Main image: Spain's Balaguer Company developed a new type of grinding roller inspection equipment called optical tooth type measuring instrument

ROLLS

The importance and methodology of checking rolls

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Wheat is the world's largest planted crop with the largest yield, and is the most widely distributed food crop. In 2016, global wheat production reached 750 million tonnes, accounting for one-third of the world's total grain output. The wheat produced is mainly eaten by people by processing it into flour.

The process of wheat processing into flour includes cleaning and milling. The main equipment used by modern flour mills in the wheat flour production section is use of the roller mill, which can crush the flour particles to the edible requirement by pressing and shearing the flour particles through two rolls, moving in opposite directions at different speeds.

Rolls are the most important and vulnerable parts of roller mills. The technical characteristics

Figure 1: Optical microscope

Figure 2: Digital microscope

Figure 3: Tooth profile measuring instrument

Figure 4: Optical gear type measuring equipment

of the roll's surface are directly related to the grinding effect, material classification, flow balance and production operation indexes. When rolls are running, they will inevitably and gradually gain roller wear, which changes the technical characteristics of the surface. The wear of rolls hold great influence on the grinding effect, energy consumption and the life of rolls.

The influence of abrasive roll wear on their condition, material characteristics and material property of the roll is critical to observe. In the continuous use process, fast rolls are generally not replaced by slow rolls. Fast rolls are usually used for three-to-six months, and slow rolls are usually used for four-to-nine months.

When the roll reaches the end of its life, it needs to be removed for processing. It is important to accurately judge the timing of roller change or repair. Changing or repairing the roll too early will affect its life, unnecessary equipment shut down and the roller repair substitute capital input. If the roll is changed or repaired too late, it will not only speed up the wear of the roll, but also affect the material output and flour quality and increase energy consumption.

The results show that the wheat flour yield increased by 24.7 percent after rolls are changed. However, the energy consumption of grinding mills is positively correlated with the wear of roller. The more serious wear, the greater the energy consumption. According to the experimental study, replacing or repairing the wear rolls too late may lead to a 50 percent increase in energy consumption. Therefore, it is particularly important for the enterprise to control the production cost by changing or repairing the roller in time through the inspection process.

According to the surface characteristics of rolls, it is divided into smooth rolls and grooved rolls. The check of smooth rolls is done by surfagauge. At present, there are four methods for the inspection of the grooved rolls, including the traditional inspection method, the microscopic measurement method, the contact tooth profile measuring instrument and the non-contact optical gear type measuring instrument.

The four types of inspection

Traditional inspection methods - Traditionally, mill technicians have evaluated the particle size, temperature, bran content of the mill, and combined this with touching the roll to determine whether the grooved roll needs to be drawn. A unworn roll has the required number of teeth, the unworn grooved roll is uniform, the tooth surface is smooth and clean, the tooth tip is uniform and the tooth groove is clear.

The severely worn surface of the tooth, touching the front and the blunt surface has a noticeable knobbly, snagged or rough feel. This method has high requirements for technical personnel and needs experienced staff, so it has low generalisation and strong limitations.

Microscopic examination method - At present, microscopy has become a very appealing form of measuring equipment. It was widely used in the biological, chemical, industrial and astronomical industries. Some roll processing enterprises use optical reading microscopes, to enlarge the tiny tooth profile and read the surface parameters of the tooth roller by observing the scale line inside the microscope, (see figure one).

Another is to use a digital microscope to display the tooth profile of the grooved roll on the display screen and read the tooth

tip width of the tooth roller through a ruler on the microscope (see figure two).

Contact tooth profile measuring instrument - In 2014, the Bühler company developed a gear profile measuring instrument for grooved rolls, (see figure three), which determines whether wire-drawing and roller replacement are required by measuring and comparing the wear changes of the tooth profile.

During the measurement, the instrument is fixed on the tooth roller and measured by the contact between the probe and the tooth. The probe of the measuring instrument is made of ruby and has good wear resistance. The contact track between the probe and the gear roller can show the profile of the tooth shape in a graphical way.

The instrument can compare the tooth profile parameters of the grinding roller with the original size to evaluate the degree of wear. The instrument's profit assessment function aims to increase production and reduce operating costs. It determines the wire drawing time and replacement time of the grinding roller, according to the degree of wear of the grinding roller. Accurate evaluation reduces energy consumption by approximately 50 percent, but the detection process is slow and has some limitations.

Non-contact optical gear type measuring instrument - In 2017, Spain's Balaguer Company developed a new type of grinding roller inspection equipment called optical tooth type measuring instrument, (see figure four). The appearance of the optical gear measuring instrument has a revolutionary breakthrough, which can avoid the error caused by human factors in the detection of grinding rolls.

This device is an optical instrument that can measure tooth profile parameters without contacting the surface of the tooth roller. The device has a 3D visual system that displays 3D graphics and parameter information of tooth slots on a 10.8-inch screen.

This device is easy to operate, easy to carry, and can measure the parameters of tooth grooves quickly and accurately. The measured data is compared with the allowable values, to evaluate and determine whether the grinding roller needs to be drawn or replaced. The measured parameters mainly include: tooth groove spacing, tooth top plane, tooth roller radius, tooth groove depth, blunt surface and frontal wear, tooth angle and tooth inclination.

The accuracy of measurement can be four μm, while the accuracy of angle measurement can be ±0.1°. If one of the measurements exceeds the allowable tolerance range, the system will alert the user. The measurement information can be transmitted to the central processing system via LAN.

Being thorough

Flour mills needs to strengthen their daily and periodic inspection of grinding rolls, to ensure that the equipment is in optimal working condition. This not only reduces production costs, but also increases the quality of the flour and reduces accidents.

At present, the inspection method of the grinding roller is limited. How to detect the grinding roller, to judge the replacement and repair time of the grinding roller, is also the research direction that the global grain machine enterprises and many grain machine researchers need to pay attention to.