of coal power plants PM2.5 keeps constantly. Therefore, the PM2.5 emission of coal power plants not directly causes the heavy haze in Changchun and Jilin in the end of October and early November.

Figure 1 and figure 2 shows the concentration of environment PM2.5 and power generation capacity of coal power plant in Changchun and Jilin. Compared operation capacity in Changchun and Jilin, Changchun operation capacity of coal power plant is 1.86 ~ 3.26 more than Jilin, but Changchun monthly average PM2.5 is not higher than Jilin, which indicates that the environmentPM2.5 has no significant relation with coal power plant.
In addition to coal using for coal power plant, other coal burning may lead the haze in Changchun and Jilin in the beginning of heating period. Heating units environmental protection facilities are not perfect than coal power plant. SCR are not installed because of the cost, the low temperature of flue gas and the requirement of SCR. The duster, such as water film dust collector, is most commonly used in small coal fired boilers, which efficiency is far less than ESP or bag duster collector used in coal power plants. Most of the small coal heating units are mainly used DFGD. The proper results show that the desulfurization efficiency of DFGD is difficult to meet the environmental protection needs. Jilin coal power plants had completed DFGD to FGD process transformation; desulfurization efficiency is at a stable and high level. In the heating period, small coal units lack the experience of operation environmental protection equipment, environmental protection facilities cannot be well adjusted and are not fully used. Although the amount of coal boilers is low, but the capacity of environmental protection facilities is limited, the amount of pollutants discharged from coal units is much larger than that of large coal power plants.

2.2. The probably reason for the causing of the haze
Previous source apportionment results show that coal dust burning is one of the main sources of PM2.5 in Changchun and Jilin in winter. Coal fired small boilers and residential bulk coal combustion may be the most important increase of coal consumption in Changchun and Jilin provinces in winter. The environmental protection facilities of coal fired small boilers are not perfect. The de-nitrification facilities were not installed because of the many factors, such as the cost of modification, the low flue gas temperature and the requirement of de-nitration catalyst. The dust removal efficiency of the dust collector, such as water film dust collector, which is most commonly used in small coal fired boilers, is far less than that of ESP or bag duster collector used in large coal power plants. Most of the small coal fired boilers are mainly dry desulfurization, and the monitoring results show that the desulfurization efficiency of dry desulfurization is difficult to meet the environmental protection needs [4]. Jilin coal power plant unit has completed dry desulfurization to wet desulfurization process transformation; desulfurization efficiency is stable at a very high level. Small coal heating units lack the experience of operation environmental protection equipment, and environmental protection facilities cannot be well adjusted, environmental protection facilities cannot be fully used. Although the consumption of coal heating units is low, but the capacity of environmental protection facilities is limited, the amount of pollutants discharged from coal units is much larger than that of large coal power plants.

Figure 2. The comparison of power generation capacity of coal power plant in Changchun and the concentration of environment PM2.5 in the year of 2016[5].
pollutants discharged from coal units is much larger than that of large coal power plants. Meanwhile, October just the end of the harvest in Jilin Province, and weather conditions is not good for pollutant dissipation, burning straw may cause a short heavy pollution. Such factors may cause a big raised the concentration of PM2.5.

3. The influence of PM2.5 coal power plant on environment

Table 1. The percentage of water soluble ions.

|       | F (%) | Cl (%) | NO₃ (%) | SO₄²⁻ (%) | Na⁺ (%) | K⁺ (%) | Mg²⁺ (%) | Ca²⁺ (%) |
|-------|-------|--------|---------|-----------|---------|--------|----------|----------|
| Winter| 0.51  | 0.80   | 11.14   | 20.44     | 1.763   | 1.527  | 1.03     | 0.927    |
| Spring| 0.244 | 4.023  | 2.538   | 4.879     | 4.773   | 1.064  | 0.219    | 2.044    |
| Summer| 0.111 | 3.715  | 13.769  | 13.571    | 0.717   | 1.729  | 0.245    | 1.483    |
| Autumn| 0.04  | 0.832  | 3.685   | 3.675     | 0.51    | 0.402  | 0.192    | 1.159    |

3.1. Influence of negative ions

From the table 1, the ratio of NO₂⁻/SO₄²⁻ always used in determines the type of pollution (automobile of coal combustion). Water soluble ions of environment PM2.5 obviously hanged seasonally in Changchun. The ratio of NO₂⁻/SO₄²⁻ varied from 0.5~3 to 1.832 in spring Changchun area, 1.027 in summer, 3.819 in autumn, and 0.510 in winter. It can be conclude that in the non heating period, automobile cause the main source of nitrogen oxides and sulfur oxides. In the heating period, the coal combustion is the main recourse. Although the emission of coal power plants increased the ratio of NO₂⁻/SO₄²⁻ in coal power plants PM2.5remained stable, indicating that coal heating units providing heat was the main reason leading to the decrease of ratio. In the heating period, coal heating units take the most contribution of coal heating units in Changchun.

Due to FGD system has absorption of Cl⁻, the percentage of Cl⁻ in coal power plant PM2.5 is very low. The emission of Cl⁻ from coal power plants has little influence to environment. Otherwise, most of F⁻ comes from coal and discharge to environment.

3.2. Influence of positive ions

SCR has increased the concentration of NH₄⁺ in coal-fired power plants PM2.5, but escape concentration must lower than 3 ppm. So NH₄⁺ in coal-fired power plants PM2.5 has little contribute to the environment PM2.5. The other four metal ions Na⁺, K⁺, Mg²⁺ and Ca²⁺ account for only about 5%. They are not linearly related to the atmospheric PM2.5. Therefore, the influence of soluble metal ions in PM2.5 in coal power plants is not significant conclusion.

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