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(71) Applicant: **ISOVER SAINT-GOBAIN**
**92400 Courbevoie (FR)**

(72) Inventors:
- **Amannt, Gerald**
  **69259 Wilhelmsfeld (DE)**
- **Holstein, Wolfang, Dr.**
  **35315 Homburg (DE)**

(74) Representative:
**KUHNEN, WACKER & PARTNER**
**Alois-Steinecker-Strasse 22**
**85354 Freising (DE)**

## (54) Needling aid for producing needle felts, a needle felt produced by using it, and a method for production thereof

(57) The present invention concerns a needle felt of mineral wool, in particular glass wool, which even at elevated temperatures does not release any toxic products, in particular no formaldehyde, into the surrounding atmosphere and therefore has optimum suitability for use as a heat insulating material in household appliances such as ovens or cookers. Freeness from formaldehyde of the needle felt results from utilisation of a novel needling aid on the basis of halogenated polymers, in particular fluorated polymers.

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## Description

The present invention concerns a needling aid for producing needle felts of mineral wool in accordance with claim 1, a needle felt in accordance with claim 7, and a method for producing a needle felt in accordance with claim 9.

Needle felts are particularly suited for thermal insulation in household appliances, for instance in ovens and cookers as well as in industrial muffle-type furnaces.

For needle-punching mineral wool felts, a needling aid, or finishing agent, must be applied onto the fibers as an additive. Such finishing agents are variously produced on the basis of mineral oils, natural oils or fatty acid derivatives. The finishing agent is required for making the fibers smooth and reducing their mutual friction during the needle-punching process to prevent breakage or rupturing of the fibers during needle-punching as far as possible. The finishing agent must furthermore be capable of binding dusts released during the production process, to thereby permit processing and utilisation of the needle felt in the absence of any additional dust protection measures.

Typically such finishing agents are sprayed onto the fibers in the chute of a fiberising machine for the molten glass material, or directly onto the felt mat. This implies a tradeoff with respect to viscosity inasmuch as sufficient spraying must be ensured on the one hand, whereas a material having a sufficiently high viscosity must be retained following evaporation of the carrier material in order to guarantee the above mentioned advantages for the needle-punching process.

Formerly, particularly suited finishing agents were therefore lubricating oils and lubricants on mineral oil basis. A drawback of utilising such substances as a needling aid did, however, reside in the fact that considerable amounts of one or several emulsifiers had to be added for producing an aqueous dispersion or emulsion to thereby prevent phase separation into mineral oil phase and aqueous phase from occurring even as early as in the storage container of the finishing agent dispenser. To this end, particularly alcohol alkoxylates and/or nonylphenol were used as emulsifiers in the past, however these had the facultative disadvantage of decomposing and thereby releasing formaldehyde upon being heated in needle felts which are utilised for thermal insulation of household appliances, e.g. ovens and cookers, and industrial muffle-type furnaces.

It has, however, also been found in the past that even if needle felts were subjected to thermal aftertreatment following needle-punching in order to remove the needling aid - not to mention the increased expense in terms of energy and costs - residual finishing agent and in particular residues of the emulsifiers contained in it may still cause malodors or even the release of formaldehyde at the location of the final user. This is particularly true for the first few weeks of operation of ovens and cookers.

In order to avoid these difficulties, various approaches were tried in the prior art. Thus it was attempted e.g. to disperse mineral oil products in water via a high-pressure dispersion mixing device in such a way as to do away with the addition of emulsifier. This did, however, amount to a major technical effort on the one hand and did not provide the desired results on the other hand.

Another approach to avoid this problem was based on the fact that, in accordance with DE-PS-42 01 868, a thixotropising additive is used with a standard finishing agent on a fatty acid polyglycolester basis. Such a thixotropising additive has the advantage of having a high viscosity at rest and thus holding the fiber loops in their anchoring positions achieved by the needle-punching process, whereas the presence of a low dynamic viscosity results in good needle-punching properties and a good lubricating effect. Owing to a high degree of fluidity while the needles are acting on the felt to be needle-punched, it is possible to have to add only small quantities of needling aid, whereby malodors under the effect of heat are correspondingly diminished.

It is, however, a drawback of this finishing agent, or of these needle felts of the prior art, that malodors and thermal decomposition products, which are particularly undesirable in the field of household appliances, continue to occur.

Starting out from this prior art, it is therefore an object of the present invention to furnish a needling aid for producing a needle felt, which practically does not release any toxic decomposition products, in particular any formaldehyde, at temperatures occurring in the heat insulation particularly of ovens and cookers.

With respect to a needling aid, this object is achieved through the characterising features of claim 1. With respect to a needle felt, the above object is achieved by the features of claim 7, and in terms of process technology the above object is achieved by the features of claim 9.

Since the needling aid of the invention contains an aqueous dispersion of at least one at least partly halogenated polymer, on the one hand there result excellent oil-like finishing agent properties owing to the molecular conditions, and on the other hand those are chemically inert, halogenated polymers which, as a rule, resist thermal decomposition or are otherwise decomposed into non-toxic products. Such partly halogenated polymers can be selected from the group consisting of:

halogenated synthetic oils, fluorated synthetic oils, in particular perfluorated synthetic oils, chlorated synthetic oils, in particular perchlorated synthetic oils, brominated synthetic oils, in particular perbrominated synthetic oils;

halogenated polyethers, fluorated polyethers, in particular perfluorated polyethers, chlorated poly-

ethers, in particular perchlorated polyethers, brominated polyethers, in particular perbrominated polyethers;

halogenated polyesters, fluorated polyesters, in particular perfluorated polyesters, chlorated polyesters, in particular perchlorated polyesters, brominated polyesters, in particular perbrominated polyesters; and

halogenated polyols, fluorated polyols, in particular perfluorated polyols, chlorated polyols, in particular perchlorated polyols, brominated polyols, in particular perbrominated polyols;

as well as mixtures thereof.

The terms "perfluorated", "perchlorated" and "perbrominated" are meant to indicate that practically each hydrogen atom within the polymer is replaced by a corresponding halogen atom, wherein one or both terminal groups can be not halogenated or partly halogenated.

Formaldehyde could be detected neither in the chute nor in the final needle felt which was exposed to a temperature of up to 500°C for approx. 1 hour.

Under practical conditions, the perfluorated polyethers in accordance with claim 2 have hitherto turned out to be particularly suitable needling aids as they bring about extremely favorable sliding properties between the fiber loops during needle-punching on the one hand, and as practially all hydrogen atoms within the polyether system are replaced by fluorine atoms on the other hand, such perfluorated polyethers are chemically inert and also thermally resistant.

The perfluorated polyether in accordance with claim 3 has been found to be a particularly preferred embodiment of a needling aid, which is commercially available e.g. under the designation Fomblin FE 20C.

Adding another alcohol, in particular a sterically inhibited alcohol, preferably t-butanol, to the needling aid in addition to the halogenated polymer in accordance with claim 4 has the advantage that the dispersion is stabilised by it, with the t-butanol, having a boiling point of approx. 80°C, instantaneously evaporating in the chute without furthermore leaving behind any decomposition products. Addition of such an alcohol stabilises the dispersion or emulsion in water of the polymer used.

A particularly preferred needling aid is one in accordance with claim 5, wherein the dispersion is present as an aqueous micro-emulsion. Such micro-emulsion has the advantage that it presents homogeneous distribution of the utilised halogenated polymer in water even without any costly mixing processes, such that the obtained good results are also reproduceable in subsequent lots.

Upon application onto the fibers of the mineral wool, in particular glass wool, the aqueous emulsion preferably has a concentration of approx. 0.1 to 0.5% (wt.) of halogenated polymer and approx. 0.05 to 0.45% (wt.) of t-butanol. At these final concentrations during application onto the mineral wool, only small quantities of needling aid are required to obtain the properties desired for needle-punching.

Owing to the small amounts of needling aid according to the invention, the incurred costs are reasonable compared with those of conventional finishing agents.

In claim 7 a needle felt is claimed which can be obtained by using a needling aid according to the invention. An important advantage of the needle felt according to the invention resides in the fact that for the first time a formaldehyde-free needle felt is available which will not release formaldehyde even under a high thermal load of up to approx. 500°C in accordance with claim 8.

The needle felts according to the invention are therefore well suited for thermal insulation in household appliances, in particular ovens and cookers, inasmuch as they produce neither unpleasant smells nor toxic decomposition products upon initial operation at the location of the end user.

In claim 9 a method for producing a needle felt is claimed which employs the needling aid according to the invention.

It should be noted in the framework of the present invention that the needling aid according to the invention is suited for needle-punching mineral wool, particularly, however, having the form of glass wool.

Further advantages and features of the present invention result from the description of an embodiment.

Example

For producing a needling aid composition according to the invention, an aqueous micro-emulsion of a perfluoropolyether commercially available under the designation "Fomblin FE 20C" was used. This emulsion has a polymer content of approx. 20% (wt.) and is stabilised with approx. 18% (wt.) of t-butanol.

The perfluorated polyether used in the example had the following general formula:

$$CF_3\text{-}(O\text{-}CF(CF_3)\text{-}CF_2)_n\text{-}(O\text{-}CF_2)_m\text{-}O\text{-}CF_2\text{-}R,$$

with R = $-COO^-NH_4^+$ or $-C(OH)_2\text{-}CF_3$, and n and m being integers with n/m approx. 20 to 40.

For producing a practically applicable solution or dispersion, the commercially available solution is diluted with water to a polymer content of approx. 12% (wt.). In the preparing vessel of the needle felt line, 3 kg of the 12% emulsion are then added into 250 kg of water and mixed by means of a propeller agitator.

This solution containing a final concentration of approx. 0.15% (wt.) polymer, e.g. perfluoropolyether, was then sprayed onto e.g. a glass wool felt, and the latter conveyed under a needle bench and subjected to a needle-punching process. As an alternative, the nee-

dling aid of thet above example is sprayed directly onto the fibers in the chute.

A needle felt produced from glass wool in this manner has a bulk density of approx. 50 kg/m$^3$ and a thickness of approx. 17 mm.

The needle felts thus produced were subjected to thermal load at approx. 250°C in a standard kitchen in accordance with DIN 44971 in previously annealed cookers, and possibly produced decomposition products were analysed.

Here it was found that on the one hand no toxic products were produced at all, in particular neither formaldehyde nor hydrogen fluoride could be detected in the oven exhaust air.

Thus annealing of the needling aid subsequent to the needle-punching process, as it is frequently required with conventional finishing agents, is not necessary. The needle felts of the present invention therefore have excellent suitability for use in household appliances such as ovens or cookers as a heat insulation material, as it was also found in tests with such apparatus that malodors occurred neither upon initial use nor upon use over a period of several weeks, and that toxic products are not released into the surrounding atmosphere.

## Claims

1. Needling aid for producing needle felts of mineral wool,
**characterised in that**

it contains an aqueous dispersion of at least one at least partly halogenated polymer which is selected from the group consisting of:

halogenated synthetic oils, fluorated synthetic oils, in particular perfluorated synthetic oils, chlorated synthetic oils, in particular perchlorated synthetic oils, brominated synthetic oils, in particular perbrominated synthetic oils;

halogenated polyethers, fluorated polyethers, in particular perfluorated polyethers, chlorated polyethers, in particular perchlorated polyethers, brominated polyethers, in particular perbrominated polyethers;

halogenated polyesters, fluorated polyesters, in particular perfluorated polyesters, chlorated polyesters, in particular perchlorated polyesters, brominated polyesters, in particular perbrominated polyesters;

halogenated polyols, fluorated polyols, in particular perfluorated polyols, chlorated polyols, in particular perchlorated polyols, brominated polyols, in particular perbrominated polyols; as well as

mixtures thereof.

2. Needling aid according to claim 1, characterised in that it contains a perfluorated polyether.

3. Needling aid according to claim 2, characterised in that the perfluorated polyether has the following general formula:

$$CF_3\text{-}(O\text{-}CF(CF_3)\text{-}CF_2)_n\text{-}(O\text{-}CF_2)_m\text{-}O\text{-}CF_2\text{-}R,$$

with R = $-COO^- NH_4^+$ or $-C(OH)_2\text{-}CF_3$, and n and m being integers with n/m approx. 20 to 40.

4. Needling aid according to any one of claims 1 to 3, characterised in that in addition to the halogenated polymer it furthermore contains an alcohol, in particular a sterically inhibited alcohol, preferably t-butanol.

5. Needling aid according to any one of claims 1 to 4, characterised in that the dispersion is present in the form of an aqueous micro-emulsion.

6. Needling aid according to any one of claims 1 to 5, characterised in that the aqueous emulsion has the following concentrations upon application onto the fibers of the mineral wool:

approx. 0.1 to 0.5% (wt.) of polymer
approx. 0.05 to 0.45% (wt.) of t-butanol.

7. Needle felt, obtainable by using a needling aid according to any one of claims 1 to 6.

8. Needle felt according to claim 7, characterised in that it does not liberate any formaldehyde upon being heated to approx. 500°C.

9. Method for producing a needle felt of mineral wool wherein a needling aid according to any one of claims 1 to 6 is added to a felt mat, and the latter is then needle-punched.