Thermal phenomenon and analysis of a grinding machine's roller

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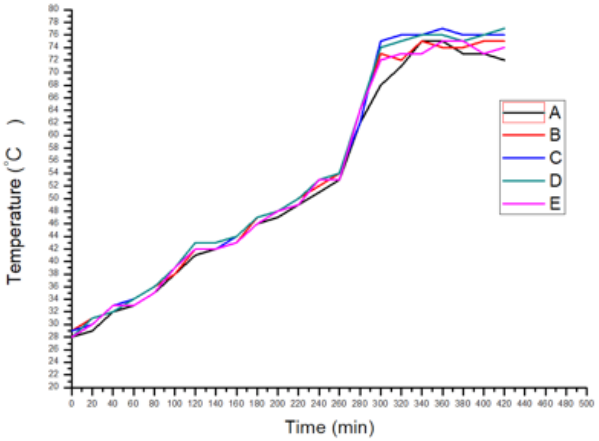
Wheat is the world's largest food crop, and the global demand for wheat flour is large every year. The milling industry has become an important basic industry in the global food industry. Roller mills are also growing more common as flour production equipment on the market, and they are the core and key equipment for all varieties of milling processes.

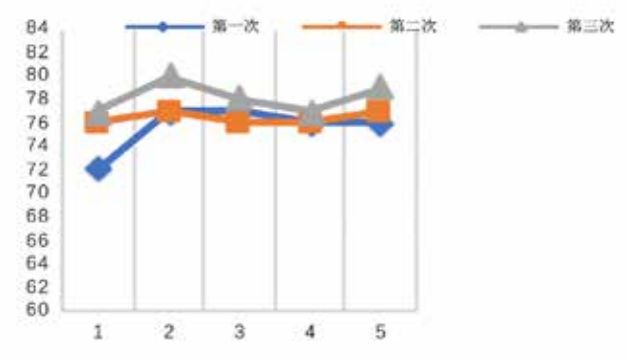
The grinding roller is the heart of the roller mill, and its performance directly affects and determines the quality and taste of the flour. However, there are some problems that can arise in the production process, mainly due to the shearing, extrusion, and friction between the grinding roller and the material, as well as the difference in technical parameters such as the rotational speed, the rolling distance and the speed ratio of the grinding roller.

When there is a large pressing force between two rollers, the pressing and rubbing of the material by the grinding roller causes a large amount of frictional heat between the roller and the material. The heat of friction generation is mainly related to the speed difference of the fast and slow rolls, the roll diameter, the roll length, the rolling distance, and the pressure between the rolls. At the same time, in the non-steady state, due to the deformation heat, friction heat and heat conduction of the material, the grinding roller continuously absorbs heat from the roller surface during the rotation process, causing the surface temperature of the grinding roller to gradually rise and for heat to transfer to the inside of the grinding roller, causing grinding. There is a large amount of heat accumulation inside the roller.

The start-up performance and isothermal performance of the mill are an important indicator to measure the performance of the mill's grinding roller. The uniformity of the roller surface temperature can greatly affect the quality and taste of the flour. The heat absorption section of the grinding roller is mainly based on heat conduction and obeys the Fourier heat conduction law.

The heat dissipation section is mainly composed of convective heat transfer and radiation heat transfer in a limited space. The success of the start-up performance mainly depends on the assembly quality of the grinding roller of the mill, and the





isothermal performance primarily depends on the temperature uniformity of the roll surface during the working process.

In the actual processing of the flour mill, in order to improve the efficiency and maximum output, the mill generally does not stop working for a long time. The long-time grinding causes the heat generated by the grinding roller to gather in the roller body and the mill cavity. The surface temperature of the grinding roller can reach 60 ° C ~ 80 ° C, and the quality of the flour will be affected to varying degrees within a certain range.

I have conducted a temperature measurement test on the one metre fast roll surface of a MDDK1000/250 mill in YiMin Flour Mill, Hebi City, Henan Province, China. Five test points were selected equidistantly on the roll surface, and were measured every 20 minutes from the start of the mill and recorded. The curve of the roll surface temperature can be judged for yourselves (see figure one).

It can be seen from Figure one that the temperature change of the roll surface shows a slowly rising trend within 0~340 minutes. It is explained that, due to the existence of the temperature difference between the roller surface and the roller body, the friction heat generated by the friction surface of the fast roller is slowly transferred from the roller surface to the inside of the roller body, and slowly accumulates inside the roller body, and the internal temperature of the roller body gradually increases.

Ascending, the temperature difference between the inside and outside is gradually reduced. When the roll surface temperature was increased to 75 ° C at 340 minutes, the temperature gradually stabilised and the temperature inside and outside the roll reached equilibrium. According to the first law of thermodynamics, the heat flowing into the roller body at this time is equal to the heat flowing out of the roller body.

I also conducted a temperature measurement test on the one-metre fast roll surface at the QuXia Flour Mill in Taixing City, Jiangsu Province, China. When the roll surface temperature reaches the steady state after the mill is turned on, the point is measured equidistantly on the roll surface, (see figure two)

As can be seen from figure two, the roll surface temperature is about 77 ° C, and the roll surface temperature uniformity is relatively good.

After the high-temperature grinding process, the loss rate of protein and other nutrients in wheat is about 80 percent. The higher the processing precision, the heavier the loss of nutrients of flour and the lower the nutritional value. The research results show that the flour extraction rate is at 60 percent, compared with wheat flour. B vitamins lost about 85 percent nutrition, vitamin E lost 50 percent nutrition, and iron, calcium, zinc and so on lost 80 percent, 50 percent and 8 percent respectively. Due to processing, the nutritional quality of the flour has been affected.

More than 2 billion tons of grain are processed every year in the world, including about 600 million tonnes of wheat. Roller mills are widely used in the milling of various grains. It is the main processing equipment for wheat flour. Its related equipment has been designed and manufactured in the world for more than 200 years. In view of the large global demand for flour, the high temperature of the rollers surface will have a great impact on the quality of the flour.

How to reduce the temperature of the roll body and improve the quality of the powder is a topic that global grain machine enterprises and many grain machine researchers need to pay attention.