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IN-LINE PREPARATION SYSTEM FOR THE PARAFFIN EMULSION USED WITHIN A PARTICLEBOARDS MANUFACTURING LINE

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Abstract: *The properties of particleboards greatly depend on the raw materials and additives used in their composition. Paraffin emulsion is one of the additives widely used to improve the surface absorption and thickness swelling of particleboards. Industrial paraffin emulsion contains a large amount of filling materials which increase the solid content unnecessarily, with negative impact on the properties of the boards. Additionally, the high amount of oil contained by the industrial emulsion causes spots on the panel surface. These shortcomings lead to the necessity of developing an original system for the in-line preparation of the paraffin emulsion. The basic design and the benefits obtained, as well as the results of the measurements regarding ammonia emissions, are presented in this article. The developed solution was efficiently implemented at industrial level.*

Key words: *particleboards, paraffin emulsion, in-line preparation system.*

1. Introduction

The particleboard is one of the most popular wood-based composites manufactured from wood and other lignocellulosic materials mixed with adhesive under pressure and temperature. The description of a typical production line of particleboards is given below.

The raw material, in different size, from softwood and hardwood waste with bark, is first chipped, and then stored in silos. In order to eliminate potential foreign objects such as metals, rocks etc., the material goes through an air-cleaning system.

During the next phase, the chips are reduced to small particles by using flakers. The particles are then transferred into the dryer, where they are fed according to a pre-set recipe (micro/macro/ sawdust/dry-waste ratio).

After drying, the raw material is transferred to the screening area, where it is divided into several fractions based on size. Here, the inappropriate oversized and then undersized particles are excluded. The too big particles

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from the “Oversize” screen are re-processed through an additional mill, then recycled through the screens, while the undersized material from the “Dust” screens is transferred to the thermal plant.

The correct-sized particles are fed into vertical air-separators, called wind-sifters, to eliminate remains of foreign objects such as metals and sand. Then, the material is transferred to the dry material silos, and stored separately for the surface and core layers.

The next phase consists in feeding the mixer (blender), where particles, adhesive, and the required additives, such as paraffin emulsion, are mixed together.

The mixture is then transferred to the forming line where the mat is formed. The unpressed mat is composed of three layers: two surface layers (top/bottom) and one core layer. The mat is first pre-pressed, for initial compactation. If the mat is inconsistent or if it contains impurities such as metals, it is discarded and then recycled by being reintroduced in the dryer’s recipe.

If the mat is consistent enough, the compacted mat is transferred to a continuous hot press. The pressing parameters (temperature and time) are set so as to reach the required product parameters (density, thickness etc.).

When exiting the hot press, the raw particleboard is sized and then it undergoes an on-line quality control system which checks its actual parameters against the set ones. If the standard requirements are not met, the board is discarded automatically through the board-breaker trap.

After quality control, the boards are cooled, and then stored in the stocking area for at least 24 hours before being transferred to the sanding line.

Both surfaces get sanded through two passes, whilst on-line control of the set thickness is performed. During the quality control after sanding, defective boards get sorted separately.

The sanded boards are stacked and labeled based on their destination and product type. Then the labels are scanned, at which point the product is registered in the system. Packing is performed automatically on a dedicated line. The packed goods are stored in the warehouse, in the finished goods area.

Several problems may occur within such a complex technological line, which can affect the quality of the end product, making it unsuitable for delivery.

For instance, the technique of applying the paraffin emulsion is an important factor of influence upon the physical and mechanical properties of particleboards [2].

Replacing paraffin with alkyd ketene dimer (AKD) was studied [4] as a possibility to improve the thickness swelling and the water uptake of the particleboards.

The present research was determined by the necessity to find a technological solution to avoid oily spots on the board surface. This defect was reported by a particleboard factory that produces thin boards which had to be painted with a water-based primer in several coatings. Because of the penetrating oil spots, the painting was affected.

The origin of the oily spots was found to be the use of industrial paraffin emulsion, which had a very high (7%) oil content.

2. Objective

The main objective of the present research was to develop an industrial system for producing paraffin emulsion for particleboards manufacturing directly in-line, in order to avoid the use of industrial paraffin.

The industrial implementation of this system was also pursued in order to assess eventual secondary advantages and the economic efficiency of the developed system.

3. Presentation of the New Technological Solution

Paraffin emulsion is an industrial product, obtained from emulsifying solid paraffin in water by adding certain emulsifiers and stabilizers. Its role within the recipe of wooden particleboards is to improve some of their most important physical properties [1]: surface absorption, thickness swelling, and for some special particleboards, moisture resistance and resistance after boiling as well.

Usually, the consumption of solid paraffin is around 1,3 kg/m^3. In order to be stable in time, the paraffin emulsion must have max. 60% solid content. The size of the paraffin particles within the emulsion should range between 500 nm and 50 μm [3]. The added emulsifiers and stabilizers should represent 5-7%. The rest of the components are represented by other substances, such as oil and water.

Industrial paraffin emulsion contains over 40% water and also a great amount of additives in order to resist various transport conditions. Depending on the time span between production and use, the particle size consistency may be affected, which lowers its technical performances within the composite product (particleboard).

Thus, came the idea to replace the industrial paraffin emulsion with a “home-made” emulsion prepared right within the technological line.

Besides eliminating the oil excess, the new technological solution also envisaged a lowering of the unnecessary solid content, better stability of the emulsion at high temperatures, zero addition of contaminants and fillings, and lower transportation costs, all these leading to a cheaper product.

One of the most important tasks which paraffin emulsion must fulfill is that of covering flakes as uniformly as possible, but in a thin layer (to reduce consumption). For this purpose, the particles must be as small as possible. Therefore, the emulsifying temperature should range between 75-85°C and rapid mixing at 600rpm is necessary [3], [5].

A four-stage preparation assembly was developed.

The first stage of preparation consists in heating-up the water inside the preparation reactor up to 85°C (Figure 1). Solid paraffin is added and temperature stabilization at 80°C is awaited.

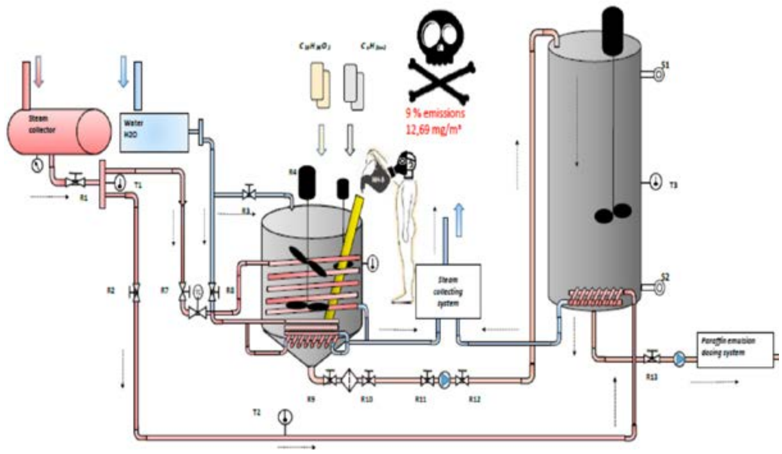


Fig. 1. *In-line paraffin emulsion preparation system, 1st version (original)*

The second stage begins after complete liquefaction. The heating is stopped and the main agitator is started (at low rotation speed). Stearic acid is added and then the rapid mixer is started (with a rotation speed of 600 rpm).

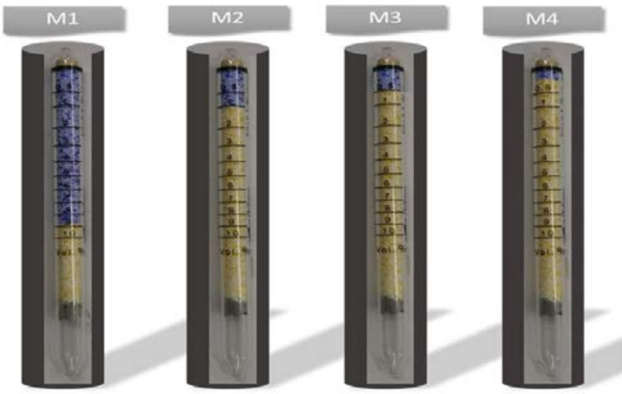
The third stage begins after complete emulsification. The rapid mixer is stopped. Ammonia solution is added in the main mixer. This step must be paid great attention to, as ammonia is a toxic and volatile substance. Water is added in order to reach the desired concentration.

Within the last stage, the emulsion is forcefully cooled below 40°C during continuous agitation. It is then transferred to the stocking tank fitted with a heating coil where it continues to be slowly agitated. There, it is maintained at a constant temperature above 35°C.

Considering the risks involved by the use of ammonia within the third stage, measurements of the ammonia vapor concentration at various heights were made by means of a Dräger Accuro apparatus [6].

DrägerTubes® are glass vials filled with a chemical reagent that reacts to a specific chemical (in our case, ammonia). A calibrated 100 ml sample of air is drawn through the tube with the Dräger accuro® bellows pump. If the targeted chemical (ammonia) is present, the reagent in the tube changes color and the length of the color change typically indicates the measured concentration [7].

The results of the performed measurements are presented in Figure 2.



Measurement	ppm	mg/m^3
M1 (operator)	9	12,69
M2 (2 meters)	1	1,41
M3 (3 meters)	0,5	0,71
M4 (5 meters)	0,25	0,35

Fig. 2. *Ammonia emission measurements, with 1st version of emulsion preparation system*

According to national restrictions [8], the concentration after short-time (15 minutes) exposure should not exceed 36 mg/cbm or 50 ppt. The values measured within this test are much lower than these limits. However, the internal (enterprise-specific) limits are much stricter, and the measured values exceeded them.

In order to eliminate this risk, a closed dosing system was designed (the yellow block in Figure 3), which introduces ammonia water pre-dosed at the bottom of the preparation reactor alongside a continuous mixing (dissolving) inside the emulsion. This modification led to a considerable reduction of the ammonia emissions, bringing them to an admissible level, as shown in Figure 4.

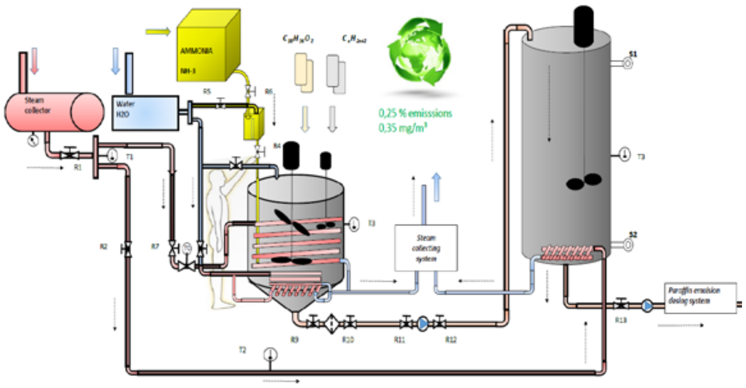
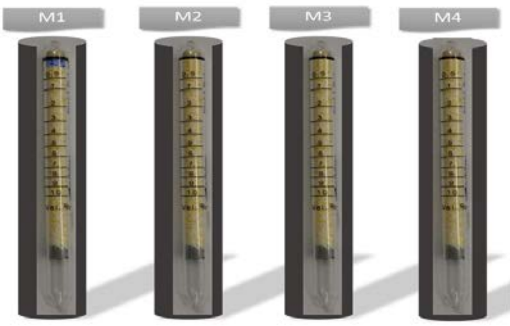


Fig. 3. *In-line paraffin emulsion preparation system, revised version (original)*



Measurement	ppm	mg/m³
M1 (operator)	0,25	0,35
M2 (2 meters)	0	0
M3 (3 meters)	0	0
M4 (5 meters)	0	0

Fig. 4. *Ammonia emission measurements, with the revised version of the emulsion preparation system*

In order for this type of preparation system to be able to produce continuously, and knowing that it takes a certain amount of time for preparation, two parallel preparation reactors were built, from which the stabilized emulsion was transferred into a buffer-stocking tank, as shown in Figure 5.

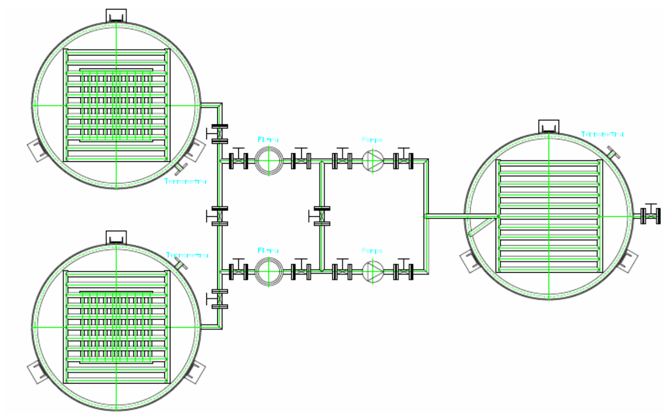


Fig. 5. *Schematic diagram of the paraffin emulsion preparation system at KASTAMONU, with two reactors and one stocking unit*

The final version of the preparation system, as presented in Fig. 3, was implemented at SC KASTAMONU ROMANIA SA REGHIN, within the particleboards manufacturing line and it functions flawlessly.

4. Conclusions

The developed in-line preparation system of paraffin emulsion not only eliminated the occurrence of oily spots, but several other benefits were additionally achieved. These can be summarized as follows:
- fully known composition of the paraffin emulsion, including the real concentration of solid paraffin (the part which ensures the improvement of boards properties);
- lower solid content (20-40%), better adapted to the product type vs. 60% solid (meant to increase transport efficiency);
- lower solid content at preparation, which leads to smaller paraffin particles in the stabilized emulsion, in turn leading to lower consumption; the particle size grows by longer storing of the emulsion, but the in-line system allows the use of fresh emulsion every time;
- controllable oil content (solid paraffin has 1.5-2% oil content compared to 7% for industrial paraffin) and other worthless or harmful impurities;
- more than 4% lower costs related to the solid paraffin in the emulsion, because the paraffin percentage from the solid content of the prepared emulsion is higher than the one from the ready-prepared bought one;
- possibility to store the solid paraffin for long periods of time: up to 12 months for the solid paraffin, compared to 3-4 weeks for the industrial emulsion;
- reduction of transport costs (considering the emulsion solid content as 60%, the other 40% is water to be transported, which means that the transport costs can be reduced by ca. 40% if the water is added in the plant).

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