Monitoring of the Effects of Dry and Wet Dust Removal Equipment at a Coal Port Transfer Station

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Abstract. Dust removal technology in port transfer station is divided into dry and wet types. Based on the monitoring data of a professional coal port, this paper compares the dust removal rates of dry and wet dust removal equipment in transfer station. The monitoring results show that the dust suppression rate of wet dust removal equipment in port transfer station is nearly twice of dry dust removal equipment. The results of this paper can provide a reference for the dust removal scheme decision of dry bulk cargo terminal transfer station.

1. Introduction

The diffusion and migration of cargo dust in the atmospheric environment constitutes one of the main components of air particulate pollution in coastal cities [1~2]. In recent years, with the development of national economy, more and more attention has been paid to environmental protection. Relevant departments have formulated corresponding rules and regulations and standard, which put forward new requirements for port dust emission. Belt conveyor system is one of the main equipment of coal port. The key to the efficient operation of the coal conveying system is the transfer point between the belt conveyors. At the transfer point, the head impact is large due to the material impact at the head funnel; the material falls in a scattered form, forming a free falling body and too fast speed, resulting in negative pressure, absorbing the surrounding air to form the induced wind. The material falls on the belt and extrudes out the air, bringing out a large amount of dust. In order to reduce the dust pollution, the method of closing and installing dust removal equipment is generally adopted. Dust removal equipment is generally dry dust removal equipment or wet dust removal equipment. In the port transfer station, the commonly used dry dust removal technology mainly includes bag dust removal and electrostatic precipitator technology, while the wet dust removal technology mainly includes dry fog dust removal and high pressure micro fog dust removal technology[3~11]. Based on the field measured data of a professional coal port, this paper compares the dust removal rates of dry dust removal equipment and wet dust removal equipment in the transfer station, so as to provide reference for the dust removal scheme decision-making of the transfer station of dry bulk cargo port.

2. Monitoring Programme

The dust suppression rates of dry dust removal and wet dust removal are measured. Six transfer stations are measured in this monitoring, and all of them are equipped with wet dust removal equipment. At the same time, five transfer stations are also equipped with bag dust removal equipment, and one transfer station is equipped with electrostatic precipitator.
Generally, the dry dust collector is organized emission, and the wet dust removal mode is fugitive emission. However, according to the definition of "fugitive emission" in "integrated emission standard of air pollutants" (GB16297-1996), the emission of low exhaust funnel can also cause the same consequence of fugitive emission. In order to unify the monitoring method, the emission from the low exhaust funnel of transfer station is regarded as fugitive emission. The monitoring methods recommended by the "Technical Guidelines for fugitive emission monitoring of Air Pollutants" (HJ/T 55-2000) are adopted for monitoring. Under the same working conditions and meteorological conditions. The dust concentration was monitored when the dust removal equipment was closed and opened to obtain the dust suppression efficiency. In addition, the organized emission monitoring method is also used for supplementary monitoring of dry dust collector. The monitoring method is recommended by “The determination of particulates and sampling methods of gaseous pollutants emitted from exhaust gas of stationary source” (GB/T16157-1996). The dust suppression efficiency is obtained by measuring the inlet and outlet particulates concentrations.

In order to improve the effectiveness, each point is monitored five times, and the dust suppression efficiency is calculated based on the average value of the five monitoring data. The monitoring factor was determined as TSP according to the pollution characteristics of bulk cargo yard, and the meteorological parameters such as atmospheric pressure, temperature, humidity, wind speed and wind direction were collected synchronously. Synchronous monitoring of wind speed and direction is shown in Fig.1.

2.1. Fugitive emission monitoring
According to HJ/T 55-2000, there are 4 emission monitoring points, which are set on both sides of the average wind direction axis. The included angle between the monitoring points and fugitive emission source is within ± s ° of wind direction variation (standard deviation of 10 wind direction readings). Without no special factors, the monitoring point shall be set in the downwind direction of the measured fugitive emission source, as close as possible to the emission source (the nearest distance to the emission source shall not be less than 2m), as shown in Figure 2. The reference point is set at the upwind direction of the measured fugitive emission source, with the emission source as the center, the arc of 2m and 50m away from the emission source, and an angle of 120 ° with the emission source, as shown in Fig. 2. The sector surrounded by CDEF is the appropriate range for setting reference points. When the average wind speed is greater than or equal to 1m/s, the reference point can be as close as possible to the emission source; when the average wind speed is less than 1m/s, the reference point is far away from the emission source in the fan-shaped range.

The medium flow particulate matter sampler produced by Wuhan Tianhong instrument factory is used for fugitive emission. The instrument model is TH-150F, the flow rate is 100L/min, and the cutting particle size is 100um. The average value of continuous 1-hour sampling meter was used. If the concentration of pollutants is too low, the sampling time should be extended appropriately if necessary. Wind speed and direction recorder adopts high-precision automatic weather instrument to collect wind speed and direction data every 2 minutes. TSP concentration monitoring using fugitive emission monitoring method is shown in Fig. 3.
2.2. Organized emission monitoring
The organized emission monitoring points are respectively set at the measuring ports of the import and export of dust removal equipment in 6 transfer stations. The sampling is carried out according to the operation steps in the manual of th880-f microcomputer smoke parallel sampler. The method meets the requirements of GB/t16157-1996, HJ/t397-2007, HJ/t48-1999. The sampling flow rate is 10 ~ 60L/min, the static pressure test range is - 30~30KPa, and the dynamic pressure test range is 0 ~ 1000Pa. The instrument meets the requirements of ISO9001 quality management system and ISO14001 environmental management system, and have undergone strict technical test and comprehensive parameter calibration before use. If the concentration of pollutants is too low, extend the sampling time if necessary. TSP concentration monitoring using organized emission monitoring method is shown in Fig. 4.
3. Results and analysis

The calculation method is shown in Formula 1 to calculate dust suppression efficiency of dust removal equipment when the fugitive emission monitoring method is used. When the method of organized emission monitoring is adopted, the calculation method is shown in Formula 2. The dust suppression efficiency data of dry dust collector obtained by two different monitoring methods are shown in Table 1.

\[
\eta_1 = \left( \frac{M_1 - M_2}{M_1} \right) \times 100\% \quad (1)
\]

\[
\eta_2 = \left( \frac{M_3 - M_4}{M_3} \right) \times 100\% \quad (2)
\]

Where \( \eta_1 \) is the dust suppression efficiency of dust removal equipment in % when the fugitive emission monitoring method is used; \( M_1 \) is the TSP mass concentration in mg/m\(^3\) when the dust collector is closed; \( M_2 \) is the TSP mass concentration in mg/m\(^3\) when the dust collector is on; \( \eta_2 \) is the dust suppression efficiency of dust removal equipment in % when the organized emission monitoring method is used; \( M_3 \) is the TSP mass concentration of dry dust collector inlet in mg/m\(^3\); \( M_4 \) is the TSP mass concentration of dry dust collector outlet in mg/m\(^3\).

Table 1. Efficiency monitoring results of dry dust removal equipment obtained by two different monitoring methods

| Dust removal equipment | Transfer station No | Fugitive emission monitoring method | Organized emission monitoring method |
|------------------------|---------------------|-----------------------------------|-------------------------------------|
|                        |                     | \( M_1 \) mg/m\(^3\) | \( M_2 \) mg/m\(^3\) | \( \eta_1 \) % | \( M_3 \) mg/m\(^3\) | \( M_4 \) mg/m\(^3\) | \( \eta_2 \) % |
| bag filter             | 1                   | 3.229                        | 2.732                        | 15.4        | 31.284                        | 26.498                        | 15.3        |
|                        | 2                   | 3.251                        | 2.617                        | 19.5        | 31.400                        | 25.934                        | 17.4        |
|                        | 3                   | 2.855                        | 2.047                        | 28.3        | 34.900                        | 25.407                        | 27.2        |
|                        | 4                   | 2.052                        | 1.449                        | 29.4        | 22.700                        | 16.276                        | 28.3        |
|                        | 5                   | 3.115                        | 2.237                        | 28.2        | 28.725                        | 20.883                        | 27.3        |
| Electrostatic precipitator | 6         | 2.545                        | 2.061                        | 19.0        | 17.703                        | 14.410                        | 18.6        |
The results of fugitive emission monitoring method show that the dust suppression efficiency range of bag filter is 15.4% ~ 29.4%, with an average of 24.2%; the average value of dust suppression efficiency of electrostatic precipitator is 19.0%. The results of organized emission monitoring show that the dust suppression efficiency of bag filter is 15.3% ~ 28.3%, and the average value is 23.0%; the average value of dust suppression efficiency of electrostatic precipitator is 18.6%. It verifies that the monitoring results of fugitive emission monitoring method are credible.

The dust suppression efficiency data of wet dust collector obtained by the fugitive emission monitoring methods are shown in Table 1.

Table 2. Efficiency monitoring results of wet dust removal equipment obtained by using fugitive emission monitoring methods

| Dust removal equipment | Transfer station No | $M_1$ (mg/m³) | $M_2$ (mg/m³) | $\eta$ (%) |
|------------------------|---------------------|---------------|---------------|------------|
| wet dust removal equipment | 1                  | 3.905         | 2.218         | 43.2       |
|                        | 2                  | 4.352         | 2.363         | 45.7       |
|                        | 3                  | 3.543         | 1.963         | 44.6       |
|                        | 4                  | 2.556         | 1.311         | 48.9       |
|                        | 5                  | 3.093         | 1.642         | 47.5       |
|                        | 6                  | 2.782         | 1.594         | 42.7       |

From table 2, the results of fugitive emission monitoring method show that the dust suppression efficiency range of wet dust removal equipment is 42.7% ~ 48.9%, with an average of 45.4%. The comparison of dust suppression efficiency of dry dust collector and wet dust collector using unorganized monitoring method is shown in Fig. 5.

In conclusion, the monitoring data show that the dust suppression efficiency of wet dust removal equipment in the transfer station is nearly twice that of dry dust removal equipment. The dust removal efficiency of dry dust removal equipment is low. According to the site conditions and the characteristics of dry dust removal technology, this may be because the outlet concentration of dry dust...
dust collector used in coal port transfer station is generally difficult to be lower than 10 mg/m³, which is more suitable for dust removal with high concentration dust of hundreds or hundreds of mg/m³.

With the improvement of domestic environmental control requirements, the port has strengthened the coal dust control, the coal moisture content has an upward trend, the concentration in the transfer tower and the dust collector inlet is low, so it has a great impact on the dust removal efficiency of the dry dust collector. Moreover, the equipment age, daily maintenance and maintenance level of the dust removal equipment have a certain impact on the dust removal efficiency of the dust removal equipment.

4. Conclusions
The monitoring results show that: the dust suppression rate of wet dust removal equipment in the transfer station is nearly twice that of dry dust removal equipment. According to the monitoring results, it is suggested that the effective wet dust removal equipment should be given priority in the dust removal scheme decision of coal port transfer station in the future.

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