PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number:
D04H 1/54	A1	WO 89/ 04886
		(43) International Publication Date: 1 June 1989 (01.06.89)

(21) International Application Number: PCT/AU88/00455

(22) International Filing Date: 25 November 1988 (25.11.88)

(31) Priority Application Number: PI 5595

(32) Priority Date: 25 November 1987 (25.11.87)

(33) Priority Country: AU

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(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.

(54) Title: BONDED FIBROUS INSULATION BATT

(57) Abstract

A method of forming batts for insulating purposes and using fibres derived predominantly from waste wool material comprises incorporating with the fibres up to 25 % bonding fibres of a thermoplastic or similar material having a softening point or melting point of between about 120°C and 200°C, forming a mat of desired thickness of the fibres and bonding fibres with the fibres randomly dispersed, causing the bonding fibres to soften to a tackiness, or melt, by increase in the temperature thereof, whereby the bonding fibres or the melted fibres, adhere other fibres together to maintain the random spacing of the fibres of the mat and hence the loft thereof.

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WO 89/04886 PCT/AU88/00455

BONDED FIBROUS INSULATION BATT

Field of the Invention

The present invention relates to improvements in thermal insulation material, and in particular to the use of bonded synthetic fibres such as monoacrylic, acrylic or polyamide, polyester and like synthetic or cellulose fibres either alone or in combination with animal fibres and either in batt form or as 'blow in' insulation.

With the present energy costs, conservation of heat is highly desirable. One method of conserving heat in the domestic scene is to insulate the dwelling. Fibreglass insulation is used extensively in this field, although it is hazardous to health, and difficult to handle in batts by reason of the glass fibres. Use of chemicals to render 'blow in' fibreglass fire-retarding is also health hazardous.

Background Art

In the Australian Patent Nos. 527,843 and 540,132 methods of forming an insulation batt of bonded fibres are disclosed in which up to 95% of wool fibres are used. The methods involve ragging and teasing wool fibres of waste wool, wool seconds and the like, and matting the randomly dispersed fibres to produce a batt of the required thickness. The batt is then sprayed with resins, pesticides, fire retardant, etc. and the resins are set by curing.

However, it has been found that the resins cannot be evenly disbursed throughout the material and therefore the mat is not bonded effectively and tends to lose its loft or thickness and associated insulating properties.

It has been proposed to form non-woven webs or fabrics using fibres which are bonded together with bonding fibres which are interspersed throughout the web and which soften or melt when heated. Australian Patent No. 459,539 describes a non-woven fabric made from wool and thermoplastic fibres, the wool fibres being saturated with water prior to blending with the thermoplastic fibres and the blended fibres being bonded together using a heated drum

to autogenously interbond crossed fibres to unify the fabric structure. Australian Patent No. 460,528 discloses a process for manufacture of a fibrous structure using conjugate, part of the surface of which is a potentially adhesive polymer which is activated by heat. In this specification, the only disclosure is of the use of conjugate fibres to produce a fabric material, and there is no disclosure of an insulating batt.

Australian Patent No. 500,317 discloses a method of producing a bonded, non-woven, fibrous batt. In this specification, the batt is formed of crimped or crimpable conjugate fibres and is subjected to a heat treatment by upward passage through the batt of a fluid having a temperature in excess of the softening temperature of the lower softening component of the conjugate fibres. Such heating effects inter-fibre bonding between the conjugate fibres. A cooling fluid is then passed upwardly through the bonded batt whereby the fibres are quenched without any batt collapse. The method of this patent is dependent on the upward passage of fluid through the material. However, an insulating batt is designed to insulate, and thereby effectively prevent passage of fluid therethrough. Accordingly, this method is not suitable for the production of an insulating batt.

Lapsed Australian Patent Application No. 59302/73 discloses the formation of non-woven fabrics from a web of fibres which include thermoplastic fibres, and subjecting the web to heat thereby the thermoplastic fibres melt to a series of fluid beads which locate at cross-over points of non-thermal fibres. For the process to work effectively, the melted thermoplastic beads must be able to locate at non-thermal fibre cross-over points. The rough surface of wool fibres mitigates against such migration of the thermoplastic beads and, therefore, a substantial quantity of the thermoplastic fibres is required for proper operation of this process with wool fibres.

While the processes previously described may be

useful in the manufacture of a non-woven web or fabric material, or may be useful in the manufacture of a loose fibrous batt, none of the described processes are able to efficiently produce an insulating batt utilizing wool fibres, particularly those from waste wool products, which batt has effective insulating properties. We have discovered that an effective insulating batt can be produced from waste wool products, and other waste fibres, by incorporating in the materials used to form the batt synthetic plastic bonding fibres which are able to be heated within the batt to soften to a degree so as to bond with other fibres in the batt and thus, when cooled, maintain the fibres randomly dispersed throughout the batt.

It is therefore an object of the present invention to provide an improved method of producing an insulating batt or an insulating material formed of waste textile and other materials.

It is also desirable to provide an insulation which is not hazardous to the health, but yet has all the properties of existing insulation, and which is economical to produce.

Summary of the Invention

Accordingly, the present invention provides a method of forming a batt of bonded fibres for use as insulation, said fibres comprising monoacrylic, acrylic or other synthetic or cellulose fibres with from 0 to 95% wool fibres, comprising the steps of incorporating with said fibres, bonding fibres of a synthetic plastics material, resin, or other material having a relatively low melting or softening point, forming said batt by any suitable means, such as by ragging, teasing and otherwise doffering the fibres of waste textile and other materials to form a randomly dispersed fibre sliver and passing said sliver through a lapper to thereby form a mat of a desired thickness, optionally incorporating in said mat a fire retardant, pesticide and a smoke retardant, heating said mat to a temperature at which the bonding

fibres at least soften to a tackiness whereby the softened fibres bond with other fibres in the mat, and cooling said mat, and cutting the mat to form batts of a desired length.

The bonded woollen fibres are bonded so the batt is lofty and has a plurality of air pockets which assists in the insulation effect. If desired for a 'blow in' installation, the batts may be broken down into small balls of bonded fibre in loose form.

Use of wool fibres can amount to between 25% and 80 of total fibres but between 70% and 80% is preferred having regard to the known fire-retardant properties of wool. In addition, it is rot proof and vermin proof. As the insulation is not visible in the finished installation, it is preferable to make use of wool 'seconds', especially black fleeces, cuttings from the shearing sheds and recycled woollen garments.

The bonding fibres may be selected from any relatively low melting point resinous or thermoplastics material, such as copolyamide fibres, saponified ethylene-vinyl acetate copolymer fibres, polyester fibres, nylon polyolifants, polyvinyl chloride and the like. Bi-component fibres may also be used in which one part, e.g. an inner core, is a relatively high melting point fibre with a second part, e.g. an outer layer, of a relatively low melting point. Alternatively, filaments may be distributed in a matrix. The bonding fibres may be present in amounts of from 1% to 60%.

Other fibres which are combined with the wool fibres and which are useful in the invention include mono-acrylic, acrylic, polyamide and polyester synthetic fibres as well as other natural fibres such as cotton. These types of fibres, when matted and bonded together in a batt, preferably with additional wool fibres, results in an insulation material which is extremely economical to produce, which can be formed of waste clothing and other waste materials and which has excellent insulating properties without the hazards of other known insulating

products. By incorporating bonding fibres into dispersed fibres throughout the mat, the softening or melting of the bonding fibres completely bonds the other fibres and maintains the loft and resiliency of the batts.

The stiffness of an insulating batt formed in accordance with the invention may be increased by the use of resins or sizing agents incorporated in or sprayed onto the batt. In one form of the invention, resinous material is incorporated in the batt by incorporating either resin fibres or resin powder in the material from which the batt is formed. The resin is activated and cured during the heating step so as to coat fibres within the batt and stiffen the batt structure.

Alternatively, the mat used for the formation of the insulating batt may be sprayed on one or both sides with a resinous material to provide a resin skin on the batt which acts to stiffen the batt. The resin spray is preferably applied prior to heating so that the heating which softens the thermoplastic fibres also cures the resin. However, the batt may be sprayed after the initial heating in which case a second heating step is required to cure the resin.

While the mat may be formed from a fibre sliver which is passed through a lapper to produce the mat of a desired thickness, the mat may also be produced by ragging, teasing or otherwise separating fibres of waste textile and other materials and blowing or otherwise conveying the fibres, randomly dispersed, to a mat forming conveyor on which the fibres are disposed at the desired thickness.

Wool and other fibres tend to be affected by heat and moisture and become soft and less resilient. Because of the water content of the natural fibres and the preferred optional materials, up to 75% by weight, the heat required to soften the thermoplastic fibres and to melt the resins may cause the mat to collapse and shrink. The mat is therefore preferably treated prior to the heating step to remove up to 80% of the water in a manner

which obviates or reduces the heating effect on the fibres and resin. Preferably the water removal treatment is carried out by dielectric heating. However, other substantially non-heating treatments may also be used.

Alternatively, microwave heating may be used for softening the thermoplastic fibres, for melting any resins present and for drying. Such microwave heating may take place in two or more stages, a first heating stage taking place to dry the batt fibres prior to mixing or incorporating the bonding fibres. A second heating stage follows the formation of the mat, after incorporation of the bonding fibres, to cause the bonding fibres to soften and bond with the other fibres in the mat.

As microwave heating is effective only if fibres contain moisture or other material receptive to the microwaves, it is a further feature of the present invention to provide the bonding fibres with microwave receptors either by incorporating a metal or other receptive material such as a polyacetylene in the fibre or by coating the bonding fibres with an appropriate microwave receptor. Preferably, the bonding fibres are formed with aluminium or other metal particles which, when subjected to the microwaves, heat the bonding fibre to soften or melt the fibre.

In an alternative arrangement, a microwave receptive material is incorporated into the fibres forming the mat so that, when subjected to microwave energy, the receptive material heats and heats the batt internally facilitating softening of the bonding fibres.

The batt may incorporate appropriate additives for fire retardant, smoke retardant and pesticide purposes. The preferred additives to the mat fibres include Aluminium trihydrate and Ken Gard (Trade Mark) (I.C.I. smoke suppressant) and Perigen (Trade Mark) (a pesticide) especially suitable against clothes moths and carpet beetle and available from Burroughs Wellcome. Alternatively, the thermoplastic bonding fibres may include therewith fibres or powders of flame retardants, pigments, smoke

suppressants, etc.

The insulation so formed may be used in any location i.e. in home, office, factory or other building, for either heat or acoustic insulation.

Detailed Description of the Invention

Example 1

A mixture of ragged garments, which include woollen, cotton and/or acrylic garments, with or without new wool, is fed together with bonding fibres of a low melting point polypropylene to a doffer, or carding machine, which separates the fibres and teases them to form a sliver or relatively thin web of randomly dispersed fibres, comprising about 5% to 20% acrylic and cotton fibres, about 70% to 80% wool fibres and about 15% bonding fibres. The sliver has a thickness of about 1/8 inch. The sliver is fed from the doffer, or carding machine, onto a horizontal lapper which oscillates at a predetermined rate to deliver the sliver to a conveyor where the sliver is lapped onto itself to build up a mat of a predetermined thickness.

Before the sliver leaving the lapper engages on the conveyor, or on to previously lapped material on the conveyor, it is sprayed with an emulsion of fire retardant, pesticides, etc. such as Aluminium Trihydrate and Perigen pesticide. The water content of the emulsion is approximately 54% by weight.

A spray boom having a plurality of spray nozzles for spraying the emulsion is mounted adjacent the lapper and is connected thereto by a linkage system which maintains the boom a predetermined distance from the sliver moving from the lapper towards the conveyor. The linkage system causes the boom to move with the lapper but through a distance related to the actual sliver movement which, because of the oscillating lapper movement and the distance between the lower end of the lapper and the conveyor, is different than the actual lapper movement.

A second boom positioned on the opposite side of the sliver to the spray boom is fed with air to produce an air cushion to thereby balance the forces produced

by the emulsion spray and maintain the sliver in its correct alignment with the conveyor.

The mat formed of the lapped sliver, which is impregnated with the emulsion sprayed onto the sliver, is conveyed to a dielectric drying station and passes between spaced plate electrodes which are electrically charged by high frequency A.C. potential. The frequency and voltage applied to the plate electrodes are chosen to optimize drying of the mat with minimum heating of the fibres. At least 50% of the water content is removed at the drying station.

The mat is then conveyed to an oven heated to between 110°C. and 180°C. to soften the bonding fibres to a tackiness so that they bond to other contacting fibres. Upon cooling, the fibres form a relatively rigid but resilient insulating mat material. The cooled batt is cut into suitable lengths, or rolled in a long length, as required.

In preferred forms of the invention the bonding fibres may comprise between 5% and 30% of the fibres in the mat before heating. It is preferred that the bonding fibres have a softening point greater than 120°C. and a melting point of less than 200°C., although it will be appreciated that lower or higher softening and melt temperatures will still be effective.

Example 2

A mat is formed on a conveyor in the same manner as described in Example 1. In this example, however, instead of adding separate bonding fibres to those obtained from the ragged garments and other natural fibres, the bonding fibres are the synthetic yarns incorporated into clothing and which form part of the waste material from which the batts are made. In this case, the heating temperature is controlled to effect melting or softening of these yarns.

A curable resin is incorporated into the material of the mat by incorporating it with the emulsion spray which impregnates the mat with both the resin material

and the other additives.

The oven which heats the bonding fibres also cures the resin incorporated in the mat, the resin being coated on fibres of the mat so as to add stiffness to the insulating batt so formed.

Example 3

A mixture of natural and artificial fibres obtained from waste, and particularly ragged woollen and cotton garments was mixed with other waste wool fibres so that the total woolen content of the mixture was approximately 90%. to this mixture was added bonding fibres having a length of approximately 20 mm, the bonding fibres comprising a mixture of copolyamide fibres, polyester fibres and nylon.

The bonding fibres and other fibres were mixed together so that the bonding fibres were randomly dispersed, and the fibres conveyed to a forming hopper. The forming hopper has substantially parallel sides extending vertically and cause the fibres to form into a mat structure which is fed from the lower end of the hopper to a conveyor passed a roller which forms the mat on the conveyor to the desired thickness.

The conveyor transports the formed mat through an oven in which the mat is heated to a temperature which is between 160° and 180°C. At this temperature, the bonding fibres soften or melt, the softened fibres developing a tackiness which enables them to bond to other, contacting fibres while the melted thermoplastic material migrates to junctions of intersecting fibres to form beads thereon.

After heating, the formed mat is cooled so that the softened or melted thermoplastic material re-solidifies to form a relatively rigid but resilient insulating mat material. The cooled mat is cut into batts of desired length.

Example 4

A mat is formed in the same manner as described in Example 3. However, prior to passing the mat through

the oven, the upper surface of the mat is sprayed with a resinous material to thereby wet the fibres forming the upper surface and form a resinous skin thereon. The mat is then passed through the oven, the oven dwell time being insufficient to fully soften or melt the thermoplastic bonding fibres, but being sufficient to cure the resin skin.

The mat is then turned so that the lower side previously in contact with the conveyor becomes the upper side, and this side is then sprayed with the resinous material. The mat is returned to the oven, or to a second oven, and the heating continues until the thermoplastic bonding fibres are softened and/or melted. In the second oven, the second resin surface is also cured.

On exiting from the second oven, the mat has a resin skin on both sides which assists in supporting the insulating batts as well as assisting in the handling of the batts.

Example 5

A mat is formed in a similar manner to that described in Example 3 except that the bonding fibres are special fibres which incorporate aluminium powder as a microwave receptor. The fibres are formed by extrusion and have a softening point of 160°C.

The formed mat is passed through a microwave oven in which the mat is subjected to microwave energy which causes the aluminium powder to heat thereby heating and softening the bonding fibres which bond with adjacent and contacting fibres. Because the heating effect occurs internally, the residence time in the oven is relatively short.

The microwave energy also acts to heat moisture in the mat fibres thus having a drying effect on those fibres and thereby reduce the moisture content of the insulating batts.

The use of an integral bonding fibre in the mat in accordance with the invention avoids difficulties associated with spraying and curing resins and attendant

problems of handling toxic materials. Further, the insulation batt so produced is substantially more economical particularly when made using waste wool and other waste materials.

From the foregoing it will be seen that wool, synthetic and other natural fibres are bonded together to form an insulation batt which may then be installed in a desired location. Alternatively, the batt may be broken down into small balls which are blown or otherwise spread over the desired location, again to provide insulation. By reason of the inherent insulating properties of the wool, synthetic and other natural fibres, particularly when matted, the batt thickness is considerably less than the thickness of the fibreglass batt of comparable heat insulation.

Thus the present invention provides a means of insulation that avoids the health hazards of the existing insulation, which is able to use discarded or second-grade wool fleeces, thereby improving the farmers' economic return on his flock, and yet the insulation so produced is equal to that which it is to replace. In addition, discarded wool, synthetic and other natural fibres, or wool, synthetic and other natural fibre garments may be ragged and used in the present invention, again reducing the cost of raw materials.

Although use of an oven has been described for heating the bonding fibres, other heating methods may be used, including electron beam irradiation, fluid heating, and the like.

Similarly, although the preferred chemical reagents and resins have been described, other reagents and resins may be used, provided they are compatible with each other and with the fibres.

In some forms of batt made with soft or light natural or synthetic fibres or fibres which have no resiliency, if the bonding fibres used do not add sufficient stiffness to the batt it is likely to collapse inwardly over time thus reducing the insulating properties.

Accordingly, the bonding fibres used should preferably be selected to ensure the batt retains its bulk and structural integrity. If desired, a stiffening agent, such as starch, resin stiffeners or similar agents, can be added to the batt either by incorporating the stiffening agent into the sprayed emulsion or by separately spraying the sliver or the mat, or by use of a suitable resin fibre dispersed through the mat or by use of resin powders dispersed through the mat.

Because of the inherent difficulty in heating an insulating batt, the mat from which the batts are made may be formed as a relatively thin mat and two or more mats subsequently laminated together to form a batt of the desired thickness.

Further, in order to provide sufficient rigidity for a batt to be self-supporting when stood on its end, the batt may be made onto a reinforcing web which becomes an integral part of the batt. Thus, the mat may be formed directly onto a reinforcing web, such as a web of plastic mesh material or an aluminium foil or the like, or two mats may be laminated together with a reinforcing web therebetween to form a batt of the desired thickness.

Alternatively, a reinforcing fibre may be incorporated with the fibres forming the matt, such reinforcing fibre having a thickness and stiffness such that the rigidity of the batt is enhanced.

Claims.

1. A method of producing a heat insulating batt of bonded fibres, said fibres comprising monoacrylic, acrylic or other synthetic or cellulose fibres with from 0 to 95% wool fibres comprising the steps of incorporating with the said fibres, bonding fibres of a heat-activatable, synthetic plastic, resin or other material having a softening or melting point of between 100°C. and 250°C. at which temperature the bonding fibre either softens to a tackiness at which it is able to adhere to other fibres, or melts, dispersing the fibres randomly, forming a mat of the randomly dispersed fibres having a desired thickness, and heating at least the bonding fibres within the mat to the softening or melting temperature of the bonding fibres to effect bonding of the mat fibres.

2. A method according to claim 1 including the steps of preparing the mat fibres by ragging, teasing and otherwise doffering the fibres of waste textiles and other waste material incorporating woollen fibres.

3. A method according to claim 1 or claim 2 including the step of adding to the randomly dispersed fibres a fire retardant, a pesticide and/or a smoke retardant.

4. A method according to any one of claims 1 to 3 including adding to the randomly dispersed fibres a resin material in fibre or powder form, the resin being activated and cured by heat.

5. A method according to any one of claims 1 to 4 including spraying at least one surface of the mat with a synthetic resin.

6. A method according to any one of the preceding claims wherein the material of the bonding fibres are selected from the group comprising copolyamide, saponified ethylene vinyl acetate copolymer, polyester, nylon, polyolifant and polyvinyl chloride.

7. A method according to any one of the preceding claims wherein at least some of the bonding fibres incorporate or contain or are coated with a microwave receptor.

8. A method according to claim 7 wherein the microwave receptor is aluminium power or polyacetylene.

9. A method according to any one of the preceding claims wherein said heating is carried out by microwave energy directed onto said mat.

10. A method according to claim 6 wherein the bonding fibres are present in the mat prior to heating in the amount of from about 5% to about 25% by weight.

11. A method according to claim 10 wherein wool fibres are present in the mat prior to heating in the amount of between about 25% and 80% by weight.

12. A method according to any one of the preceding claims wherein, prior to the heating step, the mat undergoes a drying stage during which the moisture content of the fibres is reduced.

13. A method of producing a heat insulating batt of bonded fibres of which greater than 50% are wool fibres comprising the steps of incorporating with said fibres up to about 25% bonding fibres selected from the group consisting of thermoplastic fibres having a softening point of between 120°C. and 180°C., bi-component fibres at least a surface part of which has a softening point of between 120°C. and 180°C. and composite fibres of a thermoplastic material and a microwave receptor material, forming with said fibres and said bonding fibres a mat of a desired thickness wherein said fibres and bonding fibres being randomly dispersed, applying heat and/or microwave energy to said mat to cause said bonding fibres to soften at least to a tackiness at which the bonding fibres adhere to other fibres or cause other fibres to adhere together to effect bonding of the fibres, and forming the mat into individual batts.

14. A method according to claim 13 including the step of drying said matt prior to effecting bonding of the fibres.

15. A method according to claim 13 or claim 14 including spraying or otherwise introducing into said mat a resinous material and subsequently curing the resin.

16. A method according to claim 13 including laminating two or more mat sections to form a composite batt.

17. A method according to claim 13 including forming said batt with an integral reinforcing web.

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 88/00455

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] D04H 1/54

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	D04H 1/54

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above, D04H 1/58

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

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(continued)

* Special categories of cited documents: [16]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
18 January 1989 (18.01.89)	(08.02.89) 08 FEBRUARY 1989
International Searching Authority: Australian Patent Office	Signature of Authorized Officer

Form PCT/ISA/210 (second sheet) (January 1985)

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 88/00455

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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END OF ANNEX