MINI HATSCHEK MACHINE FOR THE DEVELOPMENT OF FIBER CEMENT MATERIAL

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This article presents a model of mini Hatschek machine for development of fiber cement material. The structure of the machine is simple and compact, which is suitable for using in fiber cement laboratories. The mini Hatschek machine is helpful for fiber cement manufacturers in finding an appropriate mix proportion as well as optimizing the manufacturing process with a reasonable cost. Testing the trial samples and comparing to those manufactured by an industry-level machine shows that the mini Hatschek machine is able to simulate the actual manufacturing conditions.

Keywords: Hatschek process, mini Hatschek machine, PVA fiber cement.

1. Introduction

Manufacturers in Vietnam produce non-asbestos (NT) fiber cement sheets by using the Hatschek process and some others make silica boards based on the flow-on technology. Those production lines are built with relative big capacity, around 5 to 6 tones/hour. One of the main problem which the manufacturers are facing now is how to find out an appropriate mix proportion or technology processes in order to

- Use new raw materials or local materials for reducing product cost.
- Make new products for meeting requirement of the market.
- Satisfy specific requirements of customers in term of product quality or product characteristics (thickness, bending strength, fire-resistance, density…).

Normally, trials for finding an appropriate mix proportions and process should be carried out directly on an industrial-level production lines at site. Therefore, the cost of the trials is rather high, and it also affects production plans of the company. As a result, the cost of final products will be high, and in some cases the quality of the products are not met the customer's requirements due to the time necessary for trials is often being shortened due to the cost saving problem.

Many efforts have been made to replace the industrial-level trials, and the most common one is to make samples in a laboratory to simulate the real products. The main points of making samples of PVA cement sheets in a laboratory are illustrated in Figure 1. In the figure, the slurry containing the raw materials is firstly mixed in a high-speed mixer to ensure its uniform and good dispersion of the PVA fibers and pulp, it then being dewatered with the help of a vacuum before pressuring. The obtained samples are cured and then cut into appropriates size for testing. This method is easy to carry out, and the cost of the test is low. However, the main drawback of the method is that the samples and the test results are considerably diverged from that of the products made by industrial Hatschek machine (Quang and Kien, 2010). It is worthy to note that the samples made in the laboratory mentioned above are not the kind of laminate composite, and the orientation of the PVA fiber is just random. As a result, the bending strength of the laboratory samples is rather low comparing to that of the real sheets when the same mix proportions are used. In addition, the bonding

between the fiber and cement matrix of the laboratory samples is not strong enough, and the composite is rather soft. Figure 2 shows the load-deflection curve of a sample under three-point bending test. As seen from the figure, the curve is lengthened in compared with those samples made by an industrial Hatschek machine.

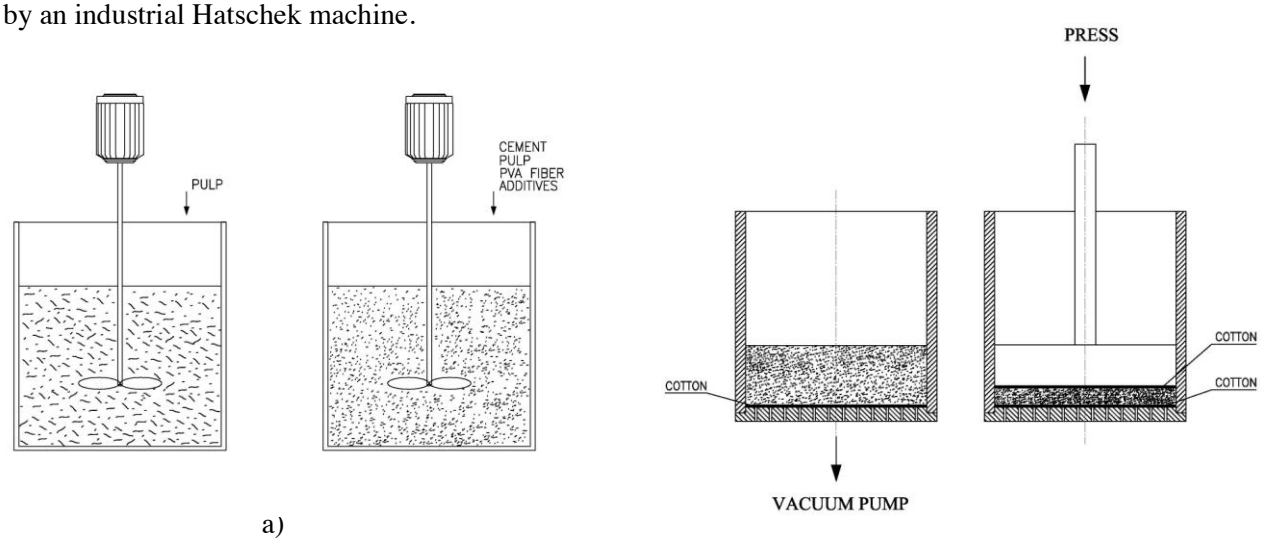

Figure 1. Making PVA fiber cement samples in the laboratory by pressuring-refining process.
a) Mixing materials by a high speed mixer, b) Pressuring-refining with a vacuum pump

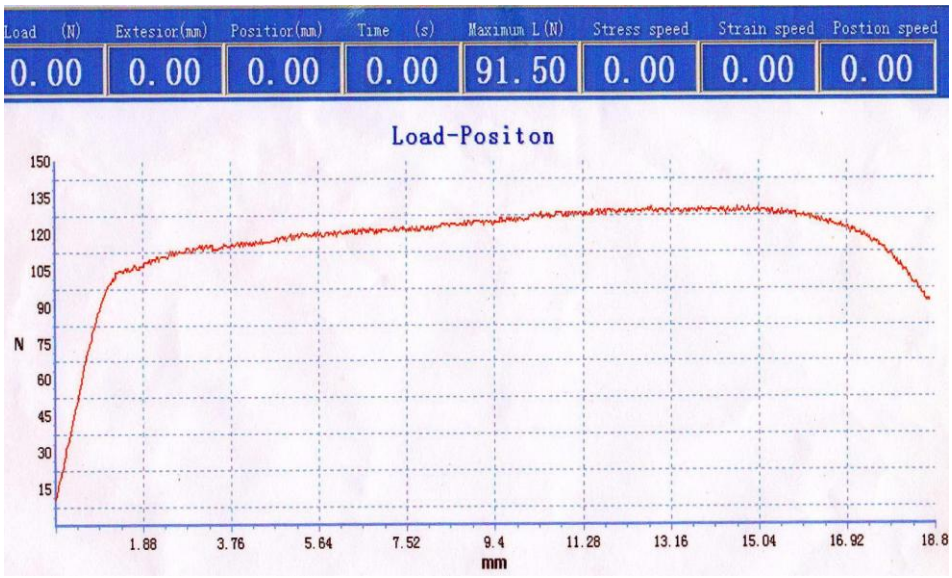

Figure 2. Load-deflection curve of a laboratory sample in three-point bending test

Thus, finding a suitable and low cost method for producing samples which are characterized as equivalent as those of the industrial Hatschek machine is important for the fiber cement industry. As an effort, we developed a mini Hatschek machine which can be used in making fiber cement sheets for testing. The machine helps fiber cement manufacturers in finding an approximate mix proportions and manufacturing process at a reasonable cost. This paper describes the main characteristics of a mini Hatschek machine which was designed and fabricated by the authors in Vietnam recently. Some properties of samples made from this kind of machine are also presented.

2 – Mini Hatschek machine

The main specifications of mini Hatschek machine showed in Figure 3 are as follows:

- Length: 3200 mm
- Width: 1200 mm
- Height: 2100 mm
- Making roller diameter: 620mm
- Felt speed: 30 m/min
- Product size: (Length x Width x Thickness) 1800 x 400 x 12 mm (max)
- Capacity: 18 - 36 sheets/hour (depend on the thickness of product)

The specifications and the characteristics of the mini Hatscheck machine have been calculated as well as the fiber cement samples made by this machine are similar to those of the industrial machine, from both the material structures and properties. The pressuring system of the making roller and couch roller have been designed as well as it can be adjustable to meet the characteristics of a industrial Hatschek machine (Tony Cooke: www.fibrecementconsulting.com/publications/011011.hatschekfilmsummary.pdf). The driving system of felt and agitators of vat is set by inverters according to the process of the operator. Subsidiary units such as the water system for cleaning felt and mesh, system of vacuum… are integrated and synchronized with the whole machine.

Figure 3. Mini Hatschek machine

The mini Hatschek machine is simply and compact structured and is easy to operate (requiring only one operator) and maintain. Subsidiary systems (i.e electricity, water, pneumatic and vacuum pumps) are all synchronized with the machine.

3. Production line of mini Hatschek machine

To produce NT fiber cement samples by using Hatschek process requires good preparation of different types of raw materials (Blanco et al., 2010; Ikai et al., 2010). Several pieces of material preparation equipment have been designed and fabricated to suit with the capacity of the mini Hatschek manchine.These equipment are combined with the mini Hatschek machine and synchronized in a unique line.

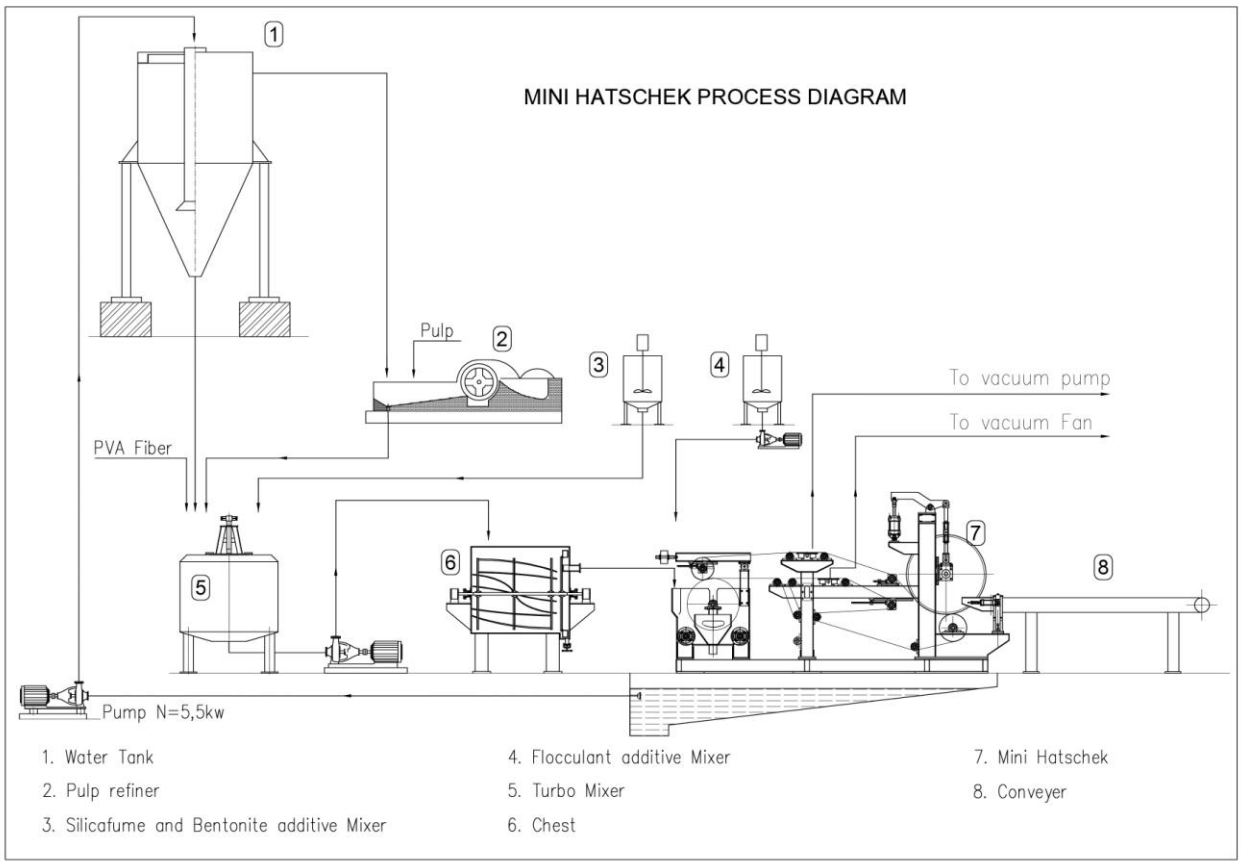

Figure 4. Diagram of Mini Hatschek line for making fiber cement samples.

The main functions of the equipment showed in the diagram are as follows:

- Hollander (2): This machine is used to grind pulp to 65°SR, and it is a simple machine but very efficient. In addition, this machine can be used with recycled material such as DLK or cotton rag.
- Mixer (3): This equipment is used in preparation of slurry of Silica Fume or Bentonite which may be required in making samples.
- Mixer (4): This equipment is a unit for preparing and dosing Polymer agent needed in the Hatschek process.
- Turbo mixer (5): This mixer is used for mixing raw materials which has been prepared properly. PVA fiber and cement are also mixed in this machine. The working volume of this mixer and Chest (6) is all 1.2m^3.
- Speed of take off - conveyor (8) is synchronized to the speed of mini Hatschek machine.
- Volume of water tank is 7.5m^3 are installed outside the workshop.

Total area (inside) requires for the workshop of the mini Hatschek line is 60m^2. General power of the line is 25kW, including the water pumps and vacuum system. The capacity of a mixing batch is 100 kg of all dry materials, and this amount of the materials is enough for running mini Hatschek in 20-30 minutes with 18 samples of (1800 x 400 x 6mm). An estimated cost of the raw materials and power for each batch is around US$ 100 - 150. Thus, the mini Hatschek machine helps us to make test samples at a considerable low cost in compared with an industrial Hatschek machine. Figure 5 shows a panorama picture of the mini Hatschek line at site.

Figure 5. Panorama of mini Hatschek line installed at site.

4. Properties of samples

Various PVA fiber cement samples have been made by using the mini Hatschek line and their bending strength was measured. Both the air-cured and autoclave samples are made. Figure 6 shows the stress-strain curves of the PVA fiber cement sheets made by the mini Hatschek machine. As seen form the figure, the stress-strain curves of the samples made by the mini machine are similar to that of the industrial PVA fiber sheets. The samples are also multi-layer and fiber oriented composite as that of the industrial sheets. Interesting note from the.

Figure 6 is that the autoclave sample is considerably brittle compares to the air-cured one. The strain corresponding the maximum stress of the air-cured sheet is about six times to that of the autoclave sample, and thus performance of the air-cured sheet is much stronger than that of the autoclave sheet.

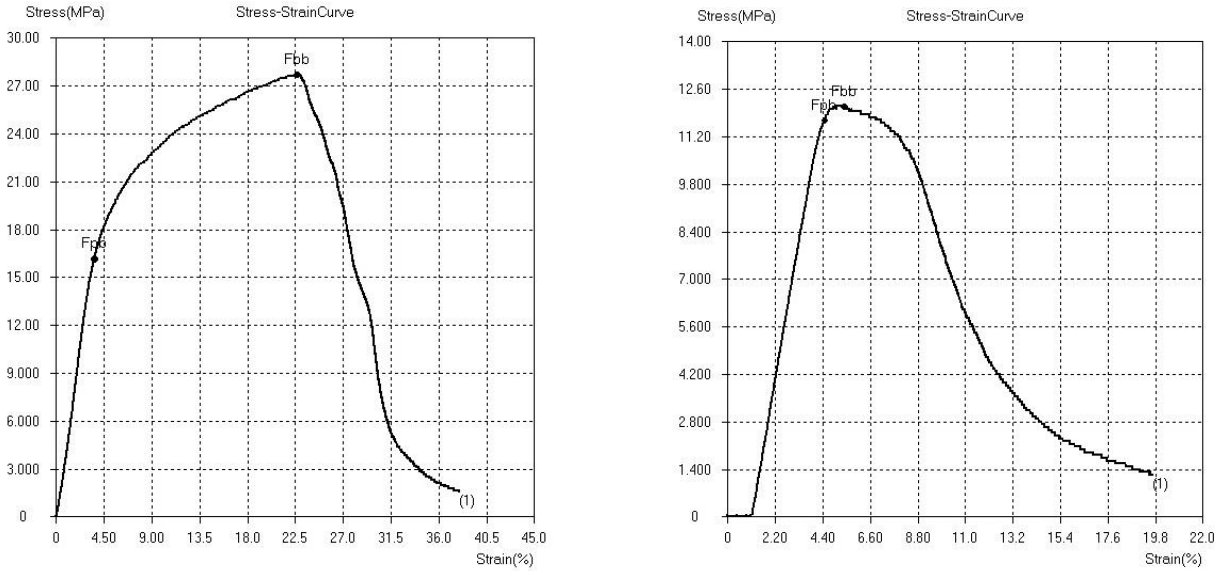

Figure 6. Stress-strain curves of fiber cement samples made by mini Hatschek machine

a) Air-cured sample ; b) Autoclave sample

5. Conclusions

The main specifications and characteristics of a mini Hatschek machine designed and fabricated in Vietnam recently have been presented. The machine is designed with adjustable pressure at the making roller and couch roller. The machine combines with a set of equipment for raw material preparation to form a complete mini production line. The properties of test samples produced by the mini Hatschek machine show the similarity to that of the industrial products. The mini Hatschek machine is useful for fiber cement manufacturers in finding approximate mix proportions and manufacturing process with a reasonable cost. The machine is also useful to the researchers in the field of fiber cement.

REFERENCES

Quang D.Q., Kien N.D., *Hatschek Machine and Equipment for Non-Asbestos Fiber Reinforced Cement Sheets*, Proceedings of the 13th IIBCC, Aalborg, Denmark, 2010.

Tony Cooke *"Formation of Films on Hatschek Machine"*.

http://www.fibrecementconsulting.com/publications/011011.hatschekfilmsummary.pdf

Blanco A., Fuente E., Alonso A., Negro C., *Optimal use of flocculants on the manufacture of fibre cement materials by the Hatschek process*, Construction and building materials, Vol. 24, 2010, pp. 158-164.

Ikai S., Reichert J.R., Rodrigues A.V., Zampieri V.A., *Asbestos-free technology with new high toughness polypropylene (PP) fibres in air-cured Hatschek process,* Construction and building materials, Vol. 34, 2010, pp. 171-180.