Study on the Real-Time Assessment Method of Maximum Output of Thermal Power Unit by Air Blower Current

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Abstract. By analyzing a large number of data about the air blower current and the unit output, this article establishes the relationship model between the air blower current and the unit output. This model has realized the function of dynamically evaluating and correcting the maximum unit output by monitoring and analyzing the air blower current, which provides support for controlling the capacity of the unit to adjust peak value upwards in real time.

1. Introduction
The rapid growth of new energy installation capacity, especially the surge of distributed photovoltaic generation has increased the difficulty of peak regulation for the power grid, and has brought more and more obvious impacts on peak regulation by Shandong Power Grid. The grid-connected thermal power units are gradually transforming to perform the peak-load regulation tasks and provide auxiliary services, but the power grid is facing the problem of insufficient space for peak load regulation. On the other hand, the frequent and deep peak-load regulation of thermal power unit leads to the excessive wear of equipment and even the occurrence of engine shutdown, which brings hidden danger to the stable operation of the power grid.

The maximum output of thermal power unit is influenced by the running state of main unit and auxiliary unit. When the main unit or auxiliary unit is in trouble or not in good working condition, the maximum output of the unit will decrease greatly. The present power grid dispatching auxiliary system of the power grid cannot predict this information ahead of time, and will overestimate the unit output, resulting that the unit cannot complete the task of peak load regulation, which affects the overall peak load regulation of the power grid. The air blower is an important auxiliary unit for the safe operation of the thermal power unit. The establishment of the relationship model between the relevant parameters of the air blower and the maximum output of the unit may predict and evaluate the maximum output capacity of the unit, which provides the reference basis for appropriate peak load regulation in power grid.

2. Data Analysis and modeling
In order to study the relationship between the air blower current and the maximum output of the thermal power unit, we take the # 5 unit in the power plant as the research object and analyze its historical data.
2.1. Introduction of the equipment

The boiler of #5 unit is produced by Dongfang Boiler Group Co., Ltd. It is DG model, with single chamber, one middle reheating, \( \Pi \)-shape open-air layout, balanced ventilation, solid slag discharge and a subcritical natural circulation drum boiler. Superheated steam is regulated by three-stage water spraying system and the reheated steam is regulated by swing burner. In abnormal condition, the water spray is set at the entrance to cool down the temperature. The combustion is of tangential firing mode. Pulverizing system is a double-ended ball mill with direct blowing under direct pressure.

2.2. Data analysis

First of all, we preprocess the historical data and select the valuable ones, such as the maximum 5 values of air blower current corresponding to five load points of 165MW, 198MW, 231MW, 264MW, 297MW and 330MW, shown in figure 1. In the figure we can see the maximum 5 values coincide almost, that is, the good repeatability of the maximum current of the air blower.

Base on the above data, we make the function fitting between the air blower current \( I_{\text{now-max}} \) and unit output \( P_{\text{now}} \) as below:

\[
I_{\text{now-max}} = 19.537 \cdot e^{0.0027 \cdot P_{\text{now}}} \quad (1)
\]

\[
P_{\text{emax}} = [1 - (I_{\text{now}} - I_{\text{now-max}}) / I_{\text{now-max}}] \cdot P_0 \quad (2)
\]

In figure 1, X axis is load value, Y axis is air blower current and \( R^2 \) is degree of correlation.

![Figure 1. Relationship between the air blower current and the unit output power](image)

2.3. Study on prediction method

In accordance with the active power \( P_{\text{now}} \) and the Eq. (1) to calculate the upper limit of air blower \( I_{\text{max}} \), and then base on Eq. (2) calculate the upper limit of unit output \( P_{\text{max}} \). Where \( I_{\text{now}} \) is the current value, \( P_0 \) is the rate output of the unit. Compare \( P_{\text{max}} \) and \( P_0 \) and take whichever smaller, that is the maximum unit output \( P_{\text{max}} \) predicted under the current air blower condition.

3. Modeling and verification

3.1. Model decision process

Based on the above analysis, the model decision process can be determined as shown in figure 2.
Figure 2. Flow chart of real-time assessment method for maximum output of thermal power unit based on air blower current

3.2. Model verification

With the active power value in a certain period of time calculated according to the above method, we get the maximum output value of the unit Pemax in that time, as shown in table 1.

| Time   | Active power \( P_{\text{now}} \) (MW) | Forced draft fan B current \( I_{\text{now}} \) (A) | Predicted active power \( P_{\text{emax}} \) (MW) |
|--------|-------------------------------------|-------------------------------------|-------------------------------------|
| 10:31  | 167.5                               | 29.1                                 | 330.00                              |
| 10:32  | 168.2                               | 28.9                                 | 330.00                              |
| 10:33  | 168.9                               | 27.9                                 | 330.00                              |
| 10:34  | 170.5                               | 29.8                                 | 330.00                              |
| 10:35  | 176.5                               | 30.2                                 | 330.00                              |
| 10:36  | 184.2                               | 33.1                                 | 319.99                              |
| 10:37  | 188.9                               | 34.1                                 | 314.13                              |
| 10:38  | 195.4                               | 33.2                                 | 329.12                              |
| 10:39  | 195.1                               | 32.1                                 | 330.00                              |
| 10:40  | 194.6                               | 31.6                                 | 330.00                              |
| 10:41  | 195.1                               | 30.5                                 | 330.00                              |

As can be seen from table 1, the sudden increase of the load at 10:35 causes the sudden increase of the air blower current beyond the normal range and the predicted maximum output of the unit, calculated from the calculation model, cannot reach the rated output of 330MW. However, at 10:38 after lifting load is stable, the air blower current also stabilizes gradually. So the unit can reach the rate maximum output of 330MW based on the model calculation. The model can identify the normal and the limit output state of the air blower, and then make a real-time prediction of the maximum output of the unit. The prediction result is in line with the theoretical rule.

4. Conclusion

The establishment of the relationship model between the relevant parameters of air blower and the maximum output of the unit can, by monitoring and analyzing the air blower current, evaluate and
correct the maximum unit output, achieving the goal of controlling the capacity of the unit to adjust peak value upwards in real time.

References
[1] Xiaofeng CAI, Xiaoyun LI. Elcetric Power Environmental Protection, 2008, 24(3): 26-29.
[2] Daoxian FENG. Electric Power Environmental Protection, 2005, 21(2): 23-26.
[3] Zongrang ZHAO. ELECTRIC POWER, 2005, 38(11): 69-74.
[4] Mingtao CHENG, JUN ZHONG, Yongjin LIAO, Junhui FAN, Zhengyang GAO. THERMAL POWER GENERATION, 2016, 45(12): 69-74.
[5] Shuangchen MA, Xin JIN, Yunxue SUN, Jiwei CUI. THERMAL POWER GENERATION, 2010, 39(08): 12-17.
[6] Caiwei NIU, Hantao LIU, Peihua ZHANG, Jiandong JIA. Journal of Engineering for Thermal Energy and Power, 2016, 31(10): 72-78.