THE NATURAL, FLAX AND HEMP VEGETATION FIBERS OF EUROPE:

Double performance – technical and ecological
About CELC

The European Confederation of Linen and Hemp (CELC) is the only agro-industrial European organization grouping together and federating all stages of production and transformation of flax & hemp.

Created in 1951 and composed of 10,000 member companies from 14 countries, the CELC creates an environment favorable to the competitiveness of industrial companies in an international context. It stimulates innovation based on values inscribed in sustainable development.

With the Technical Uses Pole and its European Scientific Committee, the CELC helps bring its members towards new technical opportunities such as composite products and eco building.

Through the Textile Pole and the MASTERS OF LINEN brand, it promotes the European linen and hemp industry in the areas of clothing and art of living.

Having opened in March 2009 in Paris and in February 2010 in Milan, the Linen Dream Lab proposes its services by appointment to order-givers in the fashion, art of living and design industries: Material - accompanying project, an aid in sourcing, an area which can be made private for members.

www.linenandhempcommunity.eu
With their strong double bonus - ecological and technological - flax and hemp fiber uses in thermoplastic and thermoset composites have imposed themselves in the industry.

This innovation, dictated by new environmental directives, depends on both the ecological performances of the raw materials and their technical performances.

Flax and hemp’s ecological properties position these natural European fibers to be increasingly used in various, innovative sectors of the industry which are today obliged to take into account sustainable development in their production methods.

Flax and hemp fibers’ mechanical properties also bring performance and competitiveness to the new materials used. R&D departments, specialized technical institutes and universities now see natural vegetation fibers as an alternative solution to synthetic fibers as they develop composite materials.

Today, the entire flax and hemp industry is focusing its research on a new generation of materials which guarantee protection of the environment all the way to their end-of-life cycle. A necessary advance dictated by environmental questions and the oil crisis.

Production of raw materials: an impressive ecological imprint

- A local resource: 85% of these fibers are produced in Europe
- A renewable resource
- No irrigation - little fertilizer
- Production using little energy
- A natural and mechanical transformation process (retting - scutching)
- Reduction of greenhouse effect gases: 450,000 tons avoided
- Emission of CO₂ almost non-existent
- CO₂ stockage – production of biomass: Co₂ compensation/year = 16T/ha
- Zero waste: all plant by-product can be used (shive, mulch, dust)
- 100 % recyclable and compostable

Hemp LCA - French Ministry of Agriculture and Fishing 2005
Flax LCA and Eco profil - ISO norms 14040 and 14044 INRA
European Commission Audit, March 2007
For healthier semi-finished products

- Lower environmental impact
- Local, renewable resource
- Low abrasion
- No skin irritation when handled
- End-of-life optimization of components
- Recycling by incineration (energy)
- No residue after incineration
- Carbon neutrality
- 100% bio-degradable when combined with an organic matrix

Existing semi-finished products:

Textile  Compound  Mat  Roving

« Concerning the environmental impact of flax and hemp cultures, the evaluation report underlines that these cultures clearly need less fertilizer and chemical pesticides than replacement cultures. In addition, they have positive effects on the agricultural eco-systems’ diversity and landscape. In this context, growing these fibers offers a welcome ‘environmental pause’ in order to maintain soil quality, preserve landscapes and encourage bio-diversity. »

FLAX AND HEMP COMPOSITES: ADVANTAGES

Flax and hemp fibers’ mechanical properties offer characteristics comparable to glass fibers because of their unique rigidity.

Thanks to the weak density of these natural fibers in relation to glass fibers (~40%), composite materials using flax and hemp prove interesting for those applications where light weight is a defining element.

RESISTANCE

Resistance to breakage, compression and twisting

BIODEGRADABLE WIND TURBINE
mixed technical fabric
40% flax/PLA
LTP

RIGIDITY

Resistance to distorsion, twisting and shearing
Weight gain

REAR VIEW MIRROR INSERT
compounding
30% Hemp/PP
Peugeot 207
VIBRATION ABSORPTION

Absorption capacity of hollow fibers
Comfort of use
Decreased risk of injury

FLAX FIBER 820 RACKET
prepreg technical fabric
15% flax/Carbon
Artengo

-22% vibration

BICYCLE
prepreg technical fabric
80% flax/Carbon
Museeuw Bikes

-20% vibration

ACOUSTIC

Absorption capacity of hollow fibers
Reduces noise caused by vibrations

AUTOMOBILE DOOR INSET
thermo-compressed
60% flax/PP
Citroën C4 Picasso
FLAX & HEMP FIBER PERFORMANCES: SCIENTIFIC DATA

Mechanical properties

<table>
<thead>
<tr>
<th>Material</th>
<th>Density (g/cm³)</th>
<th>E (GPa)</th>
<th>Strength (MPa)</th>
<th>Failure strain (%)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flax</td>
<td>1.4</td>
<td>40-85</td>
<td>800-2000</td>
<td>2.4 - 3</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td>58</td>
<td>1339</td>
<td></td>
<td>3.27</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>71</td>
<td>1381</td>
<td></td>
<td>2.1</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>77</td>
<td>1795</td>
<td></td>
<td>2.4</td>
<td>(4)</td>
</tr>
<tr>
<td>Hemp</td>
<td>1.48</td>
<td>26-30</td>
<td>500-900</td>
<td>1.6</td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>788</td>
<td></td>
<td>1.8</td>
<td>(5)</td>
</tr>
<tr>
<td>E-glass</td>
<td>2.54</td>
<td></td>
<td></td>
<td></td>
<td>(6)</td>
</tr>
</tbody>
</table>

Values in green are average values found in publications, the others are measured values.


Specific properties
Source: KU Leuven

Density (g/cm³)

Density Flax & Hemp = 1,5g/cm³
<table>
<thead>
<tr>
<th>Failure strain $p$ (g/cm$^3$)</th>
<th>$E$ (GPa)</th>
<th>Strength (MPa)</th>
<th>(%)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
<td>16</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Specific stiffness in traction (GPa*cm$^3$/g)

Specific stiffness bending

Specific strength (MPa*cm$^3$/g)
THE CELC AT THE HEART OF AN ORGANIZED EUROPEAN INDUSTRY

An assured supply that answers the market demand

IN VOLUME:
Reactivity – an organized European network that anticipates the industry's needs

Production capacity of flax and hemp
140 factories transform flax and
20 factories transform hemp

European flax and hemp cultivation (2009)
FLAX 190 000 tons of fibers
HEMP 25 000 tons of fibers

IN QUALITY:
Fiber standardization guarantees assured quality from one year to the next thanks to:
• multiple European geographic zones for production
• possibilities for homogenous fiber assemblages from one harvest to another

A committed industry that takes concrete actions

The establishment of a Commission for experimental flax fiber norms with a view to their use in plastic composites


Definition of tensile properties for elementary fibers. Applies to elementary fibers which extend less than or equal to 8% before breaking. This experimental norm specifies a method for determining tensile resistance - from distorsion to breaking - of the elasticity module when pulled (Young module) and the curve that resists the distorsion of elementary flax fibers.
A Pole dedicated to Technical Uses

Created in 2005, the Technical Uses Pole of CELC:

• Structures the initiatives related to agriculture, industry, energy, research and the environment
• Coordinates the activities linked to the development of recyclable resources and materials
• Gathers a network of exchanges documenting the different projects using a continually updated database
• Exercises an active intelligence of the policies and initiatives conducted in the concerned markets
• Anticipates a policy of sustainable development in the industry

This pole is supported by a European Scientific Committee at the service of players in the flax and hemp industry as well as industrial users of the fibers.

8 experts from different areas of research pool their knowledge of analytical and characterization techniques to:

• Establish an inventory of existing scientific resources and techniques
• Evoke possibilities for evolution and new research in correlation with the industry’s strategy
• Privilege open-ended innovation and facilitate shifts of technical competences.

The CELC is surrounded by specialized partners plus French and European professional organizations

• **KU Leuven Universiteit** in convention with the Technical Use Pole, a reference in the composite industry

• **Flax Technical Institute (I.T.L.)**

  The ITL, a research and development tool in the flax industry, offers products and services to flax producers which allow them to optimize production methods in an evolving economic, technical and regulatory context. The optimization of technical production itineraries, evaluation of fertilizers, control of bio-attackers, perfecting of tools that diagnose and aid in decision-making and the improvement of harvesting machines are areas which require substantial research efforts.

  On all these points, the ITL organizes experiments, research actions and targeted, concerted developments that can be quickly evaluated. ITL’s research and experimentation is coupled by communicating the technical results found to industry professionals – order-givers, producers, transformers … Its message is both objective and independent.

• **Technical Hemp Institute (I.T.C.)**

  This inter-professional structure for applied research specializing in hemp cultivation provides technical references to improve the production and profitability of hemp’s cultivation by producers.

At your service

A dedicated Project Manager • a technical and scientific reference Dr •

technical@mastersoflinen.com