

# Dustfall design of open coal yard in the power plant-a case study on the closed reconstruction project of coal storage yard in shengli power plant

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**Abstract.** This thesis, based on the closed reconstruction project of the coal storage yard of Shengli Power Plant which is affiliated to Sinopec Shengli Petroleum Administration, first makes an analysis on the significance of current dustfall reconstruction of open coal yard, then summarizes the methods widely adopted in the dustfall of large-scale open coal storage yard of current thermal power plant as well as their advantages and disadvantages, and finally focuses on this project, aiming at providing some reference and assistance to the future closed reconstruction project of open coal storage yard in thermal power plant.

## 1. Introduction

In the urban areas of China, there are thousands of coal storage yards where coal is stored in the open air. As a result, a lot of coal can be pulverized easily due to weathering. In the dry season, when it is windy, fine pulverized coal flies with wind easily, resulting in a large area of open coal dust pollution source, which is seriously polluting the air and ecological environment around the coal yard and threatening the health of the working staff and residents nearby. Furthermore, fire and explosion may happen to some coal yards, which not only could result in economic loss, but also threatens the personal safety directly. Therefore, as the awareness of people's environment protection and energy saving improves, enterprise administrators pay more and more attention to the dust pollution control. Thus, control of coal dust pollution by development of effective dust-control technique plays a significant role in the protection of air quality, reduction of coal waste and protection of people's health.

## 2. Common methods of dustfall in the coal yard

At present, the thermal power plant mainly has the following four kinds of dust method: dustfall separant, dustfall wall, water mist spraying dustfall and closed or semi-closed dry coal shed, etc. (figure 1). From their names, we can get some information: method dust-fall separant refers to spraying separant on the surface of the coal yard outdoor and forming a kind of protective film on the surface. Some people even use "gel water" in the open coal yard as a metaphor to vividly describe it. Method of dustfall wall means setting up windshield around the coal yard. Following the principle of aerodynamics, when the ambient air passes through the wall from outside, upper and lower air flow



interferes each other in the wall body, forming strong wind in the outer side and weak wind in the inner side, weak wind in the outer side and no wind in the inner side, thus flying of dust can be prevented[1-2] ; the principle of water mist spraying dustfall system is to cover one layer of water mist protective film on the surface of the dust to reach the target of dustfall[3-4]; dry coal shed is a kind of large-sized warehouse of coal storage in the power plant. Method of dry coal shed is to confine the coal dust in the controllable space to reduce the pollution of coal dust on the surrounding space. This paper chooses the case of connection of two methods – closed dry coal shed and water mist spraying dustfall through which dustfall will work better.

### 3. Closed reconstruction project of coal storage yard in Shengli Power Plant

#### 3.1. Project Profile

Shengli power plant is affiliated to Shengli Petroleum. It supplies electricity for the production and living for Shengli oil field. Its power grid covers 80 towns, 12 counties (districts) of three cities, Dongying, Binzhou and Zibo with working area of 32,000 square meters. The maximum power load is 1million kW. A large sum of coal is consumed every year. In the south of the power plant lies a large size of coal storage yard covering about 50,000 square meters. At present, it is stored in the open air (figure 2, 3). To reduce the pollution of coal dust on the environment and threats on people's health, through comprehensive analysis on various factors including the above methods of dustfall, it is determined that open coal storage yard is proposed to be reconstructed to closed coal storage yard. Water mist spraying dustfall system is used in the closed coal storage yard. When the project is completed, it will be the biggest closed coal yard in China, who has great significance in ecological environment protection and demonstration.



Dustfall separant



Dustfall wall



Water mist spraying dustfall



Dry coal shed

**Figure 1.** Four main methods of dustfall in coal yards.



**Figure 2.** Satellite image of shengli power plant.



**Figure 3.** Open-air coal yard a-point status photo.

### 3.2. Design of scheme

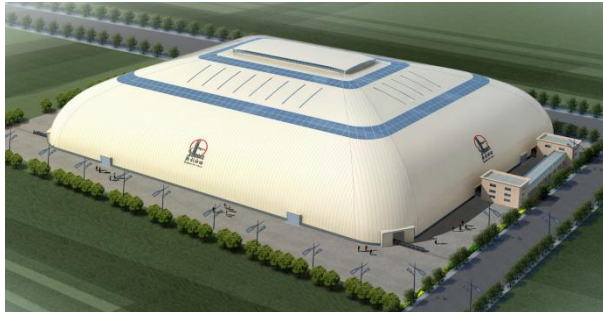
In addition to meeting the requirement of building function, the architect aims to beautifying the design to be distinct instead of being monotonous. The reconstruction project of coal storage yard in the coal plant has single layer with 211 meters from south to north and 265 meters from east to west. It covers an area of 56700 square meters, building height of 58.042 meters. The indoor and outdoor height difference is 0.20 meter. Regarding the building external, 370mm-thick sintered brick made from the Yellow River silt is used below elevation of 1.300 meters while 0.80mm thick HV250 light yellow galvanized and single layer profiled steel plate wall is used above the elevation of 1.300 meters. (figure 4,5)

The whole building is huge. But because of the use of hyperbolic spherical shape, there are no strict boundaries between building facades and roofs, but the transition gradually increased thus sense of oppression on the people and the environment can be reduced. While meeting the requirements of lighting and ventilation and other functional requirements, two ring light band will be built to divide the building into three parts. Meanwhile in the middle of the two circular lighting, the smaller size of strip hole is designed with vertical and horizontal contrast, simple and generous, which is in line with the rules of architectural form of beauty, and also in line with industrial building characteristics [5-7].

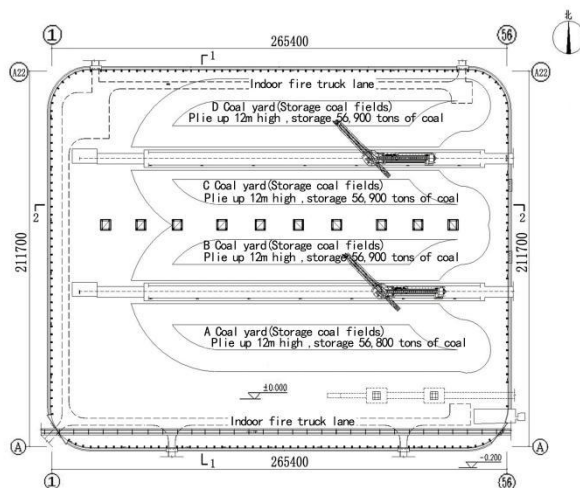
**3.2.1. Plane design.** The whole closed dry coal shed is divided into four A ~ D storage coal fields, respective storing 56,800, 56,900, 56,900 and 56,900 tons of coal, totally 227,500 tons. Two units of rotary coal handling system stackers and reclaimers are equipped internally. The coal handling system directly determines the empty contour of the dry coal shed and the determination of the empty contour line also restrains the minimum span and the vector height of the spherical reticulated shell. The coal train passes through the south side of the closed coal yard, which is convenient for coal unloading.

Because of its special function, in addition to meeting the basic requirements, there is also a need for argument in the design of fire-fighting for this project. In the closed dry coal shed, the main road is ring-shaped. The fire truck can reach the north, west and south of the building. It can only reach part of the east side due to the need of functional connection. In case of fire, fire engines can enter the dry coal shed. Concerning evacuation entrance and exit design, in addition to the opening in connection with coal conveyor belt in the east side, eight outer doors are set in the east, south and north sides in which two in the east side, four in the south (including two openings at the corner for the passing of coal train) and two in the north. The entrances and exits are directly connected with the outdoor fire truck lane, which can meet the requirements of the fire truck. The outer doors are opened with a folding side hung door (figure 6).

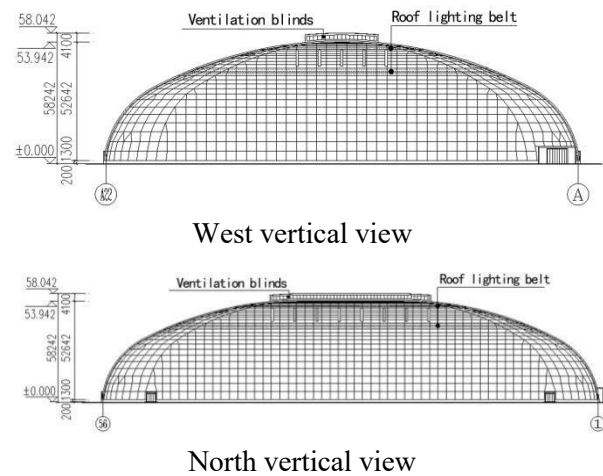




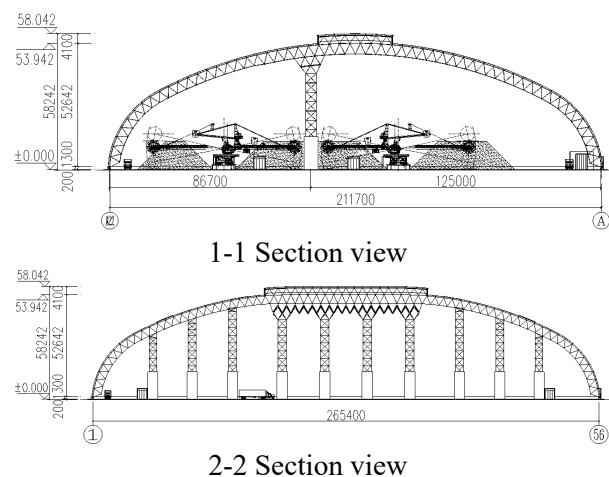
**Figure 4.** Closed-ended Coal Yard Effect Diagram.



**Figure 6.** Closed-ended Coal Yard Plan.



**Figure 5.** Vertical view.



**Figure 7.** Sectional view.

**3.2.2. Structural Selection.** The structure of the project uses a spherical reticulated shell structure, which has the dual force characteristics of the rod and the shell. Spherical reticulated shell structure not only has good performance, but also is good-looking in appearance with simple frame. The shape of the project is a spherical reticulated shell made by two curve fitting. Take the east and west axial cylindrical shells as an example. The cylindrical reticulated shells are fitted by three-centered circular. The curve in the north and south ends is an arc with a radius of 36m and the middle part of curve is an arc with the radius of 182m (figure 7 1-1 Section View). In the scheme stage, according to the actual process requirement, single-core cylindrical reticulated shell scheme which can meet the requirement of vector height and span was prepared, and the two schemes were compared. Compared with single-core cylindrical reticulated shell, 15% of shell height can be reduced, around 5% less of outer shell area covered and 10% more steel per unit area used when three-centered cylinder shell is selected. Taking all factors into consideration, it is determined that three-centered cylinder reticulated shell is used [8].

Through the structure calculation, in the lower part of the spherical reticulated shell, in every 3.7 meters, a  $1.4\text{m} \times 0.8\text{m}$  1.3m high reinforced concrete column is set, which plays the role of buttress,

and then reinforced concrete columns connects the reticulated shell structure through the embedded parts, hinge seat and the connecting ball. In combination with the plane functional requirements, a row of ten structural support columns are arranged at 87.7 meters from the north side of the buttress (figure. 6, figure 7 2-2 Section View). Spherical reticulated shell structure can be almost closed. To a greater degree, dustfall and environmental protection can be realized with less land coverage and large coal storage.

**3.2.3. Lighting and ventilation design.** As the function of the project is special, when closed renovation project is completed, unmanned operation in the coal yard can be almost realized. All the action instructions are from the central control center. In a small amount of time, coal bulldozer can be used as a support. There is no specific provision for the lighting of the project. According to the norms of industrial building lighting regulations in "Building Lighting Design Standards", among all types of industrial buildings, the lighting requirements in this project also belong to a lower class [9]. Therefore, in reference to the design of general observation of the visual operating characteristics two ring-shaped FRP lighting belts are set up on building roof. A strip of light hole is also set up between the two lighting zones. The lighting hole is not closed, which also has the function of ventilation. Ventilation blinds are equipped in the middle for lateral ventilation and lighting. Three locations totally cover an area of more than 10,000 square meters, which can meet the requirements.

#### 4. Conclusion and prospect

Dust treatment in the open coal storage of thermal power plant is a trend, regardless of dustfall separant, dustfall wall or water mist spraying dustfall system, etc., which are followed by the technical and economic development. From the actual situation of current large-scale thermal power plant, closed reconstruction like Shengli power plants is feasible. The corresponding technical specifications of the reticulated dry coal shed should be perfected as soon as possible, and attention should be paid to the design, production, installation, operation and maintenance, etc., which will further contribute to the application and popularization of the reticulated dry coal shed in the power plant.

#### Acknowledgment

Thanks Shandong Electric Power Engineering Consulting Corp., Ltd. to offer the opportunity. Thanks should also be given to the staff of Shandong Electric Power Engineering Consulting Corp., Ltd., Thanks to the technical staff for their support for this work. This work is financially supported by the Study on The Applying Strategy of Green Building Technology for Thermal Power Plant Project Foundations.

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