Water-based double layer coating transfer aluminum-plated paper material in the application

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Abstract. This paper introduces a new type of moisturizing paper, which makes the material have a stronger moisturizing effect than ordinary transfer paper through the water-based double-layer coating process. At the same time, the paper has a stronger degradation capacity than plastic film paper, more in line with environmental protection requirements. Through the paper printing machine adaptability verification, the paper has easier processing and stronger printing performance. The development and application of this moistening material is a major innovation in the field of moistening packaging materials research.

1. Introduction

The demand for the moistening of tobacco products is a long-term concern. China has a great difference in climate because of China's vast territory. How to maintain the stable taste of tobacco products in various climatic conditions is the relentless pursuit of tobacco enterprises, but also the important indicator to maintain product quality and improve the sensory experience of customers. For a long time, tobacco companies have focused on adding moisturizers to tobacco formulations, or using paper-plastic aluminum-wrapped structural materials on packaging of high price brands to achieve the goal of moistening.[1]

2. Selection of printed substrates

At present, the tobacco packaging industry basically use the structure of the shape box and moisturizing paper to solve the requirement of high standard of tobacco. And the moisturizing packaging materials generally select paper-plastic aluminum structure materials. The inner part of Shuangxi(Da Guo Xi) and Shuangxi(Spring 1979) heterogeneous packaging is also the paper-plastic aluminum material.

2.1. Paper-plastic aluminum packaging materials

Paper-plastic aluminum composite material is a kind of very safe food grade material, because the spray aluminum grade and packaging will not interact. It can completely isolate the water vapor moisture in and out, so that the packaging can perfectly achieve the moisturizing effect.[2]. However, the high cost of paper-plastic aluminum materials and the complex processing process limite the large-
scale application of paper-plastic aluminum materials. Currently only the preservation, sterile, anti-ultraviolet and other aspects in food packaging have large-scale application. Among the materials used in plastic aluminum composite packaging materials, polyethylene film is not conducive to recycling, but also not to degradation. Therefore, plastic aluminum composite packaging materials in environmental protection is innately inadequate. Of course, with the development of science and technology, many scientific and technological force have studied many recycling methods in paper-plastic aluminum material, but only paper and aluminum layer recycling in the composite material. The recovery of plastic film is still a problem that plagues mankind. Moreover, the printing adaptation of paper-plastic aluminum composite materials is not good, it can only print monochrome or simple pattern pattern, so the application range is limited[3].

2.2. Water-repacked packaging materials

Through extensive research in the early stage of this project, we learned that some fast food enterprises, such as McDonald's, its paper soup bowl used coating material to replace the original gonorrhoea production process and achieved the very good application result. Milk packaging had carried out pre-replacement operation and conducted varieties of experimental demonstration. It also achieved the great result. To this end, we understood the characteristics of this materials and the processing technology in detail through the relevant food packaging industry institution, and contacted with the material supplier in deep. We also achieved excellent results on the basis of the laboratory feasibility study and the application prospect of the new material on The tobacco packaging market.

In this paper, we introduce a new type of moistening packaging material, which uses a pure water paper coating. This moistening packaging material has good recyclability, and has a very wide range of compliance (including FDA, EU standards). This paper coating is developed by the United States McComen company and it can specifically target for the food packaging industry waterproof function and has excellent moisture and oxygen resistance function. The basic principle of the paper coating is to evenly dispersed special resin (one or more) through the emulsification process in water, and it will form a stable structure and system of water-packed oil, and than it will evenly coat on the surface of the packaging material. After drying the material will have additional moisturizing effect. The coating mainly affects the paper substrate, so that the paper has excellent anti-grease, waterproof performance and can prevent damage and contamination in the use. .

2.3. Comparison of the two moistening materials with ordinary white card transfer paper

The tobacco packaging industry usually uses a large number of conventional white card transfer paper which is a relatively environmentally friendly tobacco packaging materials. It has already entered the mature application. In order to analyze the new moistening material in more detail, it is necessary to use the conventional white card transfer aluminum paper as a comparative sample to enter the experiment. The characteristic analysis of three materials is summarized in the following table:
## Table 1. Differences between the two new materials and conventional white card transfer paper

|                                | Conventional white card transfer paper | Water-hydrative moisturizing transfer paper | Paper-plastic aluminum moisturizes the paper |
|--------------------------------|----------------------------------------|---------------------------------------------|---------------------------------------------|
| **The main composition of the material** | White paper jam, vacuum aluminum coating, glue | White paper jam, vacuum aluminum coating, special water-like preservation double coating, glue | White paper jam, aluminum foil layer, polyethylene layer, glue |
| **Eco-friendly features** | Degradable, paper type belongs to better environmental protection | Degradable, same environmentally friendly to conventional transfer paper | The degradation ability of polyethylene film in the structure is poor, and the decomposition performance of aluminum foil layer is not as good as that of vacuum aluminum coating |
| **Thickness** | About 0.3mm/225g of basic paper | Slightly thicker (about 0.31mm/225g of basic paper) | Thicker (about 0.35mm/225g of basic paper) |
| **Tingness** | Lower | Lower | Higher |
| **Moistening function** | Not available | Good moistening performance | Excellent moistening performance |
| **Printing processing capacity** | Adapt to all kinds of printing processing processes | Adaptable widely | Adaptable |
| **Performance of the cigarette pack on the machine** | Adapt to all kinds of cigarette packaging machine | Adapt to all kinds of cigarette packaging machine | Adapt to low-speed cigarette packaging machine and manual cigarette box type |

According to the comparison shown in the table, water-based coating moisturizing materials have good moisturizing properties and a wide range of printing adaptability. It can be applied to conventional transfer paper tobacco packaging printing and post-press processing of any materials. The materials can also meet the requirement of tobacco packaging materials for moistening need and a variety of printing performance effect, so the project selects water-based coating moisturizing materials as tobacco packaging materials.

### 3. Preparation and moistening testing of new double coating transfer paper packaging materials

#### 3.1. The structure of the new double coating transfer paper packaging material

The difference between the new double-layer coating transfer paper packaging material and the original conventional paper plastic aluminum is to add a water-based coating layer between the paper
and the aluminum coating layer, while remove polyethylene film and composite aluminum foil. Meanwhile, it use the transfer aluminum coating layer to replace the composite aluminum foil. The structure of conventional transfer wrapping paper, conventional paper plastic aluminum composite packaging materials and new double-layer coating material is shown in Figures 1, 2 and 3. The new double coating material greatly enhances the degradation capacity of the new material by eliminating the polyethylene layer and replacing the original aluminum foil with a vacuum aluminum coating layer.

Figure 1. The structure of conventional vacuum aluminized transfer paper packaging material

Figure 2. The structure of conventional paper-plastic aluminum composite packaging material
Figure 3. The structure of new double coating material

From the experimental results, it is feasible to place the double water-based coating between the original paper white card paper and the transfer aluminum layer (or the transfer zinc sulfide media layer). Through the treatment of the subsequent back coating process on the back of the paper, the finished paper can basically maintain flatness and surface cleanliness. The transfer film layer adopts dry compound re-transfer method which can solve the defect that can't be dried while conventional compound glue can't be effectively volatile in the double-layer compound process. The use of dry compounds method also avoids the uncertainty of moisture content caused by water-based latex[4].

Through experiments, two water-based coating models (SurCoat C and SurCoat E) were selected, and the moisturizing properties of the packaging materials will be close to paper-plastic aluminum structural materials. Through VOCs testing, the new double coating transfer paper packaging materials can meet the requirements of the tobacco industry quality and safety indicator.

3.2. A new double-layer coating transfer paper permeable test

The standard used: GB 1037-1988《Plastic film and sheet water-permeable vapor test method - cup method》. Experimental conditions: Temperature: 38℃, relative humidity: 96%RH, Time: 24Hr. The test data are water vapor transmission rate - permeable rate: units in grams/cm²/24 hours[3].

After the laboratory has made the coated samples, the new double-layer coating samples, white card paper samples, conventional laser transfer paper samples and conventional media transfer paper samples will be sent to third-party testing. White card paper samples, laser transfer paper samples and media transfer paper samples will be the standard for comparative verification. The test mainly detects material breathability and moisturizing index, low pass rate shows good results. The comparison of specific water vapor data is showed in the Table 2.

| Numble | Sample                                | Result |
|--------|---------------------------------------|--------|
| 1      | White card paper samples              | 1159   |
| 2      | Conventional laser transfer paper samples | 124    |
| 3      | Conventional media transfer paper samples | 199    |
| 4      | New double-layer coating samples C+C  | 37     |
| 5      | New double-layer coating samples C+E  | 31     |

From the test data, the moisturizing performance of conventional transfer laser paper and conventional transfer laser media paper has a qualitative difference to white card paper because of the role of surface transfer layer, intermediate plastic layer and back coating. There is no essential difference between Surface transfer aluminum layer and transfer zinc sulfide layer. Although the
surface has not been transferred processing, the overall moisturizing effect of double-coated paper sample has been significantly improved than the transfer paper.

Several paper samples were submitted to third party for testing also verified the same results. In Table 3, samples 1 and 2 are paper samples of paper-plastic aluminum moisturizing materials, samples 3, 4, and 5 are paper samples of water-powered new moisturizing materials (bottom-coated C-surface-coated E) for the second test material, samples 6 and 7 are paper samples of water-powered new moisturizing materials (bottom-coated C-bottom-coated C) for the third test material.

**Table 3.** Test value of water vapor transmission capacity $g/m^2\cdot24h$

| Sample                                  | Result 1 | Result 2 | Average |
|-----------------------------------------|----------|----------|---------|
| No.1 paper-plastic aluminum moisturizing materials | 4.2866087 | 4.2866087 | 4.3     |
| No.2 paper-plastic aluminum moisturizing materials | 3.6271304 | 5.6055652 | 4.6     |
| No.3 water-powered new moisturizing material(C+E) | 13.5546351 | 15.2205737 | 14.4    |
| No.4 water-powered new moisturizing material(C+E) | 17.4616873 | 19.6201855 | 18.5    |
| No.5 water-powered new moisturizing material(C+E) | 19.3104835 | 22.4936413 | 20.9    |
| No.6 water-powered new moisturizing material(C+C) | 26.7088723 | 47.1526963 | 36.9    |
| No.7 water-powered new moisturizing material(C+C) | 31.6549575 | 36.2713047 | 34      |

Therefore, through the laboratory coating test and water resistance test verification proved that the new water-based barrier coating paper can not only achieve the internal moisturizing of tobacco products packaging, but also achieve an ideal level of moisture barrier.

### 3.3. The moistening test of the new double coating transfer paper packaging material

Standards used: GB/T 22838.8-2009 《Measurement of the Physical Performance of Cigarettes and Filter Rods Part 8: Moisture Content》. Sample pre-treatment: The tobacco which measured each time will balance 48h at the same temperature and relative humidity.

The first test: after wrapping the tobacco with moistening packaging (the BOPP film was not packed), the sample was randomly selected by the tobacco industry oven method to test the humidity. The remaining tobacco is placed at the temperature of $26\pm1^\circ C$, relative humidity of $60\%$ RH in a constant temperature and humidity tank for 10 days, and then test the moisture data of the product tobacco in the package. Comparing the product humidity 10 days ago with 10 days later.

The second test: same packaging, same product, the temperature is $22\pm2^\circ C$, the relative humidity is $60\pm5\%$ RH, the sample is also placed for 10 days, comparing the product humidity 10 days ago with 10 days later.

After the finished sample of cigarette packaging is prepared, the moistening difference of cigarette is analyzed by oven method at the temperature of $26\pm1^\circ C$ and the relative humidity of $60\pm5\%$ RH. The finished sample is placed for 10 days in the thermostat and remove the sample to dehumidification treatment. Test result of the first experiment is showed in Table 4.

**Table 4.** The first experiment moisture content

| Sample | 10-day parallel value of moisture content(%) | Relative deviation |
|--------|--------------------------------------------|-------------------|
| 1      | 11.70                                      | 11.76             | 0.06              |
| 2      | 11.56                                      | 11.60             | 0.04              |
| 3      | 11.52                                      | 11.59             | 0.07              |
| 4      | 12.05                                      | 12.10             | 0.05              |

The second experiment of the finished sample of the cigarette pack: we use the same sample preparation method and change the equilibrium temperature to $30\pm1^\circ C$, relative humidity is $80\%$ $\pm5\%$ RH, other packaging methods and test methods have not changed. The samples balanced and placed about 10 days. Test results of the second experiment is showed in Table 5.
The conclusion shows that no matter which kind of ambient temperature and humidity, the relative deviation value is very small. According to the requirements of industry testing, it can basically meet the need of product package moistening.

4. The printing process selection and on-the-machine adaptability test of the new double coating transfer paper packaging materials

4.1. The choice of printing process

Combining with the moistening box type and product design requirement, we use water-based double-coated transfer paper as the benchmark material to carry out the new box type and ordinary box type design.

According to the product design need, these samples are using UV digital printing、UV offset printing、UV screen printing、bronzinng、bumps、die-cutting and other different forms of printing processing. Among them, UV digital printing need to coat digital liquid on the surface of the paper to meet the binding force requirement between paper surface and UV digital ink. Through these experiments, it is found that the new double-layer coating transfer paper packaging materials can be applied to the requirements of different printing processes, and the conventional printing processing process does not require additional treatment for moistening packaging materials.

4.2. On-the-machine adaptation test of new double coating transfer paper packaging materials

The new double-layer coating transfer paper packaging materials in the printing process found the following problems, and through the adjustment of coating and printing process solutions to solve these problems:

4.2.1. Paper flatness is poor. During the printing of packaging materials, the first time on the machine test found that the paper flatness was poor, the paper aluminum-plated surface was foaming, surface aluminum-plated was anti-pull phenomenon in offset printing when finished the
processing of the moistening material cutting into flat sheets. After the observation of defect phenomenon, combined with the processing record of material production. We analyse the material defects and determine the main reason is due to uneven coating and short drying drying channel. These reasons result in a poor coating of the moisturizing coating fluid level，different coating volume distribution，and then cause the coating dry impermeable. After solving the problem of smoothing，uniform coating and coating drying，the overall test of the sample product was basically smooth.

4.2.2. Packaging indentation burst. In the use of flat offset printing process, part of dark ink on the machine test have burst phenomenon. Analysis of the burst phenomenon，we can judge that the explosion phenomenon is due to the problem of the binding fastness between the glue layer and the substrate layer. Further in-depth analysis of the problem generation，low moisturizing coating water absorption is the main reason for the combination of glue and moisturizing coating. By adjusting the paper production process to improve binding force between the glue，moisturizing coating and substrate layer，we ensure that the paper processing process will not be pulled back and die-cutting indentation will not have burst phenomenon.

4.2.3. Overprinting is not precise. When semi-finished products for follow-up silk printing and hot gold bump processing，we found that overprinting is unstable and the relative deviation is about 0.4mm. The defects of deformation and alignment deviation are mainly due to the large water content of the paper and the difference in water content between the various areas of the paper.

Analysis of the above-mentioned quality defects in the printing process，we can see that the coating effect of the moisturizing coating，drying condition as well as the water absorption of the moisturizing coating and other factors are the main causes of paper moisture content，paper surface flatness and other paper defects. Therefore，how to make the material using the new water-specific moisturizing coating solution meet the requirement of adaptability is the key. According to different performance requirement，we need to choose the appropriate amount of coating for water-based back coating before the water-based double-layer coating and locking water treatment for the basic paper.

5. Conclusion

5.1. The new materials meet the need of the different level of the tobacco packaging market

After the theoretical analysis，laboratory test and on-machine test results analysis of the new water-based double layer coating moisturizing materials，it can be determined that the new double-coated transfer paper packaging materials can meet the need of tobacco packaging moisturizing requirement. It forms a step-by-step moisturizing function selection with paper-plastic aluminum structure moisturizing materials and conventional transfer paper packaging materials. According to the need of different products，we can select the different structures of the moisturizing materials.

5.2. The new material can adapt to different forms of tobacco pack packaging and the moisturizing effect is obvious

The new material can enhancing the moisturizing ability without affecting the performance of tobacco packaging. It can adapt to manual packaging，automatic packaging and other forms of packaging.

Among them，the paper-plastic aluminum structure moisturizing material has the best moisturizing effect. The moisturizing effect of bottom-coated C-surface-coated E is better. The materials have fundamental difference comparing to conventional laser aluminum-based transfer material or laser transfer medium material in moisturizing aspects.

5.3. The new material complies with the mandatory safety requirements (VOCs) of the tobacco market and has excellent biodegradability

The new water-based double layer coating moisturizing materials and its final product is very good in volatile organic compound compliance aspect. It has excellent biodegradability because it removed
the composite film and composite aluminum foil from the original paper-plastic aluminum structure materials. This new material is a competitive new material for moisturizing properties.

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