Research on Energy Consumption and Carbon Emission for Fabricated Composite Plate in Component Production

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Abstract. This article focuses on the component production stage of industrialized buildings. The factors affecting energy consumption and carbon emission during the production of fabricated composite plates in a factory in Jiangsu province are classified, the calculation formula is arranged, and the proportion of total energy consumption and carbon emission is analyzed. Based on the measured data, the distribution of energy consumption and carbon emission during the component production stage of fabricated composite plate is summarized.

1. Introduction

With the increasing global population and economic scale, environmental problems caused by energy use and their incentives have been recognized. Not only smoke, photochemical smog and acid rain, but also the global climate change caused by the increase in the concentration of carbon dioxide in the atmosphere has been recognized as an indisputable fact. Global climate change is not only an environmental issue, but also a political and economic one. This is because the main solution to global warming is to reduce the concentration of greenhouse gases in the atmosphere, especially the concentration of carbon dioxide. However, on the one hand, carbon dioxide emissions are mainly due to the development of the world economy, which forms a contradiction between greenhouse gas emissions reduction and the economic development of countries; on the other hand, the economic development of countries can’t be separated from the global climate, and the harsh climate caused by greenhouse gases has caused great losses to the economies of countries. In this context, the reduction of carbon dioxide has become a global issue, which has attracted extensive attention from the international community.

The government announced the carbon emission reduction target at the 2015 Paris world climate conference, that the carbon emissions of gross domestic product will fall by 60%-65% on the basis of 2005 by 2030\(^1\). This goal is implemented as a medium and long-term plan for sustainable development in China. For this reason, the state has formulated corresponding assessment and testing indicators to ensure the effective implementation of energy conservation and emission reduction. At present, the carbon emissions of the global construction industry have reached one-third of the total carbon emissions in the world\(^2\). With the gradual improvement of the economic level of China, Chinese construction industry is also in a\(^\text{A}\) state of rapid development, and the new building types are mostly industrialized buildings. In order to guarantee the normal development of Chinese economy, the reasonable and scientific reduction of carbon emissions in Chinese construction industry has become the only way to save energy and reduce emissions in the future. As a result, energy
consumption and carbon emission measurement for industrialized buildings are becoming the key to energy saving and emission reduction. During the whole industrialized chain, the proportion of energy consumption and carbon emission in the component production stage is not the most, but it is necessary to study because it is a special stage of the industrialized building.

2. Energy consumption and carbon emission measurement in component production plant

This paper mainly aims at the component production stage of industrialized buildings, and calculates the energy consumption and carbon emission by measuring the actual data produced in the process of producing fabricated composite plates in a factory in Jiangsu province. By acquiring the actual data of the current, voltage, running time and the amount of materials used in the component production stage, the paper calculates the energy consumption and carbon emissions from the production of a certain unit volume of the structural parts.

![Diagram of factory layout and measuring points](image)

In this measurement, the concrete mixing station as the starting point, until the production of maintenance work completed in the stacking yard waiting for the output factory as the end. The factory is divided into areas as shown above. There are 11 measuring points at all, and measuring instruments include three-phase electric quantity recorder, single-phase alternating current transformer and so on. In order to facilitate the calculation, the measuring points are sorted out and classified into four groups: automatic production line of fabricated composite plates, concrete mixing station, automatic production line of steel bar and transportation.

| Groups                                      | Equipments                                                                 |
|---------------------------------------------|-----------------------------------------------------------------------------|
| automatic production line of fabricated composite plates | sweeper, shuttle bus, trowelling machine, mold, coating machine, drawing machine, rolling machine, screw-threadsteel, vibrator, side vertical machine, feeder, initial condensate bank, maintenance library |
There are three methods for the calculation of building carbon emissions, namely, measurement method, material balance algorithm and emission factor method[3]. The carbon emission factor method is used to multiply the activity data of the source and the carbon emission factor in order to calculate the energy consumption and carbon emission in the production stage of the component factory. This method is the first carbon emission estimation method proposed by the IPCC, and it is also the most widely used method.

In this test, the production area is divided into four parts: automatic production line of fabricated composite plates, concrete mixing station, automatic production line of steel bar and transportation. By measuring these four parts separately and summing up the results, we can get the energy consumption in the whole process of fabricated composite plate, and then use the emission factor method to multiply the total electricity consumption and the power carbon emission factor to get the carbon emission[4].

\[ E_d = E_{d1} + E_{d2} + E_{d3} + E_{d4} \]

In the formula, \( E_d \) is the total electricity power consumption of production units cubic meters fabricated composite plate, \( E_{d1} \) is the electricity power consumption of automatic production line of fabricated composite plates, \( E_{d2} \) is the electricity power consumption of concrete mixing station, \( E_{d3} \) is the electricity power consumption of automatic production line of steel bar, \( E_{d4} \) is the electricity power consumption of transportation.

\[ C = E_d \times K_d \]

In the formula, \( C \) is the total carbon emissions of production units cubic meters fabricated composite plate, \( K_d \) is the electric power carbon emission factor, \( E_d \) is the total electricity power consumption of production units cubic meters fabricated.

In the selection of the power carbon emission factor, because the measured factory is located in Jiangsu Province, belongs to the East China, so 0.81kg/kw is selected to be the power carbon emission factor used in this measurement[5].

In summer, the axial fans will be arranged inside the factory for air supply. In the calculation of energy consumption and carbon emission in the component production stage under the summer working condition, the energy consumption generated by the axial fans shall be added on the original basis.

3. Analysis of measured energy consumption and carbon emission

According to the above divided area, measured data includes the equipment current, voltage, running time, output laminated plate model ratio and the amount of concrete are record every day. The measured current voltage calculates the power consumption per second and accumulates the amount of electricity consumed during working hours to obtain the total power consumption of each device per day.
Taking the summer working condition as an example, figure 2 is the proportion of energy consumption generated during the component production. It can be seen that the concrete mixing plant consumes almost half of the energy consumption, in the remaining parts of the overlapping plate automatic production line accounted for the largest, axial fan energy consumption ranked third. As the biggest part of energy consumption in the component production of fabricated composite plate, concrete mixing station is taken as an example for detailed analysis.

During the actual measurement process, the total amount of concrete is obtained from the operation room of the concrete mixing station at the end of each day. Based on the current measured by the measuring instrument, the relationship between the amount of concrete mixed and the power consumption of the concrete mixing plant is drawn.

It can be seen that the amount of concrete in the concrete mixing station is not directly proportional to the amount of electricity consumed. When the amount of concrete increases, the amount of electricity consumed also decreases. After field observation, the reason for this situation is that when the total amount of concrete is relatively small, there may be more times of concrete output from the concrete mixing station to the outside. Therefore, the amount of concrete mixed is relatively low but the power consumption is higher.

Because it is impossible to measure all the components factories which need to calculate the energy consumption and carbon emissions, and the ultimate goal of this project is to obtain the conversion coefficients which can be applied to all factories by data analysis and processing. So comparing the rated power and actual power of concrete mixing station is needed. After that, the conversion coefficient can be used in the subsequent measurement work.
Figure 5. Comparison of rated power and actual power of concrete mixing station

Taking concrete mixing station as an example, the rated power is 74 kW. After processing the measured data, it can be seen that the actual power in average of the day is lower than the rated power, only a small part of the time is in overload operation. The actual power of concrete mixing station will fluctuate in the range of 50-60 kW under normal operation. In the process of energy consumption and carbon emission measurement, the rated power can be directly used to replace the actual power for calculation and analysis.

4. Conclusion
Through the analysis of the measured data, we know that in the component production stage of the fabricated composite plates, the electric power consumption accounted for the most of the factors affecting the energy consumption. While in the equipment that consumes electricity, the concrete mixing station is the first one, the axial fans are located second in summer and the automatic production line is located in the third. Other devices account for only a small proportion. In the calculation of energy consumption and carbon emission in the component production stage of the fabricated composite plates in other factories, it is not necessary to carry out the measurement work all the time. The concrete mixing station which occupies half of the consumption is converted by the conversion factor of the rated power and the actual power, ignoring the part of the in-plant transportation with very little proportion. The actual energy consumption and carbon emissions can be obtained.

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