DELIVERABLES REPORT

MultiHemp

Multipurpose hemp for industrial bioproducts and biomass

(Ref n. 311849)

5.9 Report on the suitability of hemp fibre for building materials

10.2 Review of the industrial application of hemp-based building materials

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Introduction

This deliverable reports on activities carried out by C.M.F. Technology in the frame of tasks 5.2.2 and 10.4.2 (Biobuilding materials). In task 5.2.2 fibre obtained from a simplified disordered processing system (Bulk fibre) was used to produce building materials following the patented system "Canapalithos". Considering that biobuilding materials (Panels) at CMF are produced with hemp shives, the objective of this task was to optimise the production system on the basis of the characteristics of the bulk fibre material, in particular finding an optimal mix between fibre and binder, correcting formulations or steps process or machinery tipologies following eventually needs of new varieties. In task 10.4.2 demonstration trials were carried out on fibre obtained from different varieties and with different agronomic procedures (Task 4.1) to obtain biobuilding materials developed following the results of task 5.2.2.

It is noteworthy the fact that during Multihemp, CMF technology started the spin off company CMF Greentech to bring to market the results of the R&D project launched in 2008. A brand new industry was officially inaugurated in November 2016, but industrial production started earlier in 2016 and this gave us the chance to test results obtained in the frame of the Multihemp project at large scale industrial level. CMF Greentech is now a new business reality currently active in Emilia Romagna, near Modena with the first facility able to produce industrially panels based on hemp biomass and Royal Jelly.

CMF GREENBUILDING division aims to propose CANAPAlithos® building systems, able to combine the idea of sustainability with the value of energy saving and high technical performance combining with living comfort and healthiness in order to promote a new concept of well-living.

C.M.F. Greentech project

This project has had since its inception as the common denominators green friendly criteria; environmental sustainability, recycling, energy saving and aims to find new industrial processes and innovative products.

From the achievements of the project we find a new technological process based on the features of a new binder completely natural and 100% oil free, code named Royal Jelly.

CANAPAlithos® is the precursor of our new family of bio-materials, entirely oil and formaldehyde free,: it is the synthesis of a hemp's biomass and our "Royal Jelly" binder.

It is produced in various types, each of which expresses different technical characteristics and specifications, the choice of these bio-materials is not only based on eco sustainability, which remains our main inspiration, but also on others fundamental criteria such as high technical features and high technological standards that make our whole range of biobuilding materials an absolutely innovation on the market.

Biomass analysis

At first, two contrasting hemp biomasses were analyzed to assess their suitability to the C.M.F. technology process. Biomass characterization involved three type of analysis:

1. Density
2. Sieve analysis
3. Humidity

Density analysis

The density is measured by a graduated cylinder, weighing one liter of biomass.

Biomass	**Density [Kg/m³]**
Hemp shive	57,4
Hemp fibre bulk	60

Table 1. Biomasses density

The peculiarities and differences between biomasses have been highlighted already in the density analysis. The hemp shive, for example, had a density that was about half of that of hemp we traditionally use. Low biomass weight is a good thing for panels that can have interesting insulating properties, sound absorption, easy handling, and high breathable.

The hemp bulk fibre has also a good density value, but by handling it, we have realized that this, because of its high fiber content, can lead to management problems in our technology.

Imagine 1. Hemp shive

Imagine 2. Hemp fibre bulk

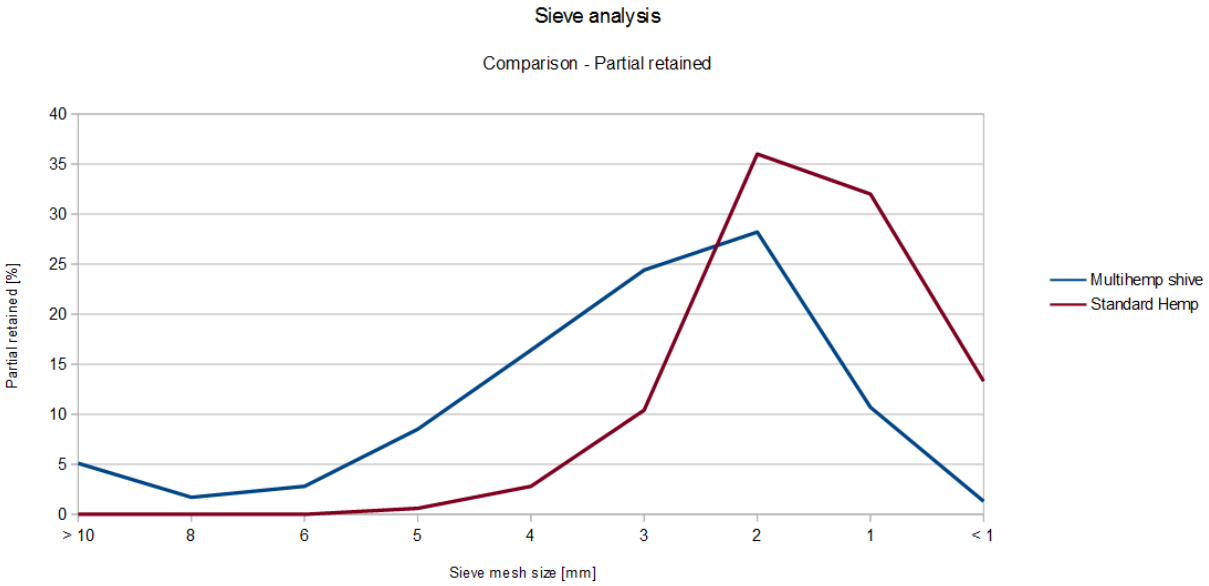
Sieve analysis

Sieve analysis involves a nested column of sieves with wire mesh cloth (screen). A representative weighed sample is poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan, called the receiver. The column is typically placed in a mechanical shaker. The shaker shakes the column, usually for some fixed amount of time. After the shaking is complete the material on each sieve is weighed. The weight of the sample of each sieve is then divided by the total weight to give a percentage retained on each sieve.

Sieve analysis 100gr			
Sieve mesh size [mm]	Partial retained [%]	Cumulative retained [%]	Percent passing [%]
> 10	5,1	5,1	94,9
8	1,7	6,8	93,2
6	2,8	9,6	90,4
5	8,5	18,1	81,9
4	16,4	34,5	65,5
3	24,4	58,9	41,1
2	28,2	87,1	12,9
1	10,7	97,8	2,2
< 1	1,3	99,1	0,9
% Fibre	0,9	100	0

Table 2. Hemp shive sieve analysis

We compared the sieve analysis of Multihemp shive with the hemp shive we use in the greentech process for the production of the panels



Graphic 1. Hemp shive comparison

The comparison shows that multihemp shive has more granulometric fractions inside and a finer size than hemp shive we used for industrial production. This features are positive for our technology. Best homogeneity of hemp shive positively affects mechanical properties of the panel

Sieve analysis 100gr			
Sieve mesh size [mm]	Partial retained [%]	Cumulative retained [%]	Percent passing [%]
> 10	/	/	/
8	/	/	/
6	/	/	/
5	/	/	/
4	/	/	/
3	/	/	/
2	/	/	/
1	/	/	/
< 1	/	/	/
% Fibre	/	/	/

Table 3. Hemp fibre bulk sieve analysis

Sieve analysis of Hemp bulk fibre presents several problems. In fact bulk fibre, since is not separated from shive, contain a little bit of granular material and a lot of fibrous material. The meshes used are too narrow for the passage of fibrous material, so sieve analysis is not possible for it. Failure in characterization of bulk fiber is definitely a parameter that has raised some doubts about its use in our technological process. Fiber grinding could help overcome the problem.

Humidity

The last characterization phase involves humidity content test.

Biomass	**Humidity [%]**
Hemp shive	8,7
Hemp bulk fibre	9,8

Table 4. Humidity of biomass

Humidity content of both biomasses is perfectly compatible with the production process. It is comparable with the humidity of our standard hemp shive (9.2%)

Second step is the production of panels in our laboratory with the aim of reproducing some of the industrial products. After biomass analysis, we decided to maintain the same biomass-binder ratio we usually use for the products.

The stages of the production process are:
1. Binder preparation and dosage of biomass
2. Mixing Binder and biomass
3. Feeding line
4. Forming and pressing
5. Maturation dryer

Binder preparation and dosage of biomass

The binder preparation step is the same for both biomasses. The weighing and dosage of them presents differences. While the hemp shive has no particular problems because it easily flows into the mixer loading conduits, the fibre bulk, by its fibrous nature, reached the mixer with some difficulties. Fiber grinding could help overcome the problem

Mixing

Mixing phase takes place inside a planetary mixer . The shive does not create any kind of problem and it can be treated like the one we use at industrial level. In fact, the mixing speeds and mixer loading volumes must not vary.

On the other hand bulk fibre has problems. Keeping the same speed and loading volumes, mixer don't work well and it locks. After trying to reduce the load of the mixer, a 50% load reduction was achieved to allow the mixer to work. In addition, for better mixing, the mixer rotation speed has been reduced. Reduction of mixer rotation speed and of mixer's load has negative effects on productivity.

Imagine 3. Fibre bulk mixing

Imagine 4. Hemp shive mixing

Imagine 5. Hemp shive after mixing

Imagine 6. Hemp bulk fibre after mixing

Feeding line

Biomass feeding on presso ribbon is through a hopper. Even for this stage, the hemp shive is perfectly compatible with the industrial process while the bulk fibre has sliding problems inside the hopper. Possible improvements to make the fibre compatible with the process is always its grinding.

Imagine 7. Feeding line

Pressing and drying unit

Both, fibre bulk and shive have proven to be compatible with the pressing and drying process. The parameters we set are the same of industrial production.

Imagine 8. Hemp bulk fibre panel

Imagine 9. Hemp shive panel

We produced the following panels typologies:

n.	Hemp shive	n.	Hemp fibre bulk
2	CANAPAlithos 350	2	CANAPAlithos 350
2	CANAPAlithos 500	1	CANAPAlithos 500
1	CANAPAlithos ARGILLA 700		

Table 4. Panels produced

The difficulties manifested in the various phases of the process, did not allow to produce other fibre bulk panels. Panel have been sent to Aalto University School of chemical Technology, for testing them.

	Biomass dosage	Mixing	Feeding line	Pressing	Drying
Hemps shive	5	5	5	5	5
Hemp fibre bulk	2	1	2	5	5

Table 5. Technology compatibility values from 1 to 5

Hemp fibre bulk	
Positive	*Negative*
Low cost of raw material	Low compatibility with technology
Low density	
Hemp shive	
Positive	*Negative*
Low densità	Cost
Compatibility with technology	
Improve mechanical properties	

Table 6. Positive and negative

Conclusion

In conclusion it can be said that hemp shives may already be used on an industrial scale because it is perfectly compatible to our technology. It have interesting prospects due to the low density of shive and for the homogeneity size of raw material that allows to improve mechanical characteristics.

The bulk fibre is interesting too but needs to be reduced to a finer particle size so that it can be compatible with our technological process otherwise we have important mixing and feeding difficulties. Fibre has very important benefits in terms of cost. The fact that it is not separated from shive means that the cost of raw material is lower than the shive we use in the industrial process. In addition, the low specific weight makes it possible to obtain very interesting panels for building construction with excellent insulating and sound absorbing properties. Also reduced fibre bulk in smaller particle sizes can be added to current mix designs to improve the mechanical properties of the products.