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(57) Abstract: The invention relates to composite structures comprising peat moss, to a foam-laid method for their manufacture and to the use thereof.

PEAT MOSS STRUCTURES

FIELD OF THE INVENTION

The invention relates to new applications of peat in composite structures. Particularly the invention relates to composite structures comprising peat moss, to methods for their manufacture and to the use thereof.

BACKGROUND

Peat moss was used as an insulator material in buildings and structures in the northern countries for centuries, however, today said use is less popular. Many other fields of use for peat moss have been proposed and for example the use of peat moss, typically in combination with other fibrous materials for absorbent products, such as sanitary napkins, diapers, dressings and the like, as well as horticultural products, e.g., as mulch for growing plants, have been suggested.

US 4,215,692 relates to absorbent products made of screened peat moss, where fines and coarse material of harvested peat moss, primarily roots and branches are discarded and the remaining peat moss is bleached, formed into a board along with finely ground mechanical wood pulp and optionally long-fibered wood pulp, followed by drying. The absorbent may be treated to include a wetting agent in quantities less than 0.5 % by weight.

A low density peat moss board, suitable as absorbent, is disclosed in US 4,507,122, where carefully selected fractions of peat moss, together with mechanical pulp fines having Canadian Standard Freeness of 60 to 500 are mixed to an aqueous slurry, which is flowed onto a Fourdrinier wire where the slurry is dewatered and dried to form the board.

US 4,676,871 teaches absorbent boards and horticultural boards made of harvested peat moss having a degree of composition of H-1 value, said peat moss being individualized and dried, followed by air-laying the dispersed particles onto a foraminous substrate to produce the low density board, which is then calandered. A surfactant may be added prior to the individualization step. Long fibers, such as

polyester, glass, polypropylene, nylon, polyacetate and rayon fibers may be added to the peat moss to impart additional strength.

US 4,473,440 relates to the manufacture of flexible absorbent boards comprising peat moss, useful for incorporating in diapers, sanitary napkins and certain industrial uses. Screened peat moss may be combined with other absorbent materials such as Kraft wood pulp and mechanical wood pulps. The obtained mixture is formed to a slurry, which is flowed to a Fourdrinier wire, dewatered and calandered. The slurry may also comprise coloring agents, wetting agents, adhesives, etc.

Boards and layered blankets comprising peat moss, for use in liquid and oil absorption, insulation, as ballistic products, and for acoustics and horticulture applications are offered commercially. Said boards and blankets may be manufactured as layered structures from peat moss and binders using heat treatment, as suggested in FI 20055272 and FI 20065675. In the heat treatment the binder is melted and upon cooling it binds the peat moss fibres together.

The prior art methods require the use of high amounts of water and they are energy consuming, or they need the use of polymeric binders, which requires heat treatment in the processing.

Technique relating to methods for producing foam-laid fiber webs is well known in the field of manufacture of non-woven and tissue products. Fiber web is formed from a dispersion of fibers in a foamed liquid. A pulp or fiber furnish is first prepared in a breaker, followed by dewatering, mixing with a foamable liquid containing a surfactant and water. The fibers are dispersed in the foam and the formed dispersion is deposited on a wire and the main portion of the liquid, which is essentially in the form of foam, is removed by the wire. This technique is disclosed in EP 481746. Surfactants may be of any suitable type, such as anionic, cationic, non-ionic and amphoteric surfactants. Additionally, wet-strengtheners, binders, starch-based binders, polyvinyl alcohol, latex creping chemicals etc may be used.

Based on the above it can be seen that there exists a need to provide improved methods for the manufacture of structures based on peat moss, and new products comprising peat moss.

SUMMARY

The present invention is based on studies relating to foam-laid methods and peat moss in order to produce porous composite structures based on peat moss. With said method composite structures may be obtained for various applications, for example such structures, which comply with present requirements of construction boards, acoustic boards etc.

The invention provides simple, continuous, flexible, economic and effective means for producing porous structures, such as boards, sheets, felts and blankets comprising peat moss.

The invention is directed to a method for the manufacture of composite structures comprising peat moss, said method comprising the steps of:

- forming at least one foamed dispersion by dispersing fibers comprising peat moss in a foamable liquid comprising water and at least one foaming agent,
- conveying the foamed dispersion or dispersions to a foraminous support and draining liquid trough the foraminous support to form a sheet, and
- drying the sheet.

The invention is further directed to a method for the manufacture of composite structures comprising peat moss, wherein the method is a continuous foam-laid method comprising the steps of:

- forming at least one foamed dispersion by dispersing fibers comprising peat moss in a foamable liquid comprising water, one or more binders and at least one foaming agent selected from anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, proteins, polyvinyl alcohols, starches and combinations thereof,
- conveying the foamed dispersion or foamed dispersions to a foraminous support and draining liquid through the foraminous support to form a sheet or web, and
- drying the sheet or web.

The invention is further directed to a composite structure comprising 25 – 99 % by weight of peat moss. Said composite structure is obtainable by the above method.

The invention is further directed to a composite structure, wherein it comprises one or more layers, it consists of 25 – 99 % by weight of peat moss, 0.005 – 5 % by weight of at least one foaming agent selected anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, proteins, polyvinyl alcohols, starches and combinations thereof, one or more binders, and optionally one or more of natural fibers and synthetic fibers, coloring agents, nutrients, fertilizers, seeds, wetting agents, softening agents, wet-strengtheners, and it has a density of 10-250 kg/m^3.

The invention is also directed to the use the composite structures comprising peat moss in liquid and oil absorption, in construction industry for insulation, as ballistic products, decorative products, in excavation, acoustics, agriculture, horticulture and landscaping applications.

The characteristic features of the invention are presented in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates graphically the fire resistance of the composite structures comprising peat moss according to the invention.

Figure 2 illustrates graphically the sound absorption coefficients of structures comprising CTMP, peat and CTMP:peat as function of frequency (Hz), with 30 mm air gap behind the samples.

Figure 3 illustrates graphically sound absorption coefficients of structures comprising CTMP, peat, CTMP:peat, and commercial reference product as function of frequency (Hz), without air gap behind the samples.

Figure 4 illustrates graphically the sound insulation (dB) of structures comprising CTMP, peat and CTMP:peat as function of frequency (Hz).

DEFINITIONS

Unless otherwise specified, the terms, which are used in the specification and claims, have the meanings commonly used in the field of forestry and pulp and paper industry. Specifically, the following terms have the meanings indicated below.

The term "peat moss" is understood here to mean the following components sedge peat, sphagnum peat, hare's tail cotton grass and any other naturally occurring peat and peat moss and any combinations thereof. The degree of decomposition may vary in said components.

"Foam-laying", also known as "foam-formation" refers here to any conventional mono-layer and multi-layer foam-laid method used in the manufacture of non-woven products, tissue products and the like.

The term "foraminous support", also known as "foraminated support" refers here to a wire or the like.

The term "foaming agent" refers here to any surface active agent, foam producing agent, surfactant and combinations thereof, including tensides etc.

DETAILED DESCRIPTION OF THE INVENTION

Peat moss is a slowly renewable material widely occurring typically in the northern countries. Peat moss may comprise sedge peat, sphagnum peat, hare's tail cotton grass any other naturally occurring peat and peat moss and any combinations thereof.

Peat moss may comprise grades having different degree of decomposition. Peat moss is often regarded as very dusty, dirty and highly inhomogeneous material, and it requires several processing steps before it can be used in products requiring higher hygiene levels.

The conventional aqueous formation methods used in the manufacture of products comprising peat moss typically yield compact structures and high amounts of water and energy are consumed in the processes. Alternatively, products comprising peat moss are manufactured using polymeric binders and heat.

It was surprisingly found that highly porous, flexible composite structures comprising peat moss can be obtained utilizing a foam-laid method, in an effective, continuous and economic way. The composite structures may be designed and manufactured according to varying needs and specifications, with respect to the composition, thickness and porosity of the desired product.

The method for the manufacture of composite structures comprising peat moss, comprises the steps of:

- forming at least one foamed dispersion by dispersing fibers comprising peat moss in a foamable liquid comprising water and at least one foaming agent,
- conveying the foamed dispersion or dispersions to a foraminous support and draining liquid trough the foraminous support to form a sheet, and
- drying the sheet.

Optionally at least one additional foamed dispersion is formed of fibrous material selected from natural fibers and synthetic fibers by dispersing said fibrous material in a foamable liquid comprising water and at least one foaming agent.

Optionally said foamed dispersions are conveyed to the foraminous support as individual layers.

The foraminous support is suitable a wire.

The draining is suitably carried out with the aid of vacuum, using vacuum pumps, or by gravitational filtration.

Drying of the formed web or sheet is suitably carried out for example by heating with means conventionally used in the manufacture of non-woven, paper and tissue products.

In the method the foamed dispersion (or dispersions) is formed of 0.1 – 10% by weight, preferably 0.5 – 8 % by weight, particularly preferably 1 - 5% by weight of peat moss, of 0.005 – 5% by weight, preferably 0.01 – 2% by weight, particularly preferably 0.01 – 1% by weight of at least one foaming agent, water and optional binders, optional fibrous materials and optional additives.

The amount of optional fibrous material may range from 0.1 to 10 % by weight, preferably 0.5 – 8 % by weight, particularly preferably 1 - 5% by weight.

The optional additional foamed dispersion (or dispersions) formed of fibrous material contain no peat moss. Said optional additional foamed dispersion (or dispersions) is formed of 0.1 – 10 % by weight, preferably 0.5 – 8 % by weight, particularly preferably 1 - 5 % by weight of at least one fibrous material selected from natural fibers and synthetic fibers, of 0.005 – 1 % by weight, preferably 0.01 – 0.05 % by weight, particularly preferably 0.01 – 0.03 % by weight of at least one foaming agent, water and optional binders and optional additives. The additional foamed dispersion (s) is conveyed individually on the support, whereby a product comprising at least two individual fiber layers is obtained.

The foamed dispersion comprises from 55 to 75 % by volume, preferably from 60 to 70 % by volume of air. Air refers here to all gases having more than 50 % by volume of nitrogen content, which includes atmospheric air or gases derived from atmospheric air.

The peat moss is selected from sedge peat, sphagnum peat, hare's tail cotton grass and any other naturally occurring peat/peat moss and any combinations thereof. The peat moss may optionally be subjected to one or more pretreatment steps selected from cutting, milling, screening, sieving, grinding and classification. Suitably fractions having average particle size in the range of 0.001 -50 mm are used.

The foaming agent may act as a surface active agent, which enables the formation of the foam and additionally it may act as a binder in the formed composite structure.

The foaming agent is selected from anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, proteins, and any combination thereof, including polyvinyl alcohol and foamable starches. Suitably said foaming agent is selected from anionic and non-ionic surface active agents, polyvinyl alcohols and foamable starches.

Optionally at least one additional binder is used in an amount of 0.005 – 10 % by weight, preferably 0.05 – 0.5 % by weight, particularly preferably 1 – 2 % by weight. Suitably the binder is selected from polyvinyl alcohols, polyvinyl acetate dispersions, ethyl vinyl alcohol dispersions, polyurethane dispersions, acrylic latexes, styrene butadiene dispersions, binders based on finely refined cellulose or cellulose derivatives, biopolymers such as binders based on starch derivatives, natural gum latexes, alginates, guar gum, hemicellulose derivatives, chitin, chitosan, pectin, agar, xanthan, amylose, amylopectin, alternan, gellan, mutan, dextran, pullulan, fructan, locust bean gum, carrageenan, glycogen, glycosaminoglycans, murein, bacterial capsular polysaccharides, and the like.

The optional fibrous material may comprise natural fibers and synthetic fibers. Natural fibers may be selected from chemical pulp, such as sulphate and sulphite pulp, organosolv pulp; recycled fibers; and/or mechanical pulp including e.g. refiner mechanical pulp (RMP), pressurized refiner mechanical pulp (PRMP), pretreatment refiner chemical alkaline peroxide mechanical pulp (P-RC APMP), thermomechanical pulp (TMP), thermomechanical chemical pulp (TMCP), high-temperature TMP (HT-TMP) RTS-TMP, alkaline peroxide pulp (APP), alkaline peroxide mechanical pulp (APMP), alkaline peroxide thermomechanical pulp (APTMP), Thermopulp, groundwood pulp (GW), stone groundwood pulp (SGW), pressure groundwood pulp (PGW), super pressure groundwood pulp (PGW-S), thermo groundwood pulp (TGW), thermo stone groundwood pulp (TSGW), chemimechanical pulp (CMP), chemirefinermechanical pulp (CRMP), chemithermomechanical pulp (CTMP), high-temperature CTMP (HT-CTMP), sulphite-modified thermomechanical pulp (SMTMP), reject CTMP (CTMPR), groundwood CTMP (G-CTMP), semichemical pulp (SC), neutral sulphite semi chemical pulp (NSSC), high-yield sulphite pulp (HYS), biomechanical pulp (BRMP), pulps produced according to the OPCO process, explosion pulping process, Bi-Vis process, dilution water sulfonation process (DWS), sulfonated long fibres process (SLF), chemically treated long fibres process (CTLF), long fibre CMP process (LFCMP), Kraft wood pulp, and modifications and combinations thereof. The pulp may be a bleached or non-bleached pulp. The pulp may originate from hardwood or softwood, including birch, beech, aspen such as European aspen, alder, eucalyptus, maple, acacia, mixed

tropical hardwood, pine such as loblolly pine, fir, hemlock, larch, spruce such as Black spruce or Norway spruce, and mixtures thereof. Suitably CTMP pulp is used.

Also non-wood plant raw material, such as seed hair fibers, leaf fibers, bast fibers, plant fibers can be provided from e.g. straws of grain crops, wheat straw, reed canary grass, reeds, flax, hemp, kenaf, jute, ramie, seed, sisal, abaca, coir, bamboo, bagasse, cotton kapok, milkweed, pineapple, cotton, rice, reed, esparto grass, *Phalaris arundinacea,* or combinations thereof.

The synthetic fibers may comprise fibers of polyester, polyethylene, polypropylene, polylactide, rayon, lyocell, nylon, glass, polyacetate, aramide, carbon and any combinations thereof.

Additionally, optional additives may be used. Said additives may comprise wetting agents, wet-strengtheners, coloring agents, fire protection agents (e.g. borates, phosphates, magnesium trihydrate), nutrients, fertilizers, seeds, softening agents, inorganic fillers and any combinations thereof.

In the foam-laid method any equipment and apparatus used in foam-formation processes in the tissue paper and non-woven manufacture can be utilized here, such as suggested for example in GB 1397378, EP 481746 and US 3716449. Products comprising one or more foam-deposited layers may be obtained.

Optionally the dried product (such as sheet, felt, board, blanket etc) is coated or laminated on one side or on both sides with at least one layer comprising at least one polymer.

The applying of the polymer may be carried out by coating using spray coating, extrusion coating, curtain coating or foam coating.

In spray coating dispersions comprising polyvinyl alcohols (PVA), polyvinyl acetate dispersions, ethyl vinyl alcohol dispersions, polyurethane dispersions, acrylic latexes, styrene butadiene dispersions, starch based binders, finely refined cellulose or cellulose derivative based binders, biopolymers such as starch derivative based binders, natural gum latexes, alginates, guar gum, hemicellulose derivatives etc are suitably used, in extrusion coating suitably polyethylene, polypropylene, polyamides,

biopolymers such as polylactide, cellulose acetate, cellulose acetate butyrate, polyhydrohyalkanoate may be used.

The obtained product i.e. composite structure comprising peat moss may have a thickness of 1 – 200 mm, preferably from 1 to 100 mm. Also a flexible product, such as a blanket or felt can be manufactured which may be winded on rolls, and it has a thickness of 0.5 to 5 cm, preferably from 1 to 2 cm.
The obtained product comprises from 25 to 99 % by weight of peat moss, preferably from 40 to 98 % by weight, particularly preferably from 55 to 98 % by weigh.

The composite structure comprising peat moss may comprise from 0.001 to 0.1% by weight of at least one foaming agent.

The composite structure comprising peat moss may additionally comprise from 0.01 to 5 % by weight of at least one binder.

The composite structure comprising peat moss may additionally comprise from 0.1 to 74 % by weight of synthetic fibers.

The composite structure comprising peat moss may additionally comprise from 0.1 to 74 % by weight of natural fibers.

The composite structure comprising peat moss is porous, with other words air containing light weight material with density of 10-250 kg/m^3.

The properties of peat moss differ significantly from other cellulose based fibrous materials and thus also the properties of the obtained products are different.

Peat has naturally low pH (around 4-5) and acidity, which provides good adhesion with polymeric materials. Dry peat is hydrophobic and thus it does not absorb water, which is desired particularly in composite structures. Peat (peat fibers) absorb readily odors, oil, grease, gasoline and volatile organic compounds (VOCs). Peat provides the products (composites) soft feeling, "natural touch" and warmth

The composite structure comprising peat moss may be cut or formed to a board, blanket, felt, element or sheet or flexible felt. Said product may be from very stiff to

very flexible depending on the end use. The manufacturing process may be adjusted accordingly.

If desired, products and elements may be formed of said structures, suitably polymeric binders are added to provide the desired rigidity when heat formed.

The composite structure comprising peat moss may be used as absorbent board, sheet or blanket in liquid and oil absorption, absorbent felt in coffins, as waste water filter, smell absorbent in bio-waste applications, as an thermal insulation board/sheet or earth/ground frost insulation board/sheet, construction sheet, as ballistic protection board or blanket or product, as decorative board/sheet in interior design applications, as geotextil or sheet in excavation, as acoustic board or sound absorption sheet, and in horticulture, landscaping and forestry applications, such as board, blanket, element or sheet for cultivation of plants, soil construction sheet (root support), biodegradable shelter, decoration item, flower holder, as packaging material such as thermo box, casing, shield material for packaging, absorption material in packaging, as moulded/shaped sheet, body works with thermosetting resins etc.

When compared to glass fiber insulation boards, to flax based insulation materials and cellulose based insulation materials the composite structure comprising peat moss is less expensive and simpler to manufacture, and it is based on natural materials. Boards and sheet complying with the present requirements in the construction industry can be met, and products according to the needs of end producers can be manufactured.

Surprisingly the fire resistance of the foam-laid composite structures comprising peat moss is very good. The products were tested according to standard EN 13501-1:2007, "Fire classification of construction products and building elements –Part 1: classification using test data from reaction to fire tests" with classes A2, B, C and D. In Example 1 boards were made of peat (100%), CTMP (100%), newspaper (100%), blend of peat and CTMP (50%, 50%) and blend of peat and newspaper (50%, 50%), without any fire retardants, and it was shown that the product containing peat moss may comply even with class B requirements. The results are illustrated in Figure 1. Thus the invention provides fire resistant products suitable as constructions boards etc. If desired, additional fire retardants may be added to the products.

Also particularly good thermal insulation materials, boards and the like can be manufactured having at least as good insulation properties as commercial flax based products.

The acoustic properties of the products comprising peat moss, such as sound absorption, particularly at low frequencies, are surprisingly good and thus the products may also be used in acoustic applications, for example in working machines where low frequencies are problematic.
The products comprising peat moss absorb readily very high amounts of oil, and they can be suitably used for collecting oil spills and the like.

The invention provides a continuous, effective and economic method for the manufacture of highly porous structures comprising peat moss, where smaller amounts of water are required in the processing, thus providing economical and environmental benefits. Completely bio-degradable products can be achieved if desired. The properties of the products can be tailored by adjusting the starting materials and process.

In horticultural use the structures may additionally comprise nutrients and fertilizers etc according to the requirements of plants which are grown on the structure, as well as seeds if desired.

Biodegradable composite structures can be obtained based on natural peat moss, having excellent properties. Tailored products can be manufactured according to end user's need, the amounts of components, surfactants and binders may be varied resulting in different properties in the products. For example when PVA is used, a soft windable felt is obtained. Also highly porous products may be obtained.

If desired, the product may be coated on one side or on both sides with a polymeric layer, or the product may comprise a layer containing other fibrous material such as Kraft wood pulp on one side etc. Coating prevents dusting of the product.

When a multilayer foam-laid method is used, the layer purity is surprisingly high and a product with clearly separated layers is obtained. No adhesives are required between the layers.

EXAMPLES

The following examples are illustrative of embodiments of the present invention, as described above, and they are not meant to limit the invention in any way.

EXAMPLE 1

Manufacture of composite structures

Foam-laid products were manufactured as follows. Partly sorted milled peat containing also hare's tail cotton grass was mixed with CTMP (chemi-thermo-mechanical pulp) or with disintegrated newspaper with a prefabricated foam. The foam was made from water containing a surfactant or polyvinyl alcohol. The foamed dispersion was conveyed to a wire, drained with suction and dried at 60 °C temperature. 0.5-10 cm thick porous sheets were obtained. The thinner sheets were flexible and windable. Boards made of peat (100%), CTMP (100%), newspaper (100%), blend of peat and CTMP (50%, 50%) and blend of peat and newspaper (50%, 50%), without any fire retardants were obtained.

Recipe 1A

Partly sorted milled peat containing hare's tail cotton grass was mixed with prefabricated foam having air content of 66 % by volume. Said foam was made by mixing of water containing 1 % by weight of polyvinyl alcohol. The flexible and windable peat sheet was made using a foam hand sheet mold.

Recipe 1B

Partly sorted milled peat containing hare's tail cotton grass was mixed with prefabricated foam having air content of 66 % by volume. Said foam was made by mixing of water containing 0.02 % by weight of anionic surfactant (sodium dodecyl sulphate). As a binder finely refined cellulose was added to the foamed dispersion in an amount of 10 % of peat dry weight. The rigid peat sheet was made using a foam hand sheet mold.

Recipe 1C

Partly sorted milled peat containing hare's tail cotton grass and CTPM (spruce) or disintegrated newspaper (50%, 50%) was mixed with prefabricated foam having air content of 66 % by volume. Said foam was made by mixing from water containing

0.02 % by weight of anionic surfactant. The rigid peat-pulp sheet was made using a foam hand sheet mold.

Fire Resistance

The obtained sheets/boards were tested for fire resistance according to standard EN ISO 11925-2:2010 – "Reaction to fire tests – Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test" (ISO 11925-2:2010). Test conditions were 22°C, 30% RH, air flow during the test was 0.69 – 0.73 m/s. the ignition of the sample was done with 20 mm long propane gas flame in 45° angle for 15 s. Sample size was 250 mm x 90 mm with a thickness of 20 mm. Two parallel samples were tested in each test. Results are presented in following table 1.

Table 1

SAMPLE	FIRE CATCH[1)]	FLAMES[2)]	POST BURNING	COMMENTS
peat	yes yes	no no	< 1 s < 1 s	5)
CTMP	yes yes	16 s 15 s	1 min 22 s extinguished	6)
recycled paper	yes yes	28 s[3)] 30 s[3)]	over 1.5 min over 1.5 min	7)
peat:CTMP	yes yes	24 s 23 s	38 s[4)] 37 s[4)]	8)
peat:recycled paper	yes yes	28 s 31 s	30 s[4)] 41 s[4)]	9)

1): Did the sample catch fire, flaming burn over 3 s.
2): Flames in 150 mm line.
3) Test was made in dark, but still it was difficult to see when the peak of the flame reached 150 mm line.
4): Flames were burned out oneself when they reached the metallic samples holder frame.
5): Both samples were left glowing, glow proceeded slowly, samples extinguished after 4.5 min.
6): Very strong flaming burn, followed by glowing. The other sample was extinguished due to strong burn after flames were at 150 mm line.
7): Due to strong flames both samples were extinguished after 1.5 min burn.
8): Weak flame, slowly proceeding glowing, samples extinguished after 2 min.
9): Weak flame, slowly proceeding glowing, samples extinguished after 2 min.

Fire resistance is presented also in Figure 1 where the time of flame to reach 150 mm line and post burning time are presented for each sample. Accordingly, structures comprising peat fulfill the requirements of classes D or C and the best even class B.

Thermal resistance

The obtained boards were tested for thermal resistance according to standard SFS-EN 12667 – "Thermal performance of building materials and products. Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance." The measurements were made at 10°C for the foam formed sheets of 400 x 400mm size, thickness 10 – 40 mm. Results are provided in table 2 below. As a reference, the thermal resistance in commercial flax insulation materials ranges in the area of 0.0350 – 0.0430 W/mK and in glass wool around 0.031 W/mK (density 60-80 kg/m^3). Results of structures comprising peat are comparable with flax insulation materials.

Table 2

Sample	Thickness d (mm)	Dry density P [1] (kg/m^3)	Average Temperature T (°C)	Temperature difference ΔT (K)	Temperature flow density q (W/m^2)	Thermal Resistance Λ_{10} W/(mK)
CTMP	35.6	23.2	10.35	18.60	21.36	0.0409
peat	60.0	67.2	10.34	18.63	11.13	0.0358
peat	35.2	24.9	10.36	18.55	22.56	0.0433
peat:rc paper[2]	60.0	43.2	10.36	18.55	12.37	0.0400
peat: CTMP	19.4	40.0	10.36	18.46	33.95	0.0357

1): Sample thickness is dependent on sample preparation; there may be variation in different parts of sample.
2): Peat: recycled paper.

Air permeability

The obtained boards were tested for air permeability according to standard EN 29053. The measurement was carried out using three different pressure differences over the analyzed sample. Air permeability was calculated as an average of three results. Sample size was 200 x 200 mm and samples were placed one on another to reach the necessary sample thickness for the measurement.

Air permeability results were mostly higher than the ones for glass wool and flax insulation materials. The results are presented in following table 3.

Table 3

Sample	Thickness of test Piece (mm)	Dry density[1)] P (kg/m^3)	Air permeability L (W3/msPa)
CTMP	45.0	18.3	880 x 10^{-6}
peat	50.0	126.0	1063 x 10^{-6}
peat	40.0	22.2	1180 x 10^{-6}
peat:rc paper	50.0	81.5	1235 x 10^{-6}
peat:CTMP	20.0	63.1	92 x 10^{-6}

1): Sample thickness is dependent on sample preparation; there may be variation in different parts of sample.

Sound absorption

Sound absorption (dB) and sound absorption coefficient (α) were measured for 30 mm and 100 mm round shaped foam formed samples with the thickness of 20 mm. Absorption coefficient and impedance were measured using two channel method with Brüel & Kjaer 4206 impedance pipe and pipes with two diameters. This method is based on standard ISO 10534-2.

Absorption coefficients of structures comprising CTMP, with thickness of 6.5 mm, peat with thickness of 11 mm and CTMP:peat (50%:50%) with thickness of 9.5 mm are presented in Figure 2 as function of frequency (Hz), with 30 mm air gap behind the samples.

In Figure 3 absorption coefficients of structures comprising CTMP, with thickness of 6.5 mm, peat with thickness of 11 mm, CTMP:peat (50%:50%) with thickness of 9.5 mm, and commercial reference product (dust-free, unbreakable pressed felt having density of 1500 g/m^2) are presented as function of frequency (Hz), without air gap behind the samples.

It can be seen that the absorption coefficient of CTMP:peat structure is comparable with the commercial reference. The sound absorption is moderate and it is related to sample air permeability and density, which both were low in these samples. Thicker samples with densities more than 20 mm yield higher sound absorption. Densities and air permeabilities of products can be adjusted during the manufacturing process.

Figure 4 presents sound insulation (dB) as a function of frequency (Hz), measured for the same samples as in Figure 3. Peat provides low sound insulation and it may be used for tailoring properties of materials having high sound insulation.

Oil absorption

Oil absorption was tested with the peat structure having thickness of 2 cm Rapeseed oil was added drop wise on the surface of a 1g sample of the dry peat sheet until oil was leaking out from the sample. The amount of absorbed oil was measured. I g sample of peat sheet was able to absorb 14 g of rapeseed oil, even without changing its shape.

CLAIMS

1. A method for the manufacture of composite structures comprising peat moss, wherein the method is a continuous foam-laid method comprising the steps of:

- forming at least one foamed dispersion by dispersing fibers comprising peat moss in a foamable liquid comprising water, one or more binders and at least one foaming agent selected from anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, proteins, polyvinyl alcohols, starches and combinations thereof,
- conveying the foamed dispersion or foamed dispersions to a foraminous support and draining liquid through the foraminous support to form a sheet or web, and
- drying the sheet or web.

2. The method according to claim 1, wherein the foamed dispersion comprises 0.1 – 10% by weight of peat moss and 0.005 – 5 % by weight of at least one foaming agent.

3. The method according to claim 1 or 2, wherein the fibers comprising peat moss comprise additionally one or more of natural fibers and synthetic fibers.

4. The method according to any one of claims 1 - 3, wherein the foaming agent is selected from anionic surface active agents non-ionic and amphoteric surface active agents, polyvinyl alcohols, and foamable starches.

5. The method according to any one of claims 1 - 4, wherein the foamed dispersion comprises additionally coloring agents, nutrients, fertilizers, seeds, wetting agents, wet strengtheners and softening agents.

6. The method according to any one of claims 1 - 5, wherein at least one additional foamed dispersion is formed by dispersing fibrous material comprising natural fibers or synthetic fibers or combinations thereof in a foamable liquid comprising water and at least one foaming agent.

7. The method according to any one of claims 1 - 6, wherein the foamed dispersions are conveyed to the support as individual layers.

8. The method according to any one of claims 1 - 7, wherein after drying the sheet or web is coated on one side or on both sides with a polymer.

9. A composite structure, wherein it comprises one or more layers, it consists of 25 – 99 % by weight of peat moss, 0.005 – 5 % by weight of at least one foaming agent selected anionic, cationic, non-ionic and amphoteric surface active agents and surfactants, proteins, polyvinyl alcohols, starches and combinations thereof, one or more binders, and optionally one or more of natural fibers and synthetic fibers, coloring agents, nutrients, fertilizers, seeds, wetting agents, softening agents, wet-strengtheners, and it has a density of 10-250 kg/m^3.

10. The composite structure according to claim 9, wherein the foaming agent is selected from anionic surface active agents non-ionic and amphoteric surface active agents, polyvinyl alcohols, and foamable starches.

11. The composite structure according to claim 9 or 10, wherein it comprises at least two individual fiber layers.

12. The composite structure according to any one of claims 9 - 11, wherein it comprises a polymeric layer on one side or both sides.

13. The composite structure according to any one of claims 9 – 12, wherein it is obtained by the method of any one of claims 1-8.

14. Use of the composite structure according to any one of claims 9 – 13 as absorbent board, sheet or blanket in liquid and oil absorption, as absorbent felt in coffins, as waste water filter, as smell absorbent in bio-waste applications, as an thermal insulation board/sheet or earth/ground frost insulation board/sheet, as construction sheet, as ballistic protection board or blanket or product, as decorative board/sheet in interior design applications, as geotextil or sheet in excavation, as acoustic board or sound absorption sheet, in horticulture, landscaping and forestry applications as board, blanket, element or sheet for cultivation of plants, soil construction sheet or root support, biodegradable shelter, decoration item, flower holder, as packaging material, shield material for packaging, absorption material in packaging, as moulded/shaped sheet or element.

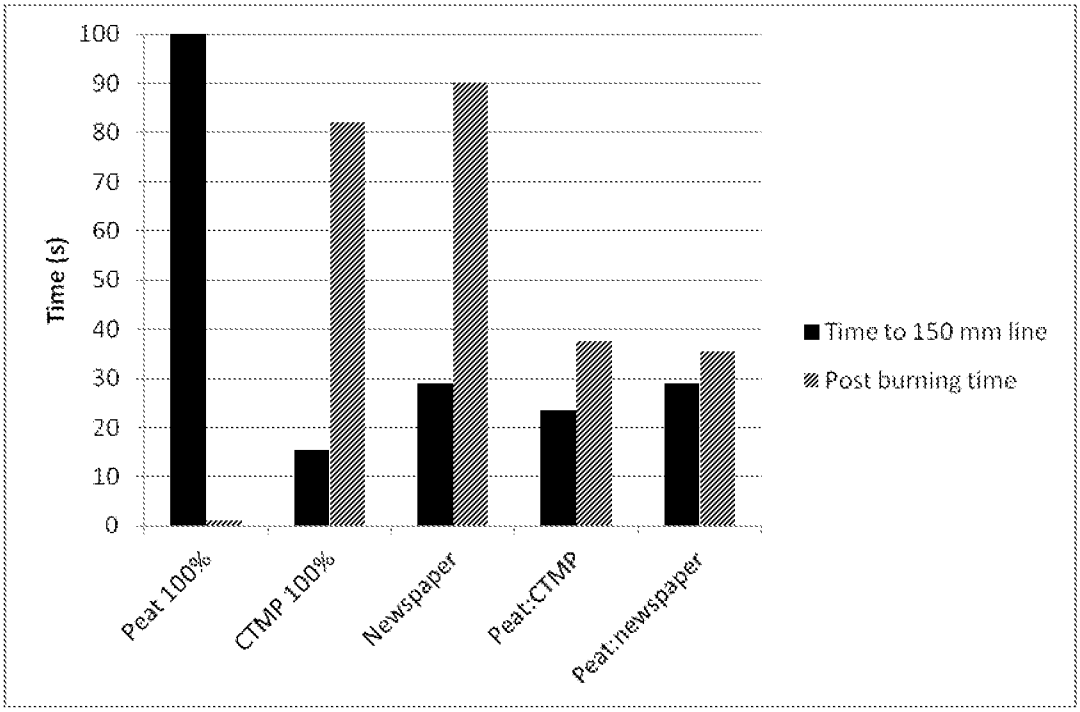
100
90
80
70
60
50
40
30
20
10
0
Time (s)
Time to 150 mm line
Post burning time
Peat 100%
CTMP 100%
Newspaper
Peat:CTMP
Peat:newspaper

Fig. 1

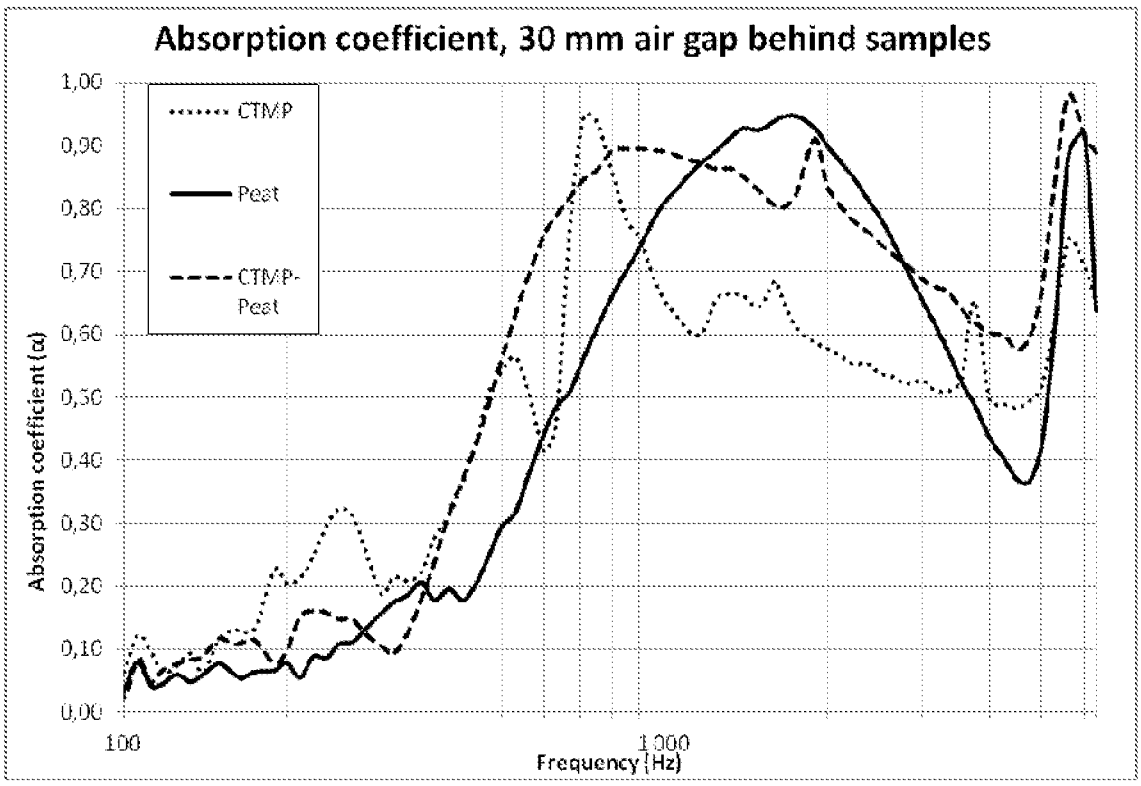
Absorption coefficient, 30 mm air gap behind samples
CTMP
Peat
CTMP-Peat
Absorption coefficient (α)
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
100
1000
Frequency (Hz)

Fig. 2

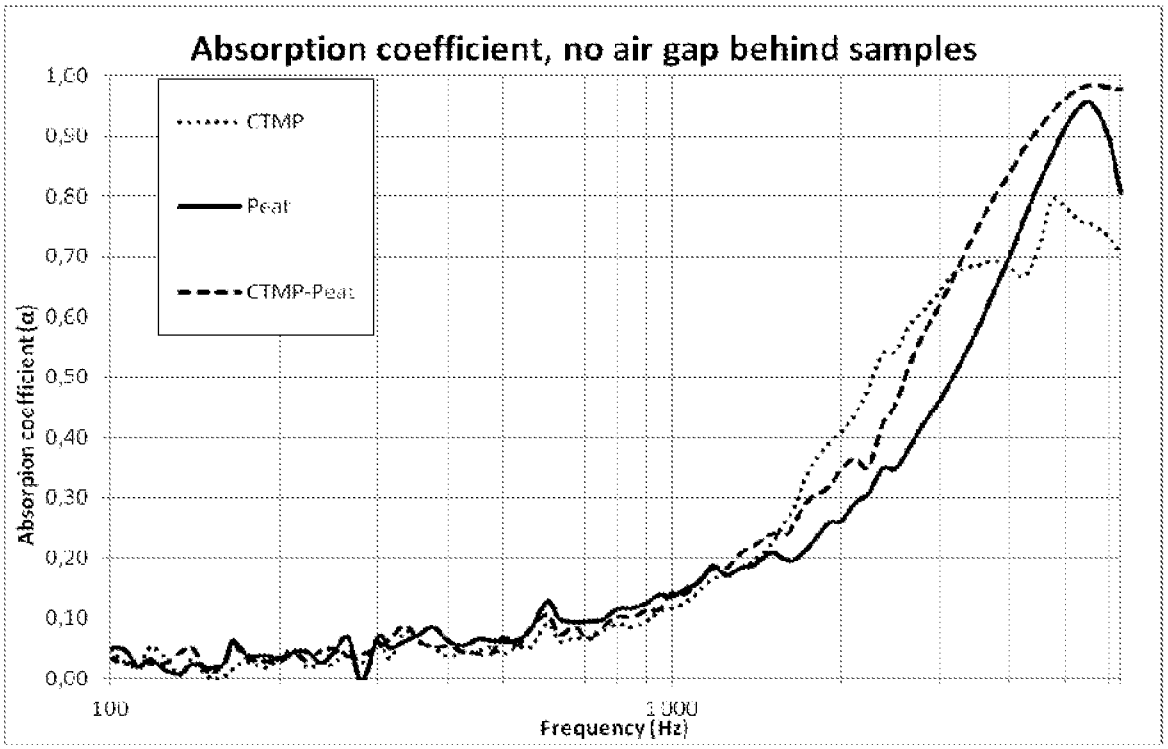
Absorption coefficient, no air gap behind samples
CTMP
Peat
CTMP-Peat
Absorption coefficient (α)
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
100
1 000
Frequency (Hz)

Fig. 3

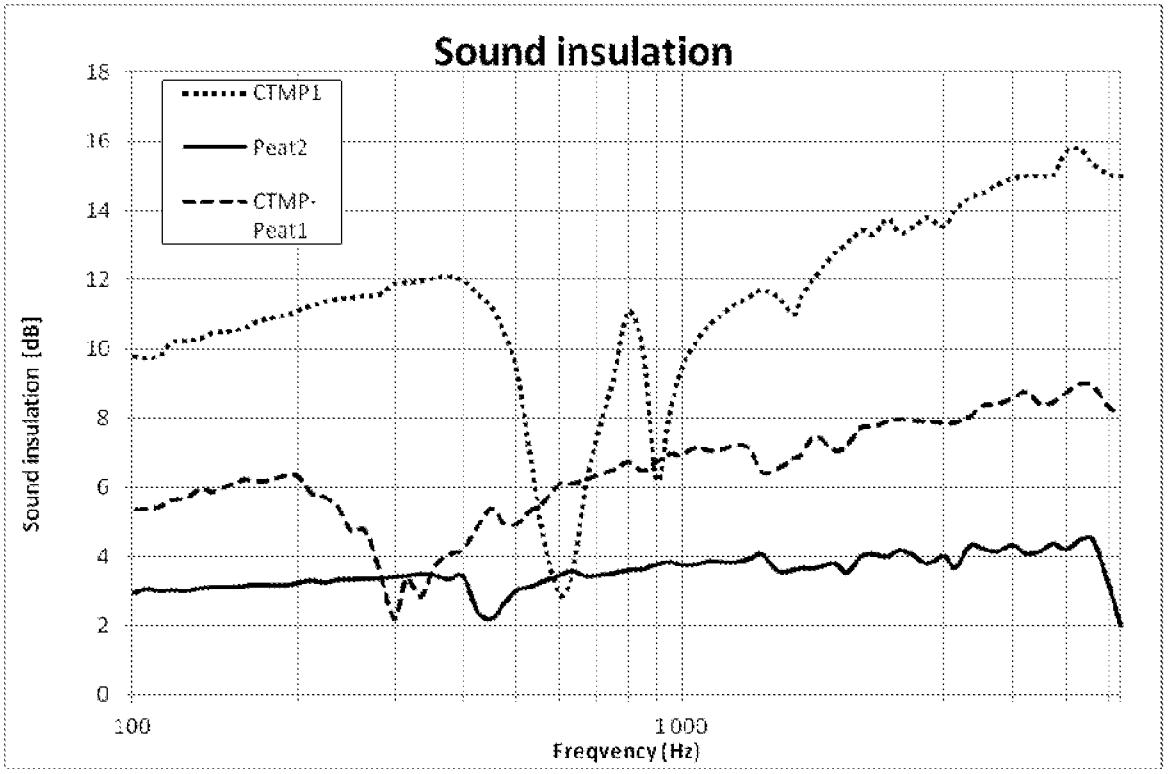
Sound insulation
CTMP1
Peat2
CTMP-Peat1
Sound insulation [dB]
18
16
14
12
10
8
6
4
2
0
100
1 000
Freqvency (Hz)

Fig. 4