

# Recycling of Impregnated Décor Paper in Particleboard

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**Abstract** – The effect of recycling dried impregnated décor paper in particleboard production was studied. The results of these experiments showed that by adding crushed impregnated paper the strength of the particleboards can be increased or the same board properties can be achieved with reduced amounts of applied adhesive (UF). This waste recycling technology is serving to protect the environment, forests and nature. Based on our recommendations (considering also the recent rules and regulations of waste handling) a particleboard company started to recycle their impregnated paper wastes.

**recycling / particleboard / impregnated paper waste**

**Kivonat** – Impregnált dekorpaír újrahasznosítása faforgácslapgyártásban. A szárított impregnált dekorpapír forgácslap alapanyagba történő visszaforgatásának hatását vizsgáltuk. A kísérletek eredményei azt mutatták, hogy a hozzáadott aprított, impregnált papír megnövelheti a forgácslapok szilárdságát ill. azonos lemez paraméterek kevesebb kötőanyag (karbamid-formaldehid) felhasználással is elérhetők. Ez a hulladék újrahasznosítási technika elősegíti a környezet, az erdők és természet védelmét. A javaslataink alapján (figyelembe véve a jelenlegi hulladékgazdálkodási törvényeket és rendelkezéseket) az egyik faforgácslap-gyártó cég megkezdte az impregnált papírhulladékának a forgácslapgyártásban történő újrahasznosítását.

**újrahasznosítás / faforgácslap / impregnált papír hulladék**

## 1 EXPERIMENTAL: RECYCLING OF IMPREGNATED DÉCOR PAPER

The described experimental work was initiated by one of the Hungarian particleboard companies to evaluate the possibilities of using impregnated paper in particleboard production.

There are already results on recycling of laminated particleboards as published earlier (Hatano et al. 2002), but at this time fresh wood particles were mixed with unused impregnated décor paper.

The main characteristics of raw décor paper are: high  $\text{TiO}_2$  filling and  $\alpha$ -cellulose content, high quality wood raw material and melamine as an additive. During impregnation the décor paper is impregnated with different chemicals (Winkler 1999).

In the dryer of the impregnation line the resin in the décor paper has not yet cross-linked, the impregnated paper contains a large amount of un-bonded adhesive. As shown in *Table 1*,

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the impregnated décor paper waste consists of only 38.75% paper, the rest 61.25% is resin compounds (Varga et al. 2004).

*Table 1. Compounds of impregnated décor paper*

Compounds	Distribution (%)
raw décor paper	38.75
melamine resin	20.20
urea resin	38.75
modifier	1.07
hardener of melamine	0.25
hardener of urea	0.67
cross-linking agent, anti-adherer	0.31

The Hungarian authorities consider impregnated paper waste as non-hazardous waste.

Two series of experiments were performed to evaluate the use of impregnated paper in particleboard production.

### 1.1 First experimental run

In the first experiment, the UF resin content was held constant (10%) and the ratio of added crushed impregnated paper waste was set to 5%, 10% and 20%. Control boards were also made without the addition of impregnated paper.

All the boards were made in laboratory. The impregnated décor paper was crushed by a hammermill and it was mixed with the particles in a blender. The UF resin was sprayed into the blender by airgun.

The mats were formed by hand in a forming frame with an internal size of 500 mm x 500 mm.

The boards were pressed in a Siempelkamp laboratory heat press with the following parameters:

- specific pressure: 4,5 Mpa
- temperature: 180 °C
- time: 3.5 min
- thickness: 12 mm

*Table 2. Main properties of the particle-impregnated paper boards (1st run)*

Ratio of impregnated paper (%)	Density EN 323 (kg/m <sup>3</sup> )	MOR EN 310 (N/mm <sup>2</sup> )	Internal-bond EN 319 (N/mm <sup>2</sup> )	Formaldehyde content EN 120 (mg/100g)
0	704.8	16.4	0.65	2.62
5	680.2	15.9	0.86	3.35
10	709.5	18.7	0.90	3.92
20	698.2	19.8	0.87	5.23

Evaluating these results, it was found that the value of MOR increased with impregnated paper ratios up to 21%, and the value of internal-bond increased by 33% compared to the control panels. These are advantages but at the same time the formaldehyde content also

increased, but the maximum value (5.23 mg/100g) was still below the standard limit value of 8 mg/100g. The results prove that:

- impregnated décor paper waste can be mixed with the raw material of particleboards in quite large amounts, with improves the physical and mechanical properties of the PB;
- it might be possible to reduce the amount of UF adhesive when adding crushed impregnated paper.

## 1.2 Second experimental run

Based on the above results a second experiment was performed. This time the ratio of added impregnated paper was set to a constant value of 20%, and the ratio of the UF resin was varied. The resin content was calculated in two different ways:

- calculated as a percentage of the dry matter content of both materials (impregnated paper + wood particles),
- calculated as a percentage of the wood particles only.

Control boards were also prepared with 5% and 10% UF resin. All the boards were made by the same method as in the first experimental run.

*Table 3. Main properties of the particle-impregnated paper boards (2nd run)*

No.	IP/UF (%)	Density EN 323 (kg/m <sup>3</sup> )	MOR EN 310 (N/mm <sup>2</sup> )	Internal-bond EN 319 (N/mm <sup>2</sup> )	Formaldehyde content EN 120 (mg/100g)
1	20/0	747	15.27	0.76	3.61
2	20/5 *	718	18.08	0.80	4.82
3	20/10 *	718	18.06	0.82	5.31
4	20/5 **	757	18.39	0.79	4.50
5	20/10 **	742	18.99	0.80	5.25
6	0/5	708	12.17	0.66	1.98
7	0/10	726	18.80	0.72	2.61

\* 5 % or 10 % UF resin based on the dry matter content of the wood particles + impregnated paper together

\*\* 5 % or 10 % UF resin based on the dry matter content of the wood particles only

The addition of 20% impregnated paper has a favorable influence on the board properties. Even without adding any UF adhesive it was possible to produce particleboards with bending strength higher than the standard requirement (16 mm thick PB suitable for use in dry condition: MOR > 13 N/mm<sup>2</sup>). When UF resin was added, the value of MOR was similar to that of the standard control board with 10% UF resin content. No significant difference could be observed between the strength values of boards with 20% impregnated paper and 10% or 5% UF content. There was also no difference between the results of boards where the resin content was based on the dry matter content of wood + impregnated paper or on the wood particles only. The values of internal-bond were higher in every case than the standard requirement (0.35 N/mm<sup>2</sup>).

The standard deviation was calculated for physical and mechanical properties according to the relevant standards.

Although the formaldehyde content was higher when both impregnated paper and UF was added, the maximum value (5.31 mg/100g) was still below the standard limit value of 8 mg/100g.

## 2 CONCLUSIONS FROM THE EXPERIMENTS

Based on the strength results it can be considered possible to produce particleboard even without using adhesive, by just adding 20% of impregnated décor paper waste to the raw material. If higher strength values are required, the addition of 5% UF resin and 20% impregnated décor paper waste is more than adequate to reach the strength of a standard board with 10% of UF resin.

Of course in a PB factory there is not a high amount of décor paper waste produced, but it is a good way to eliminate this kind of waste. If the amount of the waste allows, the percentage of UF resin can be decreased.

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