Title: USE OF FIBERS OBTAINED FROM SEEDS OF POPULUS TREES AS ABSORBENT AND FILTERING MATERIAL AND METHOD FOR THEIR PRODUCTION

Abstract: The use of fibers obtained from the seeds of Populus trees as a super absorbent for removing hydrophobic/oleophilic spills from water and ground surfaces as well as filtering materials for removing hydrophobic/oleophilic substances from their emulsions in water. In the related invention the method and machine for a super absorbent and filtering material production from fibers obtained from the seeds of Populus trees are described. The shape and application of the final product is described as well.
USE OF FIBERS OBTAINED FROM SEEDS OF POPULUS TREES
AS ABSORBENT AND FILTERING MATERIAL AND METHOD FOR
THEIR PRODUCTION

1. Field of the invention

(003) The present invention relates to the production of hydrophobic super absorbent for water and ground surface cleaning and the production of the filtering material for filtration of water emulsions, made from the natural fibers obtained from the seeds of Populus tree and to the method for their production. In particular, the present invention relates to the removal of hydrophobic organic substances from bodies of water and earth materials in an environmentally and ecologically beneficial manner.

2. Related prior art

(004) There are known solutions for using natural fibers as absorbents and filtering material. The most widely researched and used materials are cellulosic fibers and materials which contain cellulosic fibers
such as wood, bark as well as different agricultural products and remains (rice straw, rice hulls, corn corb, peat moss, cotton, cotton grass, barks, milkweed, kenaf, bagasse, coconut shells and different vegetable and fruit pulps). Agricultural remains, for example rice straw, corn corb, peat moss, cotton, cotton grass, barks, milkweed and kenaf, have good oil absorbency. All listed materials have fibrous structure composed of cellulosic fibers, lignin and hemicellulose. They are cheap and usually locally available as waste. Rice straw, corn cob, cotton, milkweed floss, kenaf, and wool fibers have already been used as sorbents in oil spill cleanup. However, rice straw, corn cob, and wood fiber have poor buoyancy, relatively low oil sorption capacity and low hydrophobicity. Milkweed and cotton have greater potential for oil spills cleanup because they absorb significantly more oil compared to commercial synthetic sorbent materials. This is because of cellulose high affinity to bind hydrophobic substances but on the other hand they express high deterioration due to the water absorption. For this reason many attempts have been made to overcome the wetting characteristics of the lignocellulosic materials. In U.S. Patent No. 3,607,741 Sohnius used the mixture of cellulosic fibers and water repellent substances such as silicone, paraffin, stearate and emulsifier for increasing the hydrophobicity of the fibers. Due to the same reason many attempts for chemical modification of the cellulose fibers have been made. For example, in U.S. Patent No. 3,464,920 Pirson et al. suggested silanisation of the cellulosic
materials, in U.S. Patent No. 3,591,524 Eriksen et al. described the treatment of cellulose containing material with ammonia salt and different amines and Fanta et al. in U.S. Patent No. 4,605,640 proposed treatment of cellulosic fibers with fatty quaternary ammonium salts. The hydrophobicity of cellulosic materials has also been increased by reaction of cellulosic material with organic isocyanates (Hoist et al., German Offen. 2,358,808) and with fatty acid derivatives, such as anhydrides (Ball et al., U.S. Patent No. 3,770,575) and acid chlorides (Teng et al., U.S. Patent No. 3,874,849). Coating cellulosic fibers with hydrophobic compounds, such as paraffin wax (Peterson et al., U.S. Patent No. 3,630,891; Matsuda et al., Japanese Kokai 77/76,285; and Orth, German Offen. 2,301,176), insoluble fatty acid salts (Aoso et al., Japanese Kokai 74/64,577), or low melting polymers, such as polyolefins (Kunitomo et al., German Offen. 2,621,961; and Saida et al., Japanese Kokai 78/04,760) is another technique used to increase the hydrophobicity of the fibers; some polymers (e.g., ethylene-vinyl acetate copolymer) have also been deposited onto fibers from aqueous emulsions (Sato et al., Japanese Kokai 77/89,244; and Sato et al., Japanese Kokai 77/90,486). Other authors simply used mixtures of different cellulosic materials, for example Raible et al. in US Patent No. 4,925,343, who used mixture of wood fibers with organophilic water wettable cottonliners.

US Patent 4,061,567 published by Kobayashi et al. on December 6, 1977 (Method for adsorption of oils) describes a method of
using kapok fibers as natural super absorbent for oil spilling sanitation. The kapok fibers have been described as micro-tubes whose cell walls are composed of 64% of cellulose, 13% of lignin, 23% of pentosans and they are naturally coated by plant waxes. They have high affinity to hydrophobic substances and they expressed good buoyancy.

3. Background of the invention

Because of the worldwide expansion of oil consumption and ecological awareness of oil production, a lot of extended researches have been made on the development of efficient absorbents for hydrophobic/oleophilic substance spilling sanitation. By definition, super absorbents are substances that absorb and retain from 10 to 100 times the mass of the substance as to their own weight. Usually they are a mixture of fibers containing super absorbing particles, made from various natural or synthetic polymers such as agar, carboxy-alkyl cellulose, resin, pectin, carboxy alkyl starch, cellulose sulphate, products of hydrolysis of starch, polyacrylates, sulphonated polystyrene, polyvinyl alcohols, polyethylene oxide polivinilpirolidin, polyacrylonitrile, polyacrylamide and hydrolyzed polyacrylamide. Due to their hydrophilic nature natural super absorbents normally do not float on water surface while on the other hand synthetic absorbents are expensive because of demanding and environmentally questionable production processes. Natural super
absorbents tend to form soft, jelly products swelled with the absorbed liquid. The occurrence of swelling and formation of gels reduces the transport and distribution of absorbing substance throughout the absorption medium. This phenomenon is known as gel blocking. Gel blocking reduces the ability of absorbing next quantity of substance and absorbent leakage occurs. In contrast, synthetic super absorbents, despite the absorbed substances, retain their mechanical structure, which prevents gel blockage due to swelling of the material. Maintaining the gap between the particles or fibers allows penetration of substances into the space between them, thereby increasing the absorption capacity of the absorbent and preventing leakage.

(008) Agricultural products and their production remains, for example kapok fibers, cotton fibers, rice husks, forage from corn mixture, fibers from sugar cane and peat, have been the subject of extensive research for producing cheap and effective natural absorbents. Among them, only kapok and cotton fibers can be classified as super absorbent, but the latter does not float on water without additional chemical treatment. Kapok fibers are obtained from fruits of *Ceiba pentandra* (L.) Gaertn. trees which belong to the family of the *Malvaceae* plants. Kapok fibers are natural hydrophobic/oleophilic micro tubes with $25 \pm 5$ mm in length, outside diameter of $16.5 \pm 2.4$ mm and with an average wall thickness of $2.0 \ \mu m$. Tube walls are composed of cellulose, hemicelluloses and lignin. Bulk density of kapok fibers is $0.0013 \ \text{g/cm}^3$ as
77 vol. % of the fibers is empty lumen. Hydrophobicity is enhanced due to acetylation of the wall saccharides and due to the coating of the tube wall surface with natural waxes. This lumen tends to be filled with hydrophilic/oleophilic substance when fibers come to contact with it.

Absorption capacity of the kapok fiber, measured according to standard ASTM F726 - 06, at a package density of 0.02 g/cm³, is 41 g/g to 45 g/g for engine oil HD 40 and 31 g/g to 36 g/g for diesel fuel D2 (Hori et al 2000, Mungasatkit 2004, Lim and Huang 2007). The fibers fully passed the degradation test according to ASTM standard F726 - 06. Kapok fibers can be characterized as a natural super absorbent for water and hard surface cleaning.

(009) The disadvantage of kapok fiber is reflected in their mechanical instability due to the high ratio of fiber length versus their external diameter. This results in decrease of the absorption capacity with increasing of package density. Gel blockage appears at absorption of large quantities of substance.

(010) The origin of the Ceiba pentandra (L.) Gaertn. tree is in South America but it can be found in tropical areas of Southeast Asia, Sri Lanka and other parts of eastern Asia and Africa. Ceiba pentandra (L.) Gaertn. trees are planted on purpose to produce fibers which are used for producing lifejackets, fillers for toys, and recently also for manufacturing absorbents. Intentional cultivation of trees reduces the extent of cultivable land. Manufacturing is hard work because it is limited
to manual collection of open flowers. Due to the low bulk density, transport of the fibers to the point of final use in North America and Europe is complex and relatively expensive.

BRIEF SUMMARY OF THE INVENTION

(01 1) The present invention relates to the use of natural fibrous material for the absorption of oil floating on or suspended in water, the method and machine for producing it.

(01 2) Poplars and aspen are angiosperm trees genus *Populus* which originates from *Salicaceae* plant family. These trees of different subgenres are widespread in western and central Europe and most parts of North America. They are planted purposely as earth erosion protectors or protection against noise. The wood is used in furniture, for package material and pulp production. Due to their fast growing nature, trees quickly spread throughout urban areas where they are unwanted because they generate large quantities of fibrous seeds which appear due to blooming in spring time.

(01 3) The method described in this invention comprises an innovative approach for using invaluable waste natural material, such as poplar seeds fibers, as a product with high added value. On average, one *Populus* tree produces 0.9 kg of seeds per year, which is approximately 54 million seeds per tree. The possibility of capturing and processing fibers derived from the seeds of *Populus* trees in super absorbent, which
is basically a high-tech product, presents an ecologically, economically and technologically progressive manufacturing method for production of absorbents and filtering materials. A produced absorbent is natural material with oil absorbing capacity twice as high as the most abundant synthetic, water floating absorbents which are available on the market today. At the same time it also presents a sustainable solution for seeds management as seeds are usually treated as waste.

**BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS**

(014) The morphological structure of the fiber obtained from the seeds of *Populus nigra italica* tree is shown in Figure 1, the schematic description of the method is shown in Figure 2, the schematic description of the device for collecting fibers lying on the ground in Figure 3, the schematic description of the device for collecting airborne fibers in Figure 4, the schematic description of the fiber concentration device in Figure 5 and the schematic description of the fiber cleaning device in Figure 6.

**DETAILED DESCRIPTION OF THE INVENTION**

(015) This invention is related to the use of fiber obtained from the seeds of Populus trees to produce super absorbent and filtering materials as well as to the method and machine for their production.
(01 6) Super absorbent will consist of fibers derived from the seeds of *Populus* trees which are, by their nature, hydrophobic/oleophilic micro tubes with 8.74 ± 5.75 mm of outer diameter, 8.24 ± 4.79 mm of internal diameter and 4 ± 1 mm in length. Micro-tubes have an average wall thickness of 500 ± 30 nm and are composed of 33-37 % of cellulose, 19-22 % of hemicelluloses (manly pentosans), 10-12 % of lignin and 1-2 % of inorganic substances. Fibers have a high acetyl groups content (approximately 19-22 %), suggesting a degree of acetylation of the saccharides from 1.3 to 1.4 of acetyl groups per monosaccharide unit. Bulk density of the fibers is 0.0036 g/cm³ as 89 vol. % of the fiber is empty lumen. This lumen tends to be filled with hydrophobic/oleophilic substance when the fiber comes into contact with this substance. Hydrophobicity of the fibers is increased due to a coat of fiber surface with natural waxes. The absorption capacity of the fibers obtained from the seeds of *Populus* trees at a package density of 0.02 g/cm³, measured according to standard methods (ASTM F726 - 06) ranges from 55 g/g to 60 g/g for engine oil HD and from 40 g/g to 44 g/g for diesel fuel D2. Fibers fully passed the degradation test according to standard methods (ASTM F726 - 06). Due to their low ratio between length and external diameter, fibers express improved resistance to gel blockage and higher mechanical resistance against collapse or clumping and thus against clogging the filters.
**Table 1.** Comparison of the absorption capacity of poplar seed fibers with other natural and synthetic absorbing materials.

<table>
<thead>
<tr>
<th>Absorbent</th>
<th>Absorption HD40 [g/g]</th>
<th>Absorption D2 [g/g]</th>
<th>Bulk density [kg/m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibers from <em>Populus nigra italica</em></td>
<td>55,07</td>
<td>44,30</td>
<td>3,68</td>
</tr>
<tr>
<td>Kapok fibers</td>
<td>51,20</td>
<td>35,65</td>
<td>3,90</td>
</tr>
<tr>
<td>Expanded polypropylene</td>
<td>26,00</td>
<td>13,61</td>
<td>20,41</td>
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</tbody>
</table>

Own measurements according to standard ASTM 726-06 at package density 0.02 g/cm³.

HD40 - motor oil SAE 15W-40
D2 - diesel fuel

(017) The invention describes a method and machine for the production of hydrophobic/oleophilic super absorbent and filtering materials based on usage of the fibers obtained from the seeds of *Populus* trees, which are considered as undesirable in urban areas and they are treated as waste. The method for the preparation of a super-absorbent and filtering material from the seeds of *Populus* trees is divided into a method for collecting released fibers and a method for cleaning and packing acquired fibers into the final product. The applicative use of the final super absorbent is described as well.
(018) Related to the invention, released fibers are collected and cleaned of the unwanted contaminants (remnants from envelopes and leaves, dust and debris) which reduce absorptivity and prevent the manufacture of filters. Fibers are packaged in permeable polyethylene or polypropylene nets with a mesh from 1.00 mm to 2.81 mm in diameter (mesh 16 to 7 according to Tyler). The optimum package density for the achievement of desired absorption efficiency ranges from 0.02 g/cm$^3$ to 0.09 g/cm$^3$.

(019) Related to the invention, fibers obtained from the seeds of Populus tree can be used as such or can be further blended with other absorption materials such as natural or chemically treated cellulose fibers, cellulosic nano-fibers, organoclay nano composites, treated papermill sludge, peat or expanded polypropylene within the ratios from 1% to 99% by weight in order to reduce production costs and achieve the optimal ratio between the price of the absorbent and its effectiveness.

(020) The method for producing absorbent or filtering material is characterized by the collection of the airborne or ground lying fibers, cleaning the collected fibers and using them as an absorbent for absorption of the hydrophobic/oleophilic liquids from water and ground surfaces or for making the filtering material for extracting hydrophobic/oleophilic substances from their aqueous emulsions. The
method and machine for the manufacture of absorbent and filtering material are shown in Figure 2.

1. Detailed description of drawings

(021) Ground lying fibers 1 are collected by vacuum suction device 2, which is shown in detail in Figure 3. The bristle roller 4, which rotates in the direction of the air flow 3, is driven by a gear or rod system 5, optionally by a separated power unit; it lifts the fibers from the ground. Lifted fibers are caught into the air flow 3 generated by a vacuum pump 17. The speed of the air flow containing collected fibers increases inside the venturi chamber 6 and thus the concentration of fiber inside the air flow increases. The fibers are sucked into the drainage system 8 through the valve 7.

(022) Airborne fibers 9 are collected with a network system 10. This system consists of hollow tubes 11 which have a suction slot built-in as is shown in detail in Figure 4. Tubes with the diameter from 6 mm to 10 mm are fitted with suction slots with heights from 1 mm to 5 mm in a way that the ratio between the height and width of the suction slots is lower than 0.005. The tubes are linked into the intake system via sucking pipes 12 which are further connected to the drainage system 8.

(023) The drainage system 8 is drawn into a device for extracting fibers from the air stream 13. The device is shown in detail in Figure 5. It works on the principle of the cyclone, where crude mixture of fibers and
foreign materials (remnants of envelopes and leaves, dust and debris) hits against the wall 14 due to the circulation of the air flow inside device 13. Due to the friction of fibers and foreign bodies with the chamber wall 14, their speed is reduced, which allows them to drop out from the air flow and accumulate at the conical bottom of the chamber 15. The air is sucked from the chamber through the vertical venturi tube, with a mouth diameter of less than 3 mm, and the air flow 16 is created inside the pipe driven by the vacuum pump 17. The collected fibers contaminated with foreign bodies are removed from the chamber by a jagged roller 21, driven by the force of the pressurized air flow 18. The air flow 18 is generated by the vacuum pump 17, and their forces are transferred onto the roller 21 through the rotor with blades 19 and the transmission axis 20. Due to the friction and shear forces within the fibers and foreign bodies which are the result of the rotation of the jagged rotor against static housing, grinding of foreign bodies occurs. The mixture of fibers and ground foreign bodies are collected inside the collecting container 22.

(024) The mixture of fibers and ground foreign bodies is baled under mechanical pressure inside the baler 24. The baled mixture 25 is transported to a location where the device for cleaning and confectioning the final product is located.

(025) The ground foreign bodies are removed from fibers on the cleaning device described by Baker et al. in 1994. The device is schematically shown in figure 6. The cleaning process starts with opening
bales and flocking the fibers on the roller 28. Meanwhile the rotary compressor 30 creates an air flow which transfers the mixture of the flocking fibers and ground foreign bodies 29 to a system of toothed rollers. The toothed roller 31 kneads the mixture of fibers and ground foreign bodies against the sieve 32. The size of the sieve openings must be from 1.00 mm to 2.81 mm in diameter (mesh 16 to 7 according to Tyler). The roller 33 removes cleaned fibers from the device 26. This generates the flow of purified fibers 34 which can be packaged as the product for further use in bulk 35 or can be led to the device for confectioning the final product 38.

(026) The ground remnants and fibers smaller than 1 mm in length drop through the sieve 32 and create a flow of organic biomass 36. Organic biomass is concentrated on the bottom of the device 26 from where it is removed by rotating cylinders 37. Organic biomass can be used as highly calorific fuel.

(027) Fibers 35 can be used for absorbent in bulk or for the production of filtering systems for the separation of hydrophobic/oleophilic liquids from aqueous emulsions.

(028) Cleaned fibers 34 are transferred on the device for confectioning the final product 38. Fibers are packaged in the shape of cushions or booms. The package density must exceed 0.02 kg/l and must be lower than 0.09 kg/l. A polyethylene or polypropylene net with rectangular or hexagonal mesh from 1.00 mm to 2.81 mm in diameter (mesh 16 to 7
according to Tyler) can be used as package material. The cushion size is limited by application needs, while the diameter of the booms which compose the barrage is limited from 12 cm to 20 cm with a view to simplified handling.

The present invention will be described more specifically with reference to working examples, which are cited solely for illustration and are not limitative of the invention in any sense.

EXAMPLE 1

(029) Hand-harvested fibers from the seeds of trees *Populus nigra italica* contaminated by foreign matter (envelopes, leaves, branches and debris particles) were put into a glass dish with 14 cm in diameter. The container was equipped with an anchor type stirrer with pointed edges 13.9 cm in diameter. The fibers were blended for 60 seconds at 5600 rpm. Fibers with ground foreign bodies were passed onto a vibrating sieve with a mesh 16. The sieve vibrated at 300 rpm with the amplitude of oscillation of about 1 cm. The rate of foreign bodies removal was higher than 95%.

EXAMPLE 2

(030) 1 g of purified fibers from the seeds of trees *Populus nigra italica* were put onto a net in accordance with standard ASTM F726 - 06. The bulk density of the fibers on the net was 0.0036 g/cm³. In a 600 ml glass beaker 400 ml of engine oil SAE 15W-40 were poured. The net with fibers was dipped into the oil. The fibers were totally imbibed with oil after 4
minutes. The rate absorption after 15 minutes was 115 g of motor oil per 1 g of fiber.

EXAMPLE 3

(031) 1 g of purified fiber from the seeds of trees *Populus nigra italic* was put onto a net, in accordance with standard ASTM F726 - 06. The bulk density of the fibers on the net was 0.0036 g/cm³. In a 600 ml glass beaker 400 ml of diesel fuel D2 were poured. The net with fibers was dipped into the diesel fuel. The fibers were totally imbibed with diesel fuel after 1 minute. The rate absorption after 15 minutes was 82 g of diesel fuel per 1 g of fiber.

EXAMPLE 4

(032) 1.3 g of purified fibers from the seeds of trees *Populus nigra italic* was packaged into a net shaped as a sphere in accordance with standard ASTM F726 - 06. The bulk density of the fibers inside the net was 0.02 g/cm³. In a 600 ml glass beaker 400 ml of engine oil SAE 15W-40 were poured. The net with fibers was dipped into the oil. The absorption rate after 15 minutes was 56 g of motor oil per 1 g of fiber.

EXAMPLE 5

(033) 1.3 g of purified fibers from the seeds of trees *Populus nigra italic* was packaged into a net shaped as a sphere in accordance with
standard ASTM F726 - 06. The bulk density of the fibers inside the net was 0.02 g/cm³. In a 600 ml glass beaker 400 ml of diesel fuel D2 were poured. The net with fibers was dipped into the diesel fuel. The rate of absorption after 15 minutes was 44 g of diesel fuel per 1 g of fiber.

**EXAMPLE 6**

(034) 2 liters of water were poured into a 5 liter glass container with the diameter of 18 cm. On the water surface 1 g of purified fibers with the bulk density 0.0036 g/cm³ was weighed. The beaker was mounted on the shaker and the contents were shaken for 15 minutes at the frequency 150 rpm and amplitude 3 cm. After 15 minutes of shaking 100% of fibers hovered on the surface.

**EXAMPLE 7**

(035) 2 liters of water were poured into a 5 liter glass container with the diameter of 18 cm. On the water surface 10 ml of motor oil SAE 15W-40 were poured. 1 g of the purified fibers was placed in the center of the oil spot. The beaker was mounted on the shaker and the contents were shaken for 15 minutes at the frequency 150 rpm and amplitude 3 cm. After 15 minutes of shaking, the water surface was clean and 100% of fibers hovered on the surface.

**EXAMPLE 8**
(036) Into a glass tube with the diameter of 2 cm and height of 10 cm and with the bottom fitted with mesh 2.82 g of purified fibers were placed. The packing density was 0.09 g/cm$^3$. 100 ml of 10 % emulsion of motor oil SAE 15W-40 in water flowed through the column. The flow rate was 1 ml/min. The cleaning rate was higher than 97.5%.
CLAIMS

1. Natural fibers useful for spreading upon the surface of oil-contaminated water or lands, for absorbing oil from the surface of such oil-contaminated water or land, and the oil-contaminated composition then readily removed by sweeping, which comprises fibers obtained from the seeds of *Populus* trees.

2. A method for adsorption of hydrophobic/oleophilic substances floating on or suspended in water comprising the step of bringing a hydrophobic substance absorbing material consisting essentially of fibers obtained from the seeds of *Populus* trees into contact with said hydrophobic substances.

3. A method according to claim 2, wherein the fibers obtained from the seeds of *Populus* trees are shaped in the form of a cushion.

4. A method according to claim 2, wherein the fibers obtained from the seeds of *Populus* trees are shaped in the form of a boom.

5. A mixture of natural fibers and absorbing materials useful for spreading upon the surface of oil-contaminated water or land, for absorbing oil from the surface of said oil-contaminated water, or land, and the oil-contaminated composition then readily removed by sweeping, which
comprises a mixture of fibers obtained from the seeds of *Populus* trees with kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam or papermill sludge, where the portion of fibers obtained from the seeds of *Populus* trees varies from 0.1 % to 99.9 % and portions of kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam and papermill sludge vary from 0 % to 99.9 %.

6. A method for adsorption of hydrophobic/oleophilic substances floating on or suspended in water comprising the step of bringing a hydrophobic substance absorbing material consisting of a mixture of fibers obtained from the seeds of *Populus* trees with kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam or papermill sludge, where the portion of fibers obtained from the seeds of *Populus* trees vary from 0.1 % to 99.9 % and portions of kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam and papermill sludge vary from 0 % to 99.9 % in contact with said hydrophobic substances.

7. A method according to claim 6, wherein the mixture of fibers obtained from the seeds of *Populus* trees with kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam or papermill sludge, where the portion of fibers obtained from the
seeds of Populus trees varies from 0.1 % to 99.9 % and portions of kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam and papermill sludge vary from 0 % to 99.9 % is shaped in the form of a cushion.

8. A method according to claim 6, wherein the mixture of fibers obtained from the seeds of Populus trees with kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam or papermill sludge, where the portion of fibers obtained from the seeds of Populus trees varies from 0.1 % to 99.9 % and portions of kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam and papermill sludge vary from 0 % to 99.9 % is shaped in the form of a boom.

9. A method for filtering the emulsions of the hydrophobic/oleophilic liquids and water, bringing the emulsion in contact with filtering material consisting essentially of fibers obtained from the seeds of Populus trees.

10. A method for filtering the emulsions of the hydrophobic/oleophilic liquids and water, bringing the emulsion in contact with filtering material consisting as a mixture of fibers obtained from the seeds of Populus trees with kapok fibers, cellulose fibers, cotton fibers, polyethylene
fibers, polypropylene fibers, polyurethane foam or papermill sludge where the portion of fibers obtained from the seeds of *Populus* trees varies from 0.1 % to 99.9 % and portions of kapok fibers, cellulose fibers, cotton fibers, polyethylene fibers, polypropylene fibers, polyurethane foam and papermill sludge vary from 0 % to 99.9 %.

11. A method for obtaining fibers released from the seeds of *Populus* trees, wherein the released fibers are captured, sucked into a cyclone, ground, sieved and used for the production of absorbing and filtering material.

12. An assembly for capturing and processing the fibers obtained from the seeds of *Populus* trees, wherein the assembly consists of a device for capturing the fibers from the ground (2) and / or device for capturing airborne fibers (10), device for fiber concentration and foreign bodies crushing (13), device for baling (24), apparatus for separating fibers from ground foreign bodies (26), packaging machines (35) and / or equipment for making the final product (38).

13. An assembly according to claim 12, wherein the assembly enables capturing of the fibers with the devices (2) and (3) from where the collected fibers are led into a device for fiber concentration and foreign bodies grinding (13), further into a device for transport preparation (24)
and forward to a device for separation of the fibers from impurities (26), its packaging system (35) and/or device for completion into the final product (38).

14. A device for capturing fibers from the ground (2), wherein the brushing cylinder (4) touches the ground and rotates in the direction of the air flow generated through the venturi tube (6) and it allows pumping and concentration of fibers in the air stream.

15. A device for capturing airborne fibers (10), wherein the device consists of tubes (11) with the diameter from 6 mm to 10 mm, which have built-in suction slots with the height from 1 mm to 5 mm where the ratio between the width of the sucking slot and its height is lower than 0.005 and which are connected to a grid system in a way that allows concentration of fibers in the air flow.
Figure 1
**INTERNATIONAL SEARCH REPORT**

**International application No.**
PCT/1211/000023

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. C02F1/68 C02F3/32 B01D17/02 B01J20/24 B09C1/00
D04H1/4266

ADD. C02F1/28 C02F101/32

According to International Patent Classification (IPC) and/or both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

C02F B01D B01J B09C D04H E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal , COMPEDEX, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US 4 070 287 A (WEGAND DONALD E ET AL) 24 January 1978 (1978-01-24) claims 1,12</td>
<td>2-8</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

A: document defining the general state of the art which is not considered to be of particular relevance

E: earlier document but published on or after the international filing date

L*: document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O: document referring to an oral disclosure, use, exhibition or other means

P: document published prior to the international filing date but later than the priority date claimed

T*: later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X: document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y: document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

**Date of the actual completion of the international search** 24 October 2011

**Date of mailing of the international search report** 23/01/2012

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Janssens, Christopher
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

   see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

   1-8

Remark on Protest

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.
<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
<td>US 5 135 578 A (BILLYINGS LANNY D [US]) 4 August 1992 (1992-08-04) the whole document</td>
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<td>A</td>
<td>NL 7 706 339 A (KEYES FIBRE CO) 19 December 1977 (1977-12-19) the whole document</td>
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<td>A</td>
<td>US 3 630 891 A (PETERSON KENNETH S ET AL) 28 December 1971 (1971-12-28) the whole document</td>
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<td>24-01-1978</td>
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<td>US 3630891 A</td>
<td>28-12-1971</td>
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</table>
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8
   An absorbent material for spreading upon the surface of oil-contaminated water or lands and a method for adsorption of hydrophobic/oleophilic substances.

2. claims: 9, 10
   A method for filtering emulsions of hydrophobic/oleophilic liquids.

3. claims: 11-13
   A method and device for capturing and processing fibres obtained from the seeds of Populus trees.

4. claim: 14
   A device for capturing fibres from the ground.

5. claim: 15
   A device for capturing airborne fibres.