Study on the architectural design of a new type of waste incineration power plant based on NIMBY effect

Li Yuanyuan

1 Department of architecture, School of architecture, South China University of technology, Guangzhou, Guangdong, 510000, China

*Corresponding author’s e-mail: 201920103877@mail.scut.edu.cn

Abstract. With the development of economy and urbanization, facing the dilemma of "garbage besieged city", China's "fourteenth five year plan" continues to focus on development and ecological protection. Waste incineration power generation is the most environmentally-friendly and efficient means of waste treatment. However, facilities such as waste incineration power plant are often faced with the problem of "NIMBY effect". Through the analysis of typical cases at home and abroad, combined with the project practice of Foshan Gaoming District waste incineration power plant, this paper explores how to alleviate the NIMBY effect through architectural design from three aspects of appearance design, ancillary functions and external environment.

1. Introduction

With the improvement of China's urbanization level and economic development, the consumption level of urban residents has increased year by year, and the intensive production and life of cities have caused the dilemma of "garbage besieged city". As early as 2000, our country proposed to recycle the garbage. In 2020, China's 13th five year plan ends. Overall, China's ecological environment quality has been improved, and the cause of ecological environment protection has been developed. However, there is still a long way to go to protect the ecological environment. During the "14th five year plan", China will continue to promote the green and low-carbon transformation of the whole society. It is worth mentioning that the power generation industry will become the first industry to carry out carbon emission quota allocation, so as to start the first performance cycle of the national carbon market [1]. This means that more and more waste incineration power plants will appear in cities.

Waste incineration power generation is the most environmentally-friendly and efficient means of waste treatment [2]. A new type of waste incineration power plant transports the power generated by waste incineration into the urban power grid for the secondary utilization of waste.

However, the public is always unable to avoid the waste incineration power plant as a pollution treatment facility. The "NIMBY effect" of the waste incineration power plant is an important obstacle in the construction of the waste incineration power plant" NIMBY effect "is developed from the English not in my backyard. The facilities that produce NIMBY effect usually have a positive effect on the whole society, but people refuse to get close to them and resist the facilities that live around them [3].

Some scholars have done a detailed study on the technological process and basic architectural design requirements of waste incineration power plant [4]. In recent years, there are many successful new waste incineration power plant practices at home and abroad, and some scholars have studied how to avoid the public's NIMBY psychology from the policy or management level. However, there is no
targeted research on the architectural design of the new waste incineration power plant from the perspective of NIMBY effect. This paper will start from the NIMBY effect, first analyze the classic waste incineration power plant at home and abroad, and then combined with the project practice of Gaoming District waste incineration power plant in Foshan City, from the appearance design, ancillary functions, external environment three aspects to explore how to alleviate the NIMBY problem through architectural design.

2. Architectural design cases of waste incineration power plant at home and abroad

2.1. Research objects
Two typical cases in China are selected, namely, the eastern Shenzhen waste incineration power plant (Figure 1) designed by SHL and Gottlieb paludan architects and the domestic waste incineration power plant in Yinzhou District of Ningbo City (Figure 2) designed by AIA architects. Two typical cases abroad are studied by the Danish Copenhagen Amager Resource Center designed by Jesper kongshaug and big ideas (Figure 3) and the Danish energy center designed by Erick van Egeraat (Figure 4). Except for the Danish energy center, which was built in 2014, all other buildings were built in five years. The waste incineration power plant in Eastern Shenzhen was built in 2020, the Amager Resource Center in Copenhagen, Denmark was built in 2019, and the domestic waste incineration power plant in Yinzhou District, Ningbo City was built in 2017. They all adopt advanced technology and design method, which is of great significance for reference.

Figure 1. Case1 Figure 2. Case2 Figure 3. Case3 Figure 4. Case4

2.2. Research on the design method of eliminating NIMBY effect
As the process flow of waste incineration plant is relatively definite, it is generally composed of several fixed functional parts, such as unloading platform, waste pool, boiler room, turbine room and device control area. Due to the limitation of technological process, the organization of functions is relatively fixed. In this respect, there is not much room for architectural design to play. Innovative architectural design is mainly for the appearance, ancillary functions, and the external environment. This paper will discuss the NIMBY effect from these three aspects.

2.2.1. Appearance design
In terms of appearance, through the design and operation of "de industrialization" of traditional industrial buildings, the industrial buildings can be beautiful and innovative in appearance, and even form a landmark building in an area, which is conducive to improving the public's psychological acceptance of waste incineration power plant.

The design of the appearance can be divided into the shape and the skin. The treatment method of the form is to divide the large-scale industrial buildings into pieces, and to break down the huge scale, to some extent, eliminate the feeling of inaccessibility. The domestic waste incineration power plant in Yinzhou District, Ningbo city adopts this method to disassemble the huge industrial building form in combination with different facade treatment methods. Another treatment method is the characteristic Gestalt method. Although the industrial buildings are presented in Gestalt, they are different from the traditional industrial buildings' generous box method. The characteristic circle of the waste incineration power plant in Eastern Shenzhen, the large slope of the Amager Resource Center in Copenhagen, Denmark and the irregular geometry of Danish energy source center are all such practices.
Skin is usually designed in collaboration with form. The complete skin is often used in the integrated design of Gestalt waste incineration power plant. In terms of color and style selection, it pays attention to the surrounding environment. The reddish brown parameterized aluminum plate skin adopted by Danish energy center echoes the reddish brown building roof in the city, which makes the large industrial buildings and the urban style integrate well. The Amager Resource Center in Copenhagen, Denmark, is built near the water. The silver gray aluminum brick skin is in harmony with the color of the sky on the water. The aluminum brick is also designed in detail. Plants can be planted to form a green surface. In addition to the integrated design, the skin can also use characteristic graphics or characteristic materials. This method is not suitable for large building volume, but can be applied to the decomposed blocks. In Ningbo Yinzhou municipal solid waste incineration power plant, the bottom block adopts the characteristic honeycomb skin, which has both characteristics and cultural metaphor. The upper block uses U-shaped glass and perforated aluminum plate. It is in harmony with the honeycomb epidermis below.

The rich and colorful subsidiary functions mainly appear in the newly-built waste incineration plants in recent years. The main innovation of the Danish energy center, which was built in 2014, is still on the surface and form. This also reflects the change of people's ideology, and the design pays more and more attention to publicity and sociality. The construction of subsidiary functions helps the public gradually dispel the NIMBY psychology from the use experience.

2.2.2 Subsidiary function

Due to the huge volume of main functions, the auxiliary functions of waste incineration power plant can not play much space, and the most common auxiliary function is to visit and educate.

Shenzhen East waste incineration power plant is equipped with a circle of visiting streamline around the circular volume. The visiting corridor is 1.5km long, which can let the public learn the whole process of waste from entering to using intuitively and vividly. One of the goals of the domestic waste incineration power plant in Yinzhou District of Ningbo city is to build a demonstration base for environmental protection publicity and education. The honeycomb like surface of the building echoes the environmental protection theme metaphor of "bees gather honey to return to the nest". In terms of the internal space of the building, it is also carefully built. In the plant area, a domestic waste treatment museum is set up, in addition to the environmental protection, waste classification, environmental protection and environmental protection. The exhibition of energy regeneration and other related knowledge also creates an experiential simulation of incineration power generation process, and turns the complex power generation system into a simple and clear visual system through the indoor logo in the form of "honeycomb" [5]. The tour flow line of Amager Resource Center in Copenhagen, Denmark is different from the horizontal expansion of other cases. A vertical sightseeing elevator leads directly to the roof. From the transparent glass side of the sightseeing elevator, you can see the scene inside the waste incinerator and learn the relevant process flow.

In addition to the educational function, Amager Resource Center in Copenhagen, Denmark also innovatively endows the building with the function of outdoor sports ground by using the unique slope shape of the building. The roof composed of three sections of different slopes can be used as different grades of ski path in winter. In addition to the snow path, the roof also has climbing wall, climbing path and climbing bike path. On the top of the building, there is also a viewing platform and a small cafe.

With the improvement of environmental protection awareness, ecological design and environmental protection functions begin to appear in the garbage incineration power plant built in recent years. The circular roof of the garbage incineration power plant in Eastern Shenzhen can collect rainwater, and the large-area solar panels can realize the utilization of natural light through photovoltaic conversion. Amager Resource Center in Copenhagen, Denmark uses slopes and green space to collect rainwater and form local microcirculation.
2.2.3. External Environment

As a simple industrial building, the traditional waste incineration plant does not pay attention to the creation of the external environment. With the implantation of new functions of the new waste incineration power plant and the enhancement of social publicity, more and more attention is paid to the design of the external environment. The external environment design of the new waste incineration power plant is mainly reflected in two aspects, one is the use of roof garden and platform, the other is the construction of entrance square. The design from these two aspects can make the public gradually accept the special type of industrial building of waste incineration plant under the infection of good environment.

In terms of the utilization of the roof, the eastern Shenzhen municipal solid waste incineration power plant, located in the mountainous area of the suburb of Shenzhen, creates a panoramic roof landscape Ring Road on the dome, which can enjoy the city and mountainous landscape 360 degrees. The roof of Amager Resource Center in Copenhagen, Denmark creates a green forest area like a real mountain, which is well combined with the above mentioned sports functions.

In terms of the entrance square, several cases are different from the simple treatment of the entrance space in the past industrial buildings. The more characteristic is the domestic waste incineration power plant in Yinzhou District of Ningbo City. In addition to the plants that are easy to maintain, there is also a waterscape design in the main entrance square, The entrance of the whole park presents a warm welcome to the employees and visitors.

3. Project practice of waste incineration power plant in Gaoming District, Foshan City

3.1. Project overview

This project is the first important project in the planning of Foshan Gaoming science and technology environmental protection Town, which will play a role of demonstration and driving. It shows the high starting point, high standard and high requirement of the future science and technology environmental protection town.

The project is located in Baishiao solid waste disposal Park, Miao village, Mingcheng Town, Gaoming District, Foshan City. The site is about 6.67 km away from Mingcheng town in the north, 10.26 km away from genglou town in the west, 3.3 km away from YUNYONG Forest Park in the south, 23 km away from the main urban area of Gaoming City and 49 km away from the main urban area of Chancheng city. In the south, there are 525 county roads with convenient transportation.

The planning area where the project is located belongs to hilly landform, which is higher in the northeast and lower in the southwest. The highest point is 160m, which is located in the northeast of the planning area; The lowest point is 40 meters, located in the Midwest of the planning area(Figure 5). The project is located in the continuous mountain depression. The ecological characteristics of the surrounding natural environment are obvious. How to integrate the huge building volume into the overall natural environment and how to adapt to the spatial structure of the science and technology environmental protection town are the problems to be studied.

Figure 5. Project location
Figure 6. Architectural renderings image source: project team
3.2. Project analysis based on NIMBY effect

The design team considered that as a new type of industrial building, the waste incineration plant has huge volume and remarkable industrialization characteristics. For the consideration of NIMBY effect in the transformation period, in order to eliminate people's traditional impression of waste treatment plant, the design principles of deindustrialization, ecology and technology are put forward. This article will be based on these principles, from the above design, ancillary functions, external environment three aspects of design analysis.

3.2.1. Appearance design

In terms of architectural modeling, the design adopts the method of wrapping the lower part and dismantling and reconstructing the upper part of the basic volume of the waste incineration power plant, so that the huge industrial buildings will not appear too abrupt in the mountains and forests, and the gradually rising shape also echoes the surrounding mountain landform. The corner elements of local festive lantern are abstracted and translated in detail modeling, and the body block is inclined and deformed, which echoes the local cultural characteristics (Figure 6).

Because of the outstanding shape characteristics, the facade adopts a relatively simple method. The dense vertical grille forms the rhythm of the facade, and the light can be penetrated from perforated aluminum plate and glass. The whole scheme is simple and full of regional characteristics.

3.2.2. Subsidiary function

In addition to the basic functions, the project also focuses on building the public education display function. The public enters from the hall. After entering, a series of visiting flow lines are organized with the hall as the center. Through the cooperation of vertical flow line and horizontal flow line, we can comprehensively understand the whole process from waste incineration to reuse (Figure 7).

The outdoor of the building also has characteristic functions. From the sloping greenway on the ground, you can reach the roof garden. Like terraces, the roof garden gradually connects multiple volumes of roofs, which maximizes the landscape and provides rich activity venues. The roof is equipped with ecological vegetable garden and roof theater (Figure 8).

3.2.3. External environment

Due to the shortage of land for the base and the lack of spacious entrance square, the design of the external environment is mainly reflected in the roof landscape. In the treatment of the opposite landscape, many circular elements are adopted, combined with the arc path, to create a relaxed and lively activity site, which helps to break the rigid impression of the public on industrial buildings (Figure 8).

4. Conclusions

This paper aims to explore how to dispel the public’s NIMBY mentality towards waste incineration power plant through architectural design. Firstly, it analyzes the successful cases of waste incineration power plants at home and abroad in recent years. From the appearance design, ancillary functions and external environment, it is found that the distinctive appearance and good external environment can help people dispel the NIMBY psychology in vision and environmental feeling. The creation of rich and public ancillary space changes people's understanding of the single function of waste incineration
power plant. The design from these three aspects can make the public gradually improve the acceptance of this special type of public buildings in the visit and use.

Next, I participate in Gaoming District of Foshan City waste incineration power plant project practice to further demonstrate. The design principle of the project is deindustrialization, ecologization and scientification. It creates a new type of waste incineration power plant with unique appearance, rich functions and beautiful environment.

With the development of economy and the further improvement of urbanization, more and more waste incineration power plants are bound to appear in the public field of vision. How to make this special public facility accepted and utilized to the maximum is the most beneficial to the society, which needs continuous exploration.

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