IIBCC
International Inorganic-Bonded Fiber Composites Conference

COMPARISON OF HATSCHEK AND FLOW-ON BOARD MACHINES

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ABSTRACT

The production of NT[1)] (non-asbestos) fiber cement boards require some adjustments to the entire production process when compared with the asbestos cement production. Above all, the selection and use of raw materials must be adapted with regard to two primary aspects: product quality and the optimal manufacturing process.

Most types of fiber cement sheets can be produced with the well-known Hatschek process, but some raw materials are difficult to run on a Hatschek board machine. In such cases, the Flow-on board machine can be a good alternative.

This paper compares these two production methods and shows their advantages and disadvantages. Furthermore, we also discuss the specific characteristics and operating conditions of Flow-on and Hatschek plants.

[1)] NT is an abbreviation for "new technology" and means production without asbestos fibers.

KEYWORDS

Hatschek board machine, Flow-on board machine, slurry preparation, formulations, water circuit

PROCESSES FOR MANUFACTURING FIBER CEMENT BOARDS

1. THE START OF A FIBER CEMENT PROJECT

The first steps in planning a fiber cement manufacturing plant include the following points:

- Products to be manufactured
- Quality requirements for the products
- Production capacity
- Production process
- Availability of raw materials

Even today, the most important question addressed by the feasibility study at the beginning of a new plant project is how to produce fiber cement products. Finding comprehensive answers to such questions is necessary to avoid making bad investments and achieve optimal production levels.

The following study, based on practical experience, should prove helpful in making a first evaluation of an optimized plant concept with regard to different production locations and therefore also different climatic conditions and, of course, the different raw materials available.

2. HATSCHEK PROCESS

Fiber-reinforced cement products were developed at the end of the 19th century by the Austrian Ludwig Hatschek (b. 1856, d. 1914), who mixed 90% cement and 10% asbestos fibers with water and fed this into a paper machine. On June 15, 1901, Hatschek applied for a patent for the process under No. 5970: "Verfahren zur Herstellung von Kunststeinplatten aus Faserstoffen und hydraulischen Bindemittel" ("Process for the manufacture of artificial stone slabs made of fiber and hydraulic binding agent").

In 1903, this new roofing material was given the trade name "ETERNIT", which comes from the Latin *aeternitas* – eternity, hinting at the product's long service life.

The production process generally called the Hatschek process is in wide use in the industry and is well known to experts. Thus, in this paper we focus primarily on the Flow-on process.

For more information on the Hatschek process (and other fiber cement processes), see IIBCC 2008 Madrid, Al Moslemi, “Technology and Market Considerations for Fiber Cement Composites” (http://www.iibcc.net/media/9784/moslemi-technology-and-market.pdf) or search Google for “Hatschek Process”.

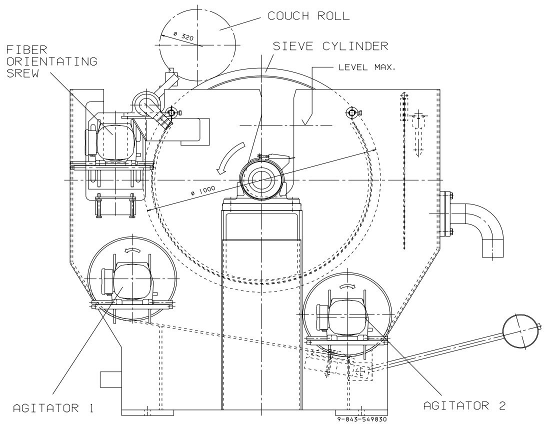

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Figure 1 -

Hatschek board machine – vat for layer formation

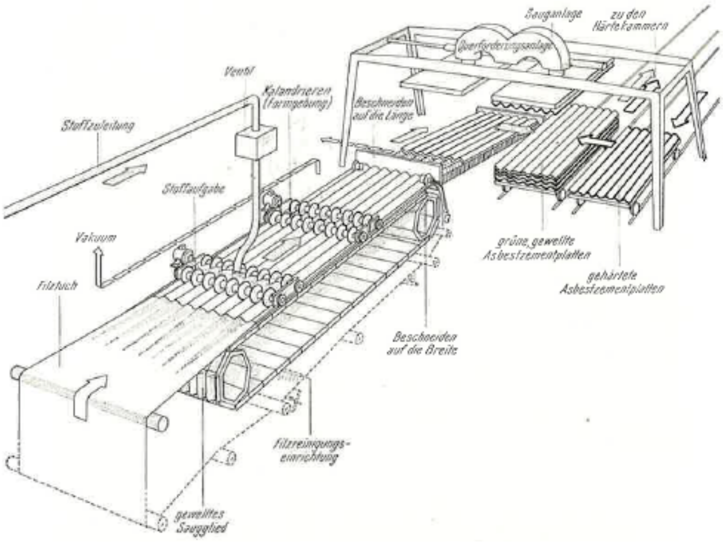
Figure 2 -

Hatschek board machine

3. MAGNANI PROCESS

(Only for informational purposes and representative of other previously used processes)

For a certain time, the “Magnani” semi-dry process also found its way into industrial application. Here, the sheets are formed continuously in one homogeneous layer, which is already corrugated. A thick slurry is cast on a slowly moving felt and spread evenly with a set of rollers shaped to the desired profile.



The Magnani Process was developed for the manufacture of corrugated sheets, but it did not catch on over the long run because of its production weaknesses (e.g. capacity).

Of course there are a certain number of other processes in use, but most of them do not enjoy worldwide usage.

←

Figure 3 -

Diagram of a Magnani plant for corrugated fiber cement sheets

(Harald Klos, *Asbestzement*, page 124)

4. BELL FLOW-ON PROCESS (also well known as the FOURDRINIER machine)

When people in Europe started to develop processes to replace asbestos in fiber cement products with other raw materials, BELL had the idea to develop its own flow-on process, which it did between 1977 and 1979. With flow-on processes, the vats along with the sieve cylinders of the Hatschek sheet machine are replaced with what is known as a layer former.

Other fiber-application machines which deviated from the BELL design were already known earlier for the manufacture of fiber cement products (see *Asbestzement* (*Asbestos cement*), pg. 132/133 by Harald Klos, 1967, Springer Verlag). The flow-on process (FOURDRINIER) was already known in the paper and paper-making industries. Because back then BELL was also working in this area, it seemed like an obvious idea to use the flow-on process for the production of fiber cement.

BELL registered the Flow-on process with patents in 1979 (Switzerland, Germany, Austria), in 1980 (Italy, France, UK, Japan, Denmark, Belgium, Australia, India, Spain, Brazil, Canada, Mexico) and in 1982 (USA). Patents were issued for the following countries: Switzerland (1984), Germany (1982), Austria (1983), Great Britain (1983), Belgium (1981), Spain (1981), UK (1983) and Canada (1983).

Starting in 1984 the patents were no longer renewed because the Hatschek Process had firmly established itself at that time.

COMPARISON OF EQUIPMENT

Now consider an overview of the differences between a Hatschek and Flow-on board machine with regard to slurry flows, starting with the preparation plant and ending with the finished green sheet at the forming roll.

For both systems – Hatschek and Flow-on – the equipment following the forming roll is almost identical. For this reason we will not go into a more detailed examination of these sections of the plant. The preparation plant for the Flow-on process is similar to the Hatschek (sieve cylinder) process.

The main differences between the two production methods are in how the layer is formed on the felt and in the amount of water and slurry in the system. The slurry density is much higher in Flow-on plants; Flow-on plants run with only approximately 30% of the amount of water and slurry. This lower amount of excess water eliminates the need for a sophisticated water recuperating system.

Only mixing chests and the flow-on box are full of slurry. With this reduced volume of water and slurry, the phenomenon of dead material in the slurry circuit is also reduced.

The slurry can be composed of any available raw material and fiber. Lightweight products, pressed products and all kinds of claddings can be produced on a Flow-on board machine, i.e. the product portfolio for flat sheets is larger.

There is a reasonably good ratio of fiber distribution in both the cross and longitudinal directions of the sheet.

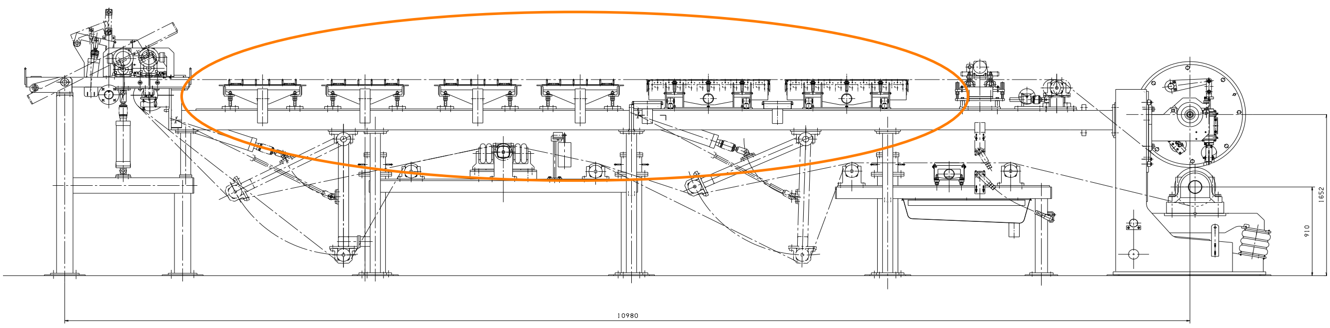


Figure 4 – Dewatering section of a Flow-on board machine © FCM Bell

1. OPERATION OF THE FLOW-ON BOARD MACHINE

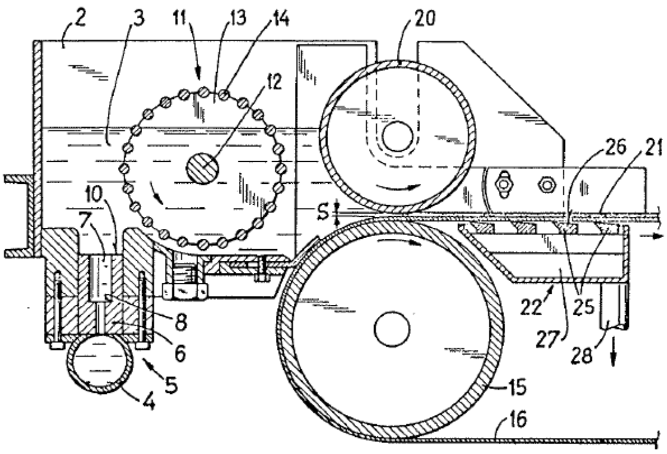


Figure 5 – Diagram of a flow-on box from:

SWISS PATENT	641 085
GERMAN PATENT	2941 640 C2
CANADIAN PATENT	1 156 440
UK PATENT	2 059 867 B

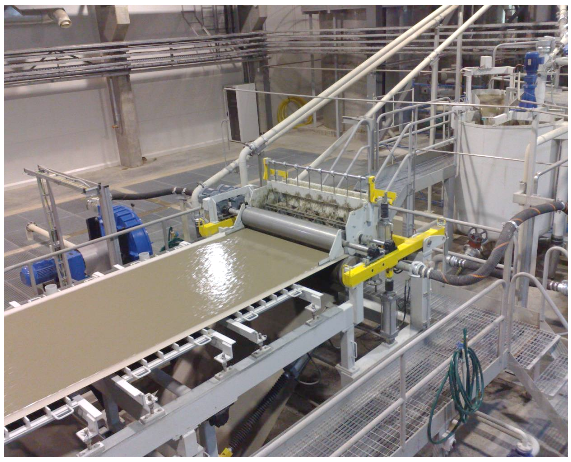


Figure 6 -

Flow-on board machine

The Flow-on board machine is much simpler compared to a Hatschek machine and therefore easier to operate. The slurry flows directly onto the felt via a layer former (flow-on box). The flow-on box on the top of the felt forms a layer approximate 0.7 mm thick in the (adjustable) gap between the felt and the calibrating roll. Felt speed and therefore the output rate is limited by the dewatering properties of the slurry. The layer measuring ~0.7 mm must be dewatered in three main steps: first, with foils or scrapers (without vacuum pumps); second, with suction boxes (with vacuum pumps); third, with nip line pressure at the breast roll.

The Flow-on board machine does not need sieve cylinders (meaning less maintenance and cleaning).

The production rate achieved depends on the drainage properties and slurry consistency. Compared to the Hatschek process, the production rate of a Flow-on board machine is generally equivalent to or somewhat less than a 3-vat Hatschek board machine.

The optimum slurry consistency for the flow-on box has proven to be about twice that of the same furnished for a sieve cylinder machine. Consistencies which are too high result in lumpy web formation; whereas when consistencies are too low the production rate drops and there is a loss of fine material in the slurry while strength does not improve.

The material distribution across the width of the sheet (= sheet thickness across the width) can be held within close limits. This is an improvement compared to the sieve cylinder machine, where this parameter is more difficult to attain.

Figure 7 Figure 8

Flow-on board plant – general view Forming roll, off-take conveyor

2. COMPARISON OF PROPERTIES: HATSCHEK VS. FLOW-ON

Property	Hatschek (4 vats)	Flow-on
1. Investment costs	higher	lower
2. Production rate	100%	approx. 60 - 80%
3. Power consumption	100%	approx. 70%
4. Back water	100%	approx. 30%
5. Slurry density	approx. 1,070 g/l (AC)	approx. 1,140 g/l
6. Slurry recipe	limited	less restriction
7. 6-mm sheet thickness	4 - 6 layers (on forming drum)	8 - 9 layers (on forming drum)
8. Flat sheets	proven	proven
9. Corrugated sheets	proven	poor
10. Layer bond	lower	higher
11. Sheet flexural strength	higher	lower
12. Sheet "flexibility" (handling)	higher	lower
13. L/C strength ratio	~ 0.6 - 0.7	~ 0.7 - 0.9
14. Raw material	fibers flow to the cones	fiber savings
15. Dewatering	faster	slower
16. Vacuum	100%	approx. 50%
17. Dead material in circulation	more	less
18. Start of the board machine	longer	very short
19. Maintenance, cleaning	more	less
20. Production	standard flat and corrugated sheets	high- and low-density flat sheets

Table 1 – Basic overview comparison: Hatschek vs. Flow-on

The **main advantage** of a Flow-on board machine compared to a Hatschek board machine is the ability to produce fiber cement sheets which in the Hatschek process cause difficulties in the vats (settling or buoying of solid material in the vats, layer forming on the sieve cylinders, picking up of the layer at the couch rollers, etc.). That means with flow-on technology the production of low-density sheets, using light raw materials, is easier and possible down till lower board densities. Indeed, lightweight fiber cement products (0.8-0.9 g/cm^3) can also be made by Hatschek.

Because the slurry fed to the flow-on box is of higher consistency and there are no sieve cylinders to shower, there is a great reduction in the amount of water circulated in the process, i.e. approximately 30% compared to 100% of a similar Hatschek machine. This results in savings in terms of waste water, energy and maintenance costs.

The **main disadvantages** are the lower production output and different physical properties of the sheets (i.e. slightly lower strength because there are fewer "mono-layers").

OPERATOR SKILLS

Having examined differences in the equipment, next consider the operating challenges associated with these two systems.

Hatschek:
There are numerous opportunities to influence production results by changing the parameters for each agitator, sieve cylinder, fiber orientating screw, the line pressure of the couch roll and the vacuum of the suction boxes.

These numerous possibilities may easily lead to negative results, and operators must be well trained to master all these "buttons" on the machine. New electrical control systems with simple communication interfaces help the operators accordingly.

Flow-on:
The opportunities for influencing production figures are mainly located in the flow-on box. Felt speed, agitator, gap at the calibrating roll and the vacuum of the suction boxes are the main parameters that can be changed by the operator. Another parameter which can be changed is the solids content of the feed to the flow-on box. There are fewer "buttons" and therefore less opportunity to make mistakes; the Flow-on machine is easier to operate.

Furthermore, changing from one product to another is much faster on a Flow-on than on a Hatschek machine because there is much less slurry in circulation (recall that it is about 70% less).

MAINTENANCE

Cleaning a Hatschek board machine is one of the most time-consuming tasks in every fiber cement plant. Operators must perform high-pressure cleaning on equipment which has been in contact with slurry. Even the mesh of the sieve cylinder must be cleaned regularly with chemicals.

Cleaning the flow-on box is usually done with a high-pressure cleaner and takes only a short time.

INVESTMENT COSTS AND POWER CONSUMPTION

Due to less equipment needed and a simpler machine concept without any vats, sieve cylinders, couch rolls and so on, the **investment costs for a new Flow-on board machine are about 25% less** than for a Hatschek machine.

Being able to produce fiber cement sheets with less vacuum results on less friction on the felt because there are no sieve cylinders and fewer suction boxes. Therefore, the main drive of the board machine requires less installed power, and in addition the vacuum plant is smaller for the Flow-on process. It should be possible to save **up to 50% of the electrical power consumed**.

These advantages should not be the only decisive reason for choosing the Flow-on method. According to our opinion, the key point should be the final product (i.e. products with low density, fire protection boards, buoyant raw materials, etc.) and market demand (i.e. low production rate, often change of boards to be produced, etc.). Market research is vital for each feasibility study of a fiber cement plant project.

TYPICAL MIX COMPONENTS AND PRODUCTS (here for an air-cured process)

Material	Cladding (HD)	Internal (MD)	Wind shield (WS)	Fire protect (LD)
Cement	+	+	+	+
Cellulose	+	+	+	+
PVA fiber	+		+	
Hydrophobing agent	+		+	
Limestone filler	+	+	+	+
Mica filler		+	+	+
Lightweight filler				+

HD	High density
WS	Wind shield
MD	Medium density
LD	Low density

Table 2
Formulation as used for Flow-on machines

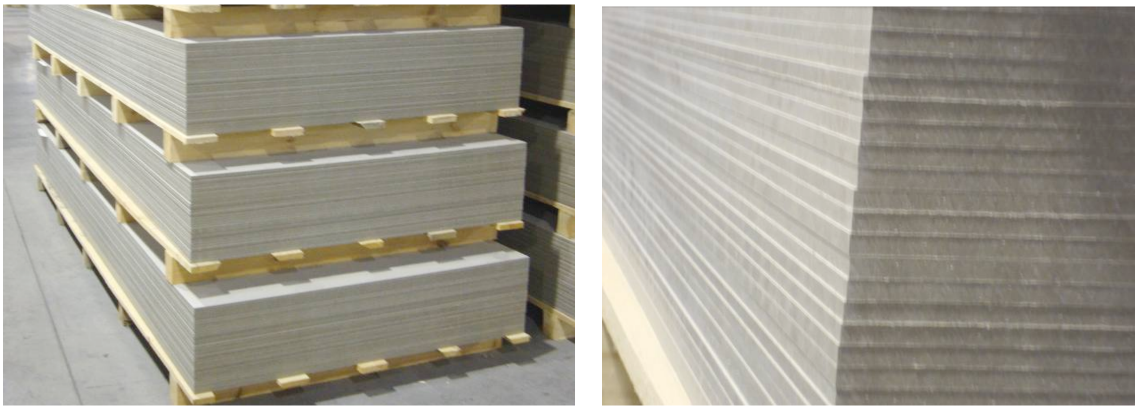


Figure 9 – Pressed flat sheets produced on Flow-on board machine

CONCLUSION

After this short examination of both types of forming system (Hatschek and Flow-on board machines), we see that it might be justified to check both processes during feasibility studies. Market information and, from this, determining market needs for the end products are relevant when making the decision on the plant system.

During this phase it might also be helpful to check standards in the target market area. Perhaps in the near future there will be a strengthening of fire standards. In this regard, a Flow-on board machine could be helpful for producing fire protection sheets and making the expected business successful very quickly.

The state-of-the-art of the Hatschek process has been worked out over a long period of time. Even so, there may be opportunities for optimizing the operation, output and quality of each new machine.

The same is true for the Flow-on process because this technology has not been in use for the same length of time as the Hatschek process. We believe that, through innovation of equipment (i.e. new types of felt, improved layer dewatering system or others); this process can be improved so that the disadvantages of its smaller capacity will gradually disappear.

Flow-on technology is **recommended** for
- fiber cement flat sheet production using raw materials that create production problems on Hatschek machines (e.g. lightweight fillers)
- short-time production of fiber cement sheets using different formulation (fast start/stop of production)
- plants where the goal is to reduce the amount of water and slurry in circulation (less wastewater and waste slurry, closed water circuit)
- plants whose goal is to reduce power consumption and maintenance

Flow-on technology is **not recommended** for
- high-output production
- corrugated sheet production

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