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The preparation method and performance analysis of coated kraft paper with wear resistance

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Abstract. The goal of the research is to improve the surface states of kraft paper and to make coated kraft paper with wear resistance suitable for packaging material. Based on wear and coating mechanism, the research analyzed and compared the characteristics and microstructure of uncoated paper and coated paper. The result shows that coating can reduce the surface resistance and friction of paper. Kraft paper was coated with the VaporCoatTM2200.s coating in the research. The research studied the influence of coating process on wear resistance of coated kraft paper. Two hundred groups of experimental datum of each sample show that the optimal coating weight is 18g/m². As expected, coated kraft paper has better wear resistance and other performance than the uncoated kraft paper. The results show that the coating technology is an inexpensive and environmentally friendly process. The research provides the theoretical basis and data supporting for packaging enterprises to produce the coated paper-based packaging materials with wear resistance.

1. Introduction

As an important means of improving material properties and coating characteristics, new coating technology has been widely used in light industry papermaking, plastic film deep processing, information materials, printed circuit and other important areas^[1]. In the papermaking process, coating can improve the compactness of the paper and the mechanical strength and printability^[2]. Teng Minghui et al^[3] studied the relationship between the friction properties of coated paper and the paper encountered in the printing process. Ma Xin et al^[4] confirmed that the friction coefficient of the coated paper-based packaging material is closely related to the surface state of the coating, the curing forming process and the friction coefficient test method. Sun Shiqiong^[5] studied the paper-based material surface strength by the internal coating of paper, pulp processing and wet end charge and other factors.

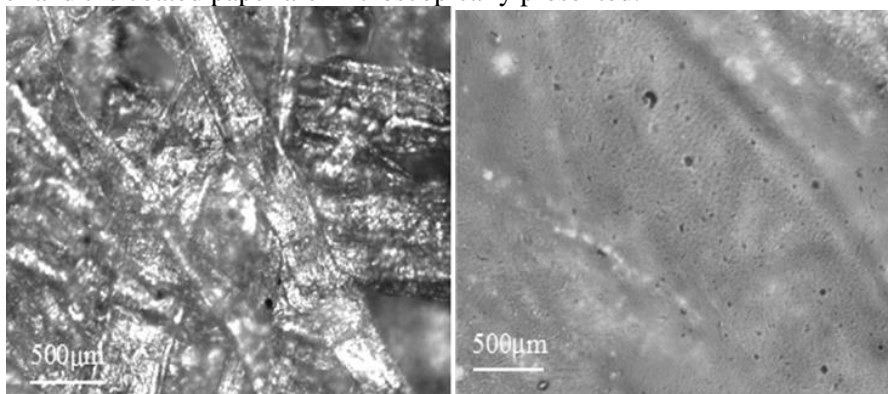
In the transportation process of heavy metal electromechanical products of large volume, heavy weight, hard edges and irregular structure, the product will contact with the inner surface of the carton and produce relative motion and resulting in the friction. If the relative motion is frequent, the inner product will cause the phenomenon of material falling off and breaking holes in the packaging carton, which will make the carton lose the function of protecting the inner product and cause the product to be damaged. Therefore, the paper based materials used to package must have good wear resistance. At present, the methods of protecting products by adding plastic cushion and special shaped Kraft paper cushion are commonly used to protect products, such as wasting materials, polluting the environment



and designing large quantities. Therefore, developing coated paper with better wear-resisting property is of great practical significance. To mitigate this inadequacy, surfaces are to be simulated to those witnessed in actual conditions.

2. Friction mechanism Microstructural characterization of coated paper

The principle of coating is that the wear-resistant coating is coated on the surface of the whole roll of paper based material by the coating machine. Several groups of rollers extruded the coating into the surface of the paper and the coating is instantly dried at high temperature at the same time. The surface of the uncoated paper and the coated paper surface was observed and measured by size measurement of 20 times super depth of depth metallographic microscope [6]. Figure 1 (a) and (b) are micrographs of the surface of an uncoated base paper and the coated paper. Figure 2 (a) and (b), the images of the uncoated paper and the coated paper are microscopically presented.



(a) surface of base paper (b) surface of coated paper

Figure 1. Microscopic image of paper surface.



(a) cross-section of base paper (b) cross-section of coated paper

Figure 2. Microscopic image of paper cross-section.

It can be seen that the coated paper is more blurred than the common base paper and the uneven porosity is reduced. It can be seen that waterborne coatings can fill up the surface gaps of base paper, paint and adhere to the surface and internal surface of the paper. It forms a continuous and smooth coating layer and reconstructs the fiber structure of the packaging materials. Therefore, the surface friction coefficient of the smooth and smooth coated paper based and the wear resistance is significantly enhanced.

3. Experimental apparatus and procedures

3.1. Experimental apparatus

The experimental materials are first grade cowhide paper and the VaporCoatTM2200.s water-based coatings produced by Michelman company in the United States. Experimental apparatus are ball disc

friction and wear tester, constant temperature and humidity incubator PYX-2500-A, precision coating equipment MRC-1000, computer measurement and control compression tester. The pin-disk friction and wear testing machine.

3.2. Experimental procedure

Experiments were conducted using a pin-disk friction and wear testing machine. The usefulness of this test is that from a single experiment and the effect of the process on the coated paper of friction could be studied.

The base paper was kraft paper with gram of 125,180,200,250. VaporCoatTM2200.s water paint is as the coating material. se of the roll type "MRC-1000" precision coating machine. The kraft paper is cut into a circular specimen with a diameter of 40mm, which is classified and annotated. Before each experiment. According to GB/T 10739-2002, kraft paper sample is placed in the constant temperature and constant humidity box for 24h with the temperature of 23 and the relative humidity is 50%. The pin-disk friction and wear testing machine is used to test the friction force between the specimen and GCr steel ball. The friction coefficient is calculated according to the formula and the wear resistance of coated paper under different parameters is analyzed.

The coefficient of friction was calculated using the formula given by

$$\mu = \frac{F}{N} \quad (1)$$

Where F is the friction force, N is the load, μ is the coefficient of friction.

After the tests, the coated paper was observed using a scanning electron microscope (SEM) to study the surface features. In the following sections, micrographs of the center region of the pins and the flats are presented.

4. Results and discussion

4.1. The influence of coating amount on wear resistance of coated kraft paper

Keeping other parameters unchanged, the coating amount is respectively 0, 8, 12, 18, 22g/m² of the kraft paper samples. When the coating amount is $C_w = 0$, $C_w = 8\text{g/m}^2$, $C_w = 12\text{g/m}^2$, $C_w = 18\text{g/m}^2$, $C_w = 22\text{g/m}^2$, the data acquisition system collects 200 groups of the friction force of each sample and then calculates the 200 groups of friction coefficients of each sample. Figure 3 shows the friction coefficient of kraft paper under different coating amount.

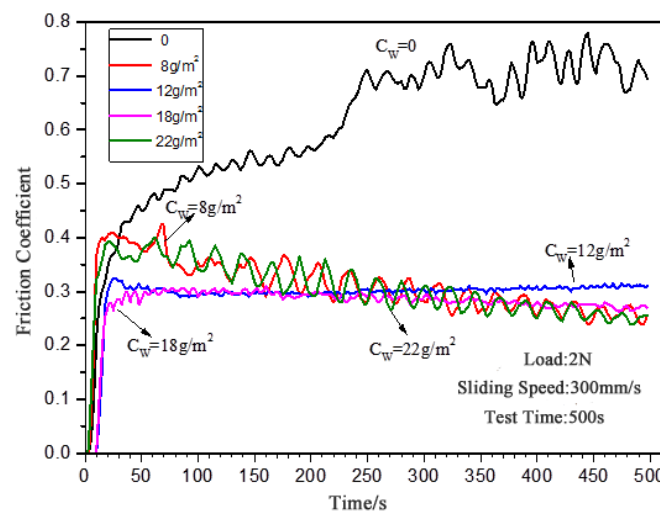


Figure 3. Friction coefficient of kraft paper with different coating amount.

Figure 3 shows that coating VaporCoat the on the surface of kraft paper can reduce the friction coefficient of kraft paper. With the increase of friction time, the surface of uncoated kraft paper is becoming rougher and rougher by GCr steel ball but the roughness of the surface will not change any more when the friction is reached to a certain extent. The coating forms a smooth film on the surface of the kraft paper. So the surface roughness changes little with the increase of friction time. Friction coefficient of the uncoated kraft paper surface increased first with the increase of friction time, then tended to be stable and the friction coefficient of coated kraft paper almost does not fluctuate with the increase of friction time.

4.2. The influence of different gram of paper based materials on friction coefficient of coated kraft paper

In the experiment, the base materials were coated with 125,180,200,250g/m², the coating time was one time, and the coating amount was 18g/m². The relationship between the gram of the coated paper and the friction coefficient is analyzed by the chart. The results are shown in Figure 4. In addition, according to the friction coefficient values of uncoated and coated cartons shown in table1.

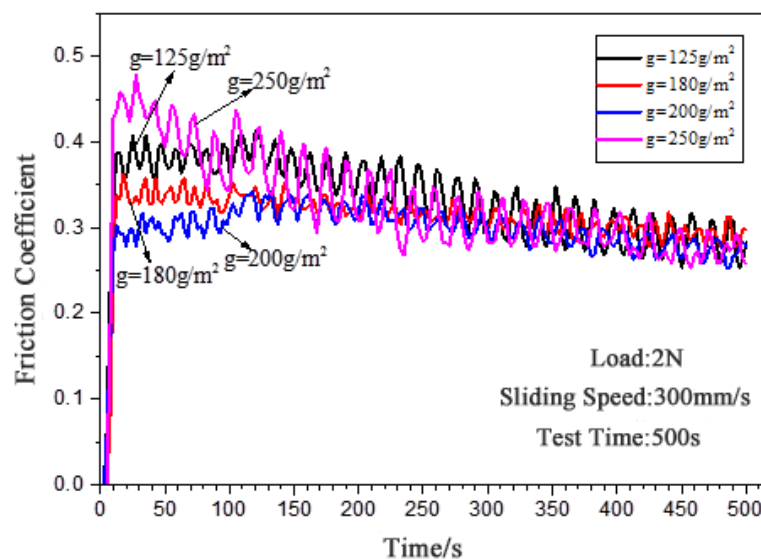


Figure 4 Friction coefficient of kraft paper with different base material.

From figure 4, it is known that the friction coefficient of coated paper is nonlinear with the gram of kraft paper and the size of paper has little influence on the wear resistance of coated paper surface.

After coating the surface friction coefficient of the kraft paper box with the growth of time tends to be uniform. This is because the coating makes quantitative kraft paper surface forming a coating layer of dense and originally porous paper surface becomes smooth. So all kinds of coated kraft paper surface friction coefficient will be more close to.

Table 1. Friction coefficient of different quantitative coated cartons compared with uncoated ones

| Frictioncoefficient | Quantificati (g/m ²) | | | |
|---------------------|----------------------------------|--------|--------|--------|
| | 125 | 180 | 200 | 250 |
| Paper | 0.627 | 0.609 | 0.607 | 0.547 |
| Coated paper | 0.333 | 0.312 | 0.298 | 0.327 |
| Decreases percent | 46.90% | 48.80% | 50.90% | 40.30% |

5. Conclutions

In this paper, the wear mechanism and wear resistance of coated kraft paper is studied and analyzed and the coating process is used to enhance the wear resistance. The results show that the wear resistance of the coated kraft paper can be enhanced significantly. In the case of the friction between

the kraft paper and metal products, the best kraft paper is 200g/m², the coating amount is 18g/m². It shows that the coated kraft paper not only has good wear resistance, but also can improve other properties, which has guiding significance for the production of functional wear-resistant paper.

Acknowledgments

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