Monitoring and Optimization of Vacuum Energy Consumption of Paper Machine Net and Press Section Based on PLC

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Keywords: Corrugated Paper Machine; Energy Consumption; Net Department; Press Section.

Abstract. A monitoring system for the operation of a corrugating machine is established here to monitor the factors affecting the dryness of the web and the parameters that can be optimized. Through the monitoring system to obtain the vacuum degree data, the vacuum system of the net part and the press part is analyzed, and the influence of the change of the vacuum degree on the dryness of the paper web is appropriately measured, the vacuum size is appropriately adjusted, and the excess vacuum degree is reduced to save energy consumption.

Introduction

The production of corrugated paper is a series of processes of forming a wet pulp containing only about 0.5% of pulp through a headbox, a wire section, pressing, drying, sizing, and coiling to form a dry paper web having a water content of about 5%. It takes a lot of electric energy in the papermaking process, and how to reduce the energy consumption of paper machine production is the goal pursued by paper manufacturers. Paper machine energy consumption is mainly concentrated in the wire section, press section and dryer section, accounting for more than 70% of the entire paper production line. The cost of removing the same three parts is about 1:70:330 [1]. Therefore, the dewatering of the net and the press section can be improved, which can save steam in the drying section and play a good role in reducing the energy consumption of the paper machine[2].

Paper Production Process

The papermaking process is shown in Figure 1. The slurry with a concentration of about 0.5% is supplied to the headbox by a slurry pump at a steady pressure. About 80% of the moisture is removed from the wire to form a wet paper web. The wet paper web is pressed and dehydrated by the press section to increase the dryness to about 45%. Finally, after the sizing, the dryness of the paper web is raised to about 95%, and finally the coiling mechanism is rolled into a finished paper roll [3，4].

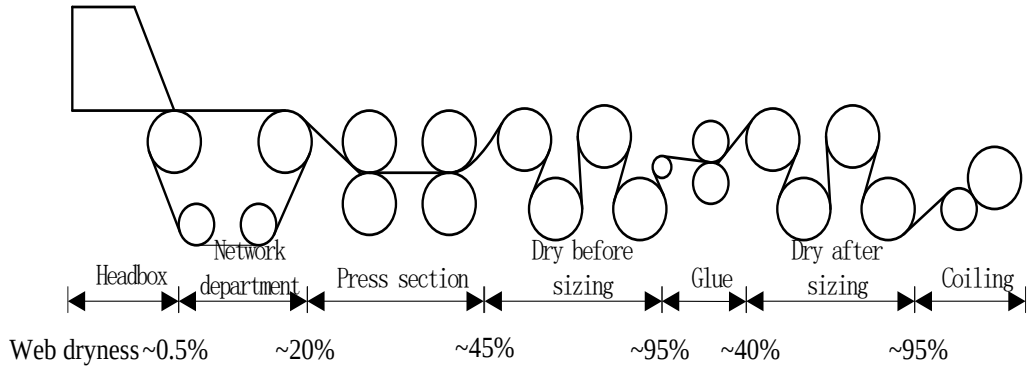

Figure 1. Paper production process

  DOI: 10.25236/ciais.2019.032

Dewatering Process for Wire Section and Press Section of a Paper Machine

Net Dehydration Process. The headbox coats the pulp on the forming wire at a stable speed, and the forming wire is driven by the driving of the case roller, and the wet paper web is sequentially dehydrated through the back suction box, and the suction box is connected with the vacuum pump, and the corresponding vacuum degree is further Also larger [6]. The dehydration process of the net department is shown in Figure 2.

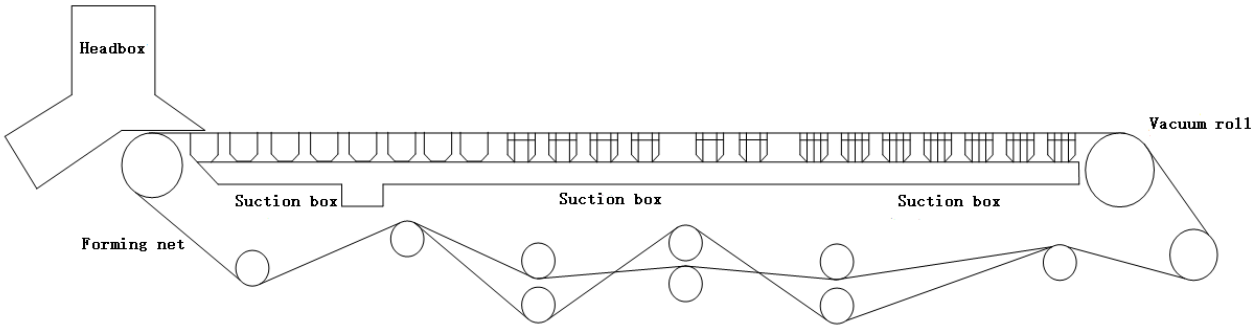

Figure 2. Net dehydration process

Pressing Process. The dewatering of the press section is to squeeze the moisture out of the wet paper web by mechanical extrusion, and the moisture is taken away by the felt between the upper and lower press rolls, and then the vacuum suction box is used to absorb the moisture in the felt [7], the press section The work is shown in Figure 3.

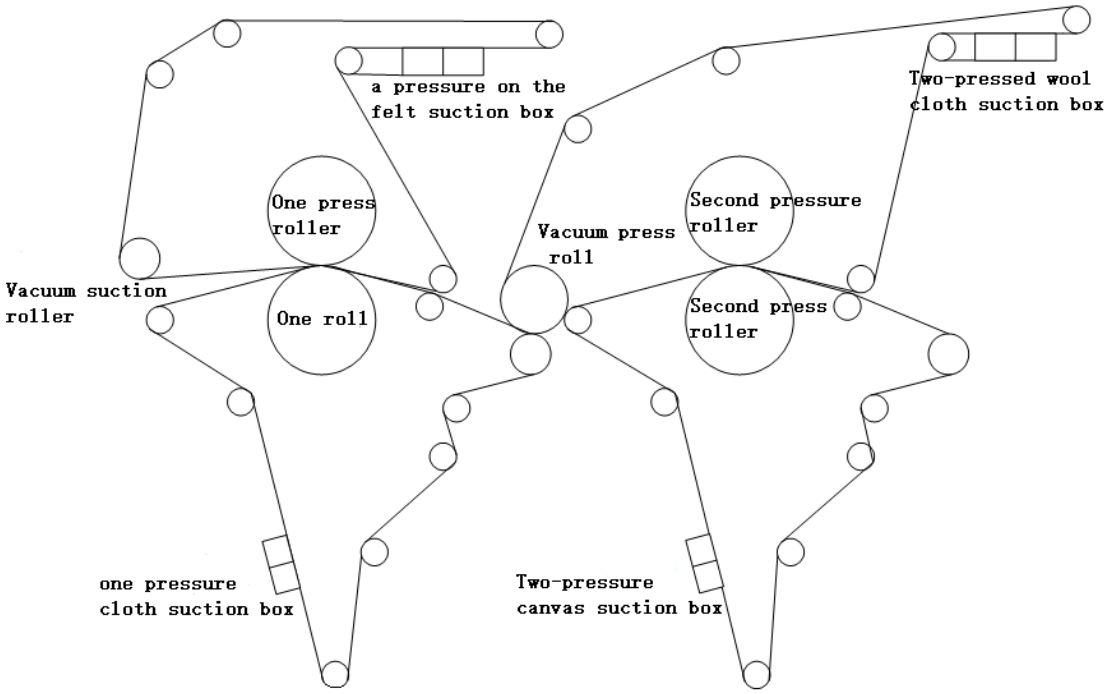

Figure 3. Schematic diagram of the dewatering process in the press section

Monitoring Location Selection

Network Monitoring Position Selection. The wet pulp is coated on the net part through the headbox, and the vacuum degree of each section has a set value range. When the range is exceeded, the dewatering of the paper web will be affected, thereby affecting the production standard of the paper web, and the paper may be broken. It is essential to monitor the vacuum of each suction box in the net

section[8]. The distribution of the vacuum monitoring position of the suction box of the net is shown in Table 1.

Table 1 Net suction box vacuum monitoring position

Dehydration point	Preset vacuum	measuring instrument
Low vacuum suction box	5Kpa~7Kpa	Vacuum sensor
Medium vacuum suction box	10Kpa~12Kpa	Vacuum sensor
High vacuum suction box	35Kpa~40Kpa	Vacuum sensor
Vacuum roll	25Kpa~40Kpa	Vacuum sensor

Press Section Monitoring Position Selection. From Figure 3, the press section is mechanically pressed by the upper and lower press rolls in combination with the vacuum press for dewatering, wherein the latter two are blind hole presses, and the middle is vacuum press. As the blanket grows with time, the performance will change. Dewatering with a constant vacuum will result in some waste. The selection of the vacuum monitoring position of the press section is shown in Table 2.

Table 2 Net suction box vacuum monitoring position

Monitoring points	Preset vacuum	measuring instrument
One pressure on the blanket suction box	47Kpa	Vacuum sensor
One pressure blanket suction box	47Kpa	Vacuum sensor
Two pressure on the blanket suction box	47Kpa	Vacuum sensor
Two-pressure blanket suction box	47Kpa	Vacuum sensor

Monitoring System Design

Here the vacuum sensor and S7-200PLC are combined with the TD-400C operation panel to form a vacuum monitoring system. The vacuum degree is collected using a vacuum sensor, and the collected vacuum information is converted into a current signal and then transmitted to the PLC. Through the man-machine interface, the command can also be sent to the PLC, and then the inverter of the vacuum pump is controlled to change the output of the vacuum pump, and finally the vacuum degree is adjusted[9]. The hardware system of the vacuum monitoring system of the net part and the press section is shown in Figure 4 .

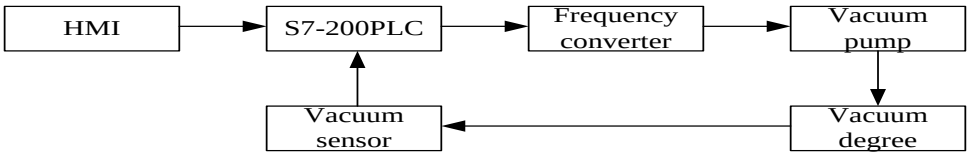

Figure 4. Vacuum monitoring system for the wire section and press section

The network part and the press part monitoring system mainly collect the vacuum degree signal. For the vacuum degree analog quantity signal, it is necessary to expand the analog input port. According to the actual situation of the site, the wiring of the vacuum transmitter in the monitoring system is shown in Figure 5. Because the signal is collected to avoid interference as much as possible, the analog cable is twisted with shielded wires to ensure measurement accuracy.

The vacuum frequency conversion control system of the net part and the press part is composed of PLC, frequency converter and vacuum sensor. According to the experiment, the adjustment range of the vacuum degree of the inverter control is determined. On the basis of the monitoring system, the vacuum frequency conversion control system of the net part and the press part is designed. Based on

the vacuum system of the paper machine, the PLC program is designed to accurately control the output of the inverter to maintain the optimal vacuum[10].

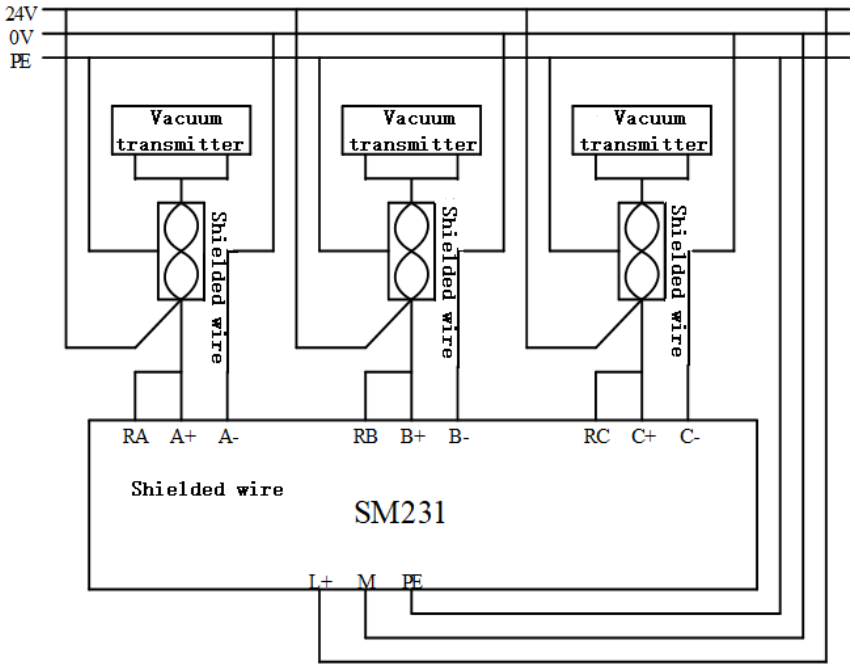

Figure 5. vacuum transmitter wiring diagram

The vacuum pump motor is controlled by the inverter to adjust the degree of vacuum. Here, the ACS800 inverter is used to control the vacuum pump motor. The wiring is shown in Figure 6.

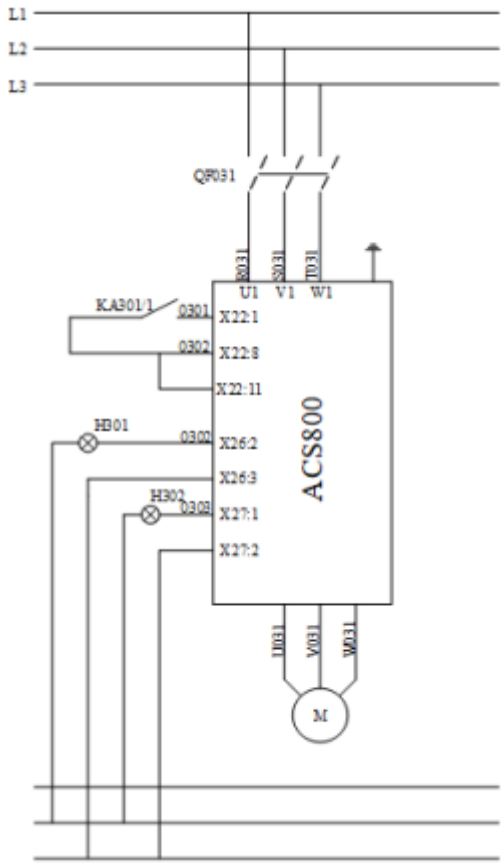

Figure 6. Vacuum pump inverter wiring diagram

The specific parameter settings of the ACS800 inverter are shown in Table 3 and Table 4.

Table 3 ACS800 inverter external interface parameter setting table

Numbering	parameter name	Settings
10.24	X26:2signal source	run
10.27	X27:1signal source	run
20.01	Ext1command	Fieldbus A
20.02	Ext1Start trigger	Level
20.03	Ext1Input	01.01.00
20.12	Run permission1	DI1
22.11	Speed given 1 choice	FBA Desired point 1
22.14	Speed given 1/2 choice	Speed reference1

Table 4 ACS800 inverter motor parameter setting table

Numbering	parameter name	Settings
99.04	Motor control mode	DTC
99.05	Motor rated voltage	380V
99.06	Motor rated current	357A
99.08	Motor rated speed	1485rpm
99.09	Motor rated power	200Kw

Optimization of Vacuum Energy Consumption in Net Section and Press Section

Optimization of Vacuum Energy Consumption in the Network. After a large number of experiments, after changing the new network, firstly, the vacuum of the high vacuum suction box under the net is lowered by 5 (Kpa) on the basis of the original vacuum, and then gradually increase the vacuum with the passage of time. Degree, increase the vacuum degree of 1 (Kpa) every 5 days, record the vacuum degree of the 25-day under-net high vacuum suction box and its corresponding paper dryness, and the vacuum reaches the set maximum value after 25 days. 40 (Kpa). With the increase of the use time of the net part net, after the vacuum degree of the vacuum suction box of the net part is adjusted to a small extent, the dryness of the paper machine net part can be guaranteed to be in the normal range, and the degree of vacuum is adjusted according to the actual number according to the actual number. Expert experience in the operation to determine.

Optimization of Vacuum Energy Consumption of Suction Blanket of Press Section. After a lot of experiments, the vacuum of the suction box of the felt dropped from 47 (Kpa) to 42 (Kpa), and the dryness of the paper began to change. After 42 (Kpa), the dryness of the paper began to deviate from 45. %, in order to minimize the energy consumption of the dryer section, take 42 (Kpa) for the minimum vacuum required to dewater the press felt. After replacing the new felt, adjust the vacuum of the initial felt suction box to 42 (Kpa), and then adjust the vacuum of the felt suction box every 2 to 4 days according to the experience with the use of the blanket. As with the vacuum suction box of the same mesh section, the vacuum degree of 1 (Kpa) is increased each time, and then the dryness of the paper sheet is measured by an infrared moisture meter, and the degree of vacuum is finely adjusted, on the one hand, the dryness of the paper sheet is not greatly affected. It is possible to maintain the normal production of the paper machine. On the other hand, it is possible to find the relationship between the use time of the felt and the vacuum of the suction box of the felt, and to find the optimum vacuum degree of the use time of the felt and the required dewatering.

Energy Optimization Effect. It can be seen from the test of the net part that the vacuum of the high vacuum suction box is unchanged from the original fixed 40 (Kpa) to gradually increase from 35 (Kpa) to 40 (Kpa), which saves 1 (Kpa) to 5 (Kpa) surplus vacuum; the vacuum of the press part of the press part is unchanged from fixed 47 (Kpa) to gradually increasing from 42 (Kpa) to 47 (Kpa), which also saves 1 (Kpa) to 5 (Kpa)'s surplus vacuum.

Conclusion

Optimizing the energy consumption of the wire and press section with high energy consumption during the papermaking process of the paper machine not only reduces the energy consumption in the corrugated paper production process, but also reduces the production cost of the enterprise, both from the perspective of energy saving and economy. It is very necessary.

A monitoring system for the operation of a corrugating machine is established here to monitor the factors affecting the dryness of the web and the parameters that can be optimized. Through the monitoring system to obtain the vacuum degree data, the vacuum system of the net part and the press part is analyzed, and the influence of the change of the vacuum degree on the dryness of the paper web is appropriately measured, the vacuum size is appropriately adjusted, and the excess vacuum degree is reduced to save energy consumption.

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