Figure 1: Sandblasting test block

Roller mills

A study of the effects of sandblasting on the surface morphology of grinding rollers

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Nowadays, the roller mill has become the most important piece of milling equipment in the flour mill, with the grinding roller being the main working component, which directly affects the milling effect.

According to different surface treatment technology, the grinding roller is divided into two varieties, the 'tooth roller' and the 'sandblasting roller'. The sandblasting roller shape is either a drum shape or a conical, rough surface, with its rough surface created through a high-pressure air jet on the surface of the smooth roller made from brown abrasive corundum.

According to the different processes, the sandblasting of rollers is used in the core grinding system. In the core grinding system, sandblasting plays a grinding role on the material, and its surface topography will affect the grinding effect.

In the actual production process, the engineer indirectly judges the wear situation by touching the surface of the sandblasting roller or by grinding mechanical power consumption and powder rate, without specific description indicators.

Therefore, the analysis of the surface topography of the sandblasting roller and scientific description of its surface wear is a very concerned problem in the industry.

There have been many studies of the sandblasted roller, with many of the associated scholars mainly examining the material, processing methods, as well as simple surface detection methods, amongst other aspects. The evaluation of its surface topography has not formulated relevant standards, so there is no accurate description of the surface wear of sandblasting roller index.

The surface morphology wear of the sandblasted roller will directly influence the effectiveness of the pulverising process. Combined with the current description index of the surface of the sandblasting roller, it can be concluded that it is reasonable to analyse the surface morphology of the sandblasting roller by using the fractal theory.

Finally, the surface morphology of the two sandblasting samples with the same wear condition is acquired by image collection, and the surface morphology of the sandblasting roller in the same state has fractal self-similar characteristics.

Recognition of surface morphology of sandblasting roller

In order to ensure that the test block is consistent with the surface morphology of the real sandblasting roller, the test block is provided by Jinxing Roll Factory, and the size of the test block is 50 x 60 x 30 millimetres (Figure 1).

The surface of the test block was cleaned, and the surface morphology of the sandblasting test block was measured by the super depth-of-field 3D microscopy system (Figure 2). The super depth-of-field image (Figure 3) was obtained, which was converted into 3D three-dimensional morphology (Figure 4).

It can be observed that the surface of sandblasting roller is uneven, with obvious peaks and valleys. Using the measurement function to measure the linear contour of 3D three-dimensional morphology, it can be concluded that the peak-valley contour is uniform in the linear direction, and the valley depth is basically the same.

Common surface description methods

According to the different measurement methods and practical applications, the surface morphology description methods are also different. The surface morphology is complicated, and it is difficult to characterise various characteristics with limited parameters.

With the in-depth study of the surface morphology, various parameters have been proposed and added to the original standard, the number of parameters is increasing, forming the situation of parameter explosion. The traditional characteristic parameters are mainly divided into height difference parameters and texture parameters.

Height difference parameters mainly describe the change characteristics and distribution rules of surface morphology in the height direction, and texture parameters describe the position relationship between points of surface morphology.

Surface roughness parameters

Roughness parameters are also commonly used to describe rough surface morphology. Six parameters are specified in the national standard, namely contour arithmetic mean deviation Ra, micro-unflatness ten-point height Rz, maximum contour height Ry, contour single peak mean interval S, micro-unflatness mean interval Sm and contour support length ratio Pt.

Calculation of each evaluation parameter is based on the contour least squares center line, as shown in Figure 2. The centre line of least square contour is the reference line for evaluating surface roughness parameters. Its correct determination plays a decisive role in the calculation of various parameters.

The above commonly used description parameters for rough surfaces have the advantages of convenience in calculation and measurement. However, it is not enough to describe the whole three-dimensional topography because the two-dimensional evaluation is local dependent and cannot reflect the microscopic characteristics of the surface as a whole.

Figure 2: Ultra-depth-of-field 3D microscopic system

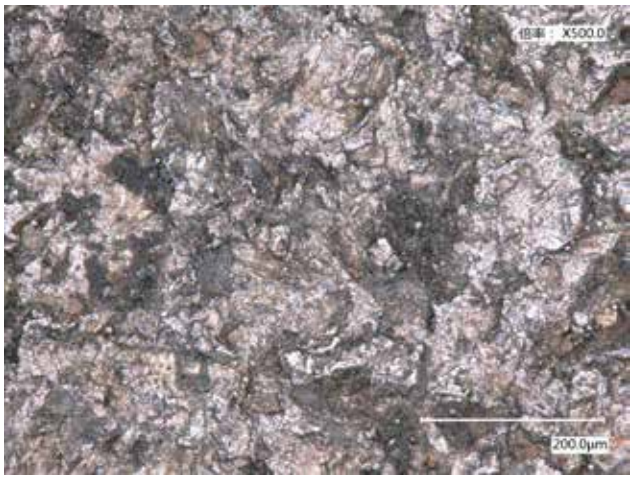

Figure 3: Ultra depth of field image of sandblasted surface

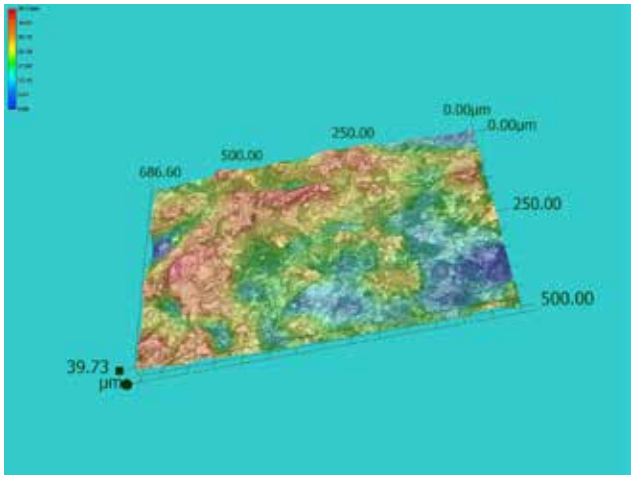

Figure 4: 3D morphology of sandblasted surface

Sandblasted roller surface description

A rollCare measuring instrument developed by Bühler is used to measure the surface of the sandblasting roller by touching the surface of the sandblasting roller. Its working principle is similar to that of the contact roughness measuring instrument.

Which measures the linear profile of the surface of the sandblasting roller. The description index is two-dimensional roughness, and the measurement result is roughness value Ra.

After investigation roller manufacturers found with sandblasting machine to roughen the sand roller surface, rely mainly on sandblasting machine specific program guarantee sandblasting sand roller surface morphology, in sandblasting machine working pressure, sand blasting distance, corundum type, such as feed rate condition certain cases.

By controlling the times guarantee sandblasting sand blasting effect. After that, the contact roughness measuring instrument was used to measure the sandblasting surface, and the average Ra value of three points was measured to check the qualification of the sandblasting roller. It can be seen that the roller manufacturers also take two-dimensional roughness as the description index of the surface morphology of sandblasting roller.

At present, two-dimensional roughness parameters are used to describe the surface of sandblasting roller. Although the measurement is simple and easy to calculate. This parameter has directivity and can only describe the contour of a straight line on the surface of sandblasting roller.

It has local dependence and cannot reflect the microscopic characteristics of the surface as a whole, which is not enough to describe the whole three-dimensional topography.

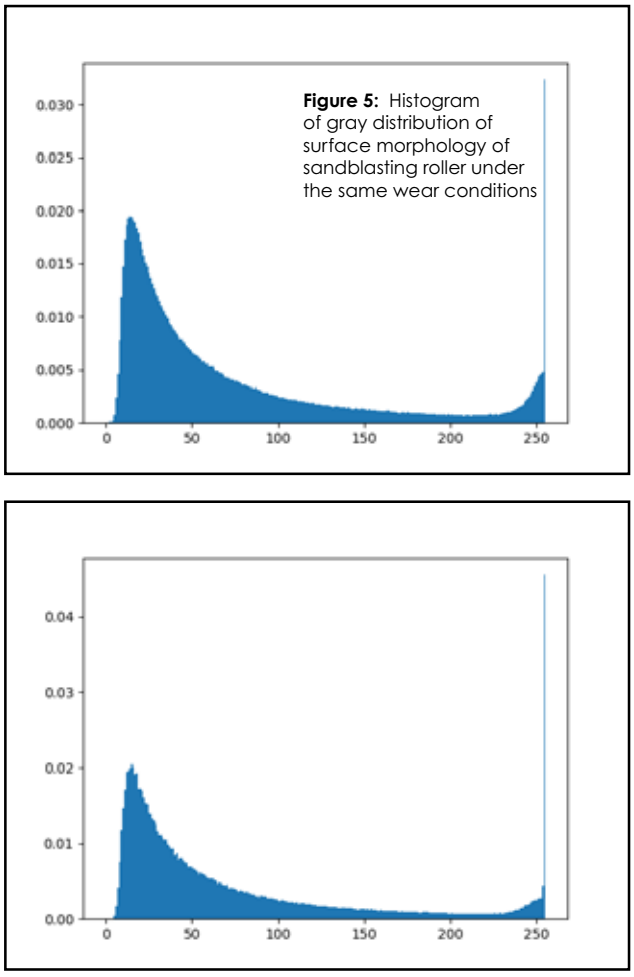

Figure 5: Histogram of gray distribution of surface morphology of sandblasting roller under the same wear conditions

Fractal behaviour of sand blast roller surface

Although sand roller surface is irregular, but within a certain range sandblasting surface and has a certain self-similarity, can try to use a single fractal dimension parameters to reflect the morphology of sandblasting.

The scholars to explore the quantitative law of friction and wear in the process of fractal geometry method as a kind of nonlinear science theory is applied in tribology research of the problem.

By studying the fractal behaviour of its surface, the surface morphology description index of sandblast roller can be determined, and the method for further determining the wear state of sandblast roller can be provided.

Figure 5 shows the gray distribution histogram of the surface morphology images of the two sandblasting rollers. It can be seen from the figure that the gray scale distribution of the surface morphology images of the two sandblasting rollers is significantly similar.

This indicates that the surface morphology and wear of the sandblasting rollers are similar under the same wear state. In fact, this reflects the fractal characteristics of the sandblasting morphology, which contains abundant fractal self-similar feature information.

The surface morphology of sandblasting roller directly affects the grinding effect of flour. The accurate description of the surface of sandblasting roller and the formulation of the corresponding parameter standard are always concerned by the flour industry.