United States Patent Office 3,059,311 Patented Oct. 23, 1962

3,059,311

STABLE NON-WOVEN BATT OF POLYTETRAFLUOROETHYLENE FIBERS

Jerome Hochberg, Newburgh, N.Y., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

No Drawing. Filed Dec. 16, 1958, Ser. No. 780,680
2 Claims. (Cl. 28—72.2)

This invention relates to non-woven sheet materials and more particularly to a process for making non-woven sheet materials of polytetrafluoroethylene.

Because of its outstanding properties such as heat and chemical resistance, polytetrafluoroethylene has found wide use in recent years. Non-woven felt-like sheet materials of polytetrafluoroethylene are used in many applications such as, for example, wicks for corrosive liquids, gaskets, electrical and heat insulation, chemically resistant clothing, sound absorbents and filters.

Briefly, non-woven sheet materials of polytetrafluoroethylene are generally prepared by the process which comprises forming a non-woven batt of drawn or heat retractable fibers, needle punching the batt, and heat-treating the resulting product to form a heat-stable non-woven sheet material. One conventional method of performing the first step in the aforementioned process involves carding the fibers on a conventional card or garnett to form a sliver which is a thin layer of filaments all laid roughly parallel to the machine direction. Next, several slivers are laid on top of each other usually with the fibers in adjacent layers set at an angle to each other. The loose batts of fibers, formed by the aforementioned or other well-known procedures, is next needle punched, usually on a conventional needle loom, to strengthen and compact the batt by forceably orienting small separate groups of fibers at intervals into a position that is substantially perpendicular to the plane of the sheet material. These known needle looms consist of a large number of closely spaced needles supported in a position to move into and out of the batt. The batt can be moved continuously through the loom or, preferably moved intermittently through the loom being advanced only when the needles are withdrawn from the batt. Finally, the needle punched batts are heated at a temperature usually ranging from about 500 to 600° F. to further strengthen the batt and to stabilize the product against shrinkage when, in use, it is subjected to elevated temperatures.

Several disadvantages have resulted from this conventional process. First, prior to needle punching, the non-woven batts of fibers of polytetrafluoroethylene are extremely difficult to handle because they pull apart and stretch readily. Secondly, when they are heat-stabilized, conventional non-woven batts of polytetrafluoroethylene shrink drastically; for example, non-woven batts of polytetrafluoroethylene stabilized at temperatures of about 550° F. shrink as much as 25% or more in area, while those stabilized at 600 to 650° F. may shrink 75% or more in area. This results in several problems. For example, full use cannot be made of machine capacity since a machine such as a card, garnett or needle loom capable of forming a batt of a given surface area actually yields a heat-stabilized product of much smaller area. Also, when conventional non-woven batts are heat-stabilized, the density of the batts increase greatly while the porosity decreases. In air filtration, for example, where maximum porosity and minimum density, hence minimum pressure drop, are desirable, conventional non-woven heat-stabilized sheet materials of fibrous polytetrafluoroethylene are often not suitable. Furthermore, in impregnated non-woven sheet materials, since the ratio of impregnant to fiber increases as the density of the non-

woven sheet material decreases, conventional non-woven heat-stabilized sheets of fibrous polytetrafluoroethylene are often limited.

I have found a method for making non-woven sheets of fibrous polytetrafluoroethylene which reduces distortion during processing, which makes full use of machine capacity and which can be used to make products having a low density and high porosity.

The process of this invention comprises heating drawn or heat-retractable polytetrafluoroethylene fibers at a temperature of at least about 450°, and preferably about from 500 to 625° F., forming the fibers into a non-woven batt and needle-punching the resulting product.

Any of a wide variety of fibrous forms of heat-retractable polytetrafluoroethylene can be used in the process of this invention. These include, for example, staple and monofilament polytetrafluoroethylene and yarns thereof. Fibers ranging from 0.5 to 16 denier or even 50 to 1,500 denier can be used. Staple fibers ranging from 2 to 10, and preferably 4 to 8 inches in length and having a denier of 0.5 to 16 and preferably 2 to 8 are particularly preferred. Usually, fibers made heat-retractable by being drawn 1 to 15 times in length are used. Such fibrous polytetrafluoroethylene can be prepared as described, for example, in U.S. Patent No. 2,559,750.

Considering the process of this invention in more detail, first, the fibrous polytetrafluoroethylene is heat treated at a temperature of at least about 450° F. The particular temperature selected varies with the temperature to which the product is to be subjected during use. Preferably, the temperature of the heat treatment exceeds that to which the products are subjected during use. The duration of the heat treatment varies with the temperature employed. At temperatures of about 450° F., the fibers are preferably heated for several hours. At higher temperatures of 750 to 850° F., the fibers are treated only for a few seconds; otherwise, the fibers will stick or lose their fibrous form. Preferably, the fibers of polytetrafluoroethylene are heated at about 500 to 625° F. for about from 45 to 15 minutes. The fibers of polytetrafluoroethylene can be heated in drums, trays, ovens or baths by media such as, for example, air, fused salt, molten metal, oil, steam or other fluids or by infrared radiation.

Next, the heat-treated fibers are formed in a fibrous batt. Any of the conventional means used for forming batts can be used. These include, for example, carding and cross-lapping the fibers, depositing the fibers on a moving belt, conveyor, drum or the like with air jets, or collecting the fibers on perforated screens from dispersions in water, air or other fluid media.

Finally, the non-woven batts of fibers are needle punched. This can be done on a conventional needle loom or other apparatus adapted to forceably orient the fibers in the desired position. Usually the batts are punched about from 300 to 30,000 times per square inch and preferably 1,000 to 10,000 times per square inch, depending on the degree of strength and compactness desired.

By the process of this invention, it is possible to form heat-stable non-woven sheets of fibrous polytetrafluoroethylene which have a low density and high porosity. Full use is made of machine capacity. Before needle punching, the non-woven batts produced in accordance with this invention have greatly improved processability and resistance to stretching and pulling apart. Furthermore, the products of this invention require no heat stabilization after needle punching.

The products of this invention are useful as heat and chemical resistant carpets and underliners, heat, sound and electrical insulation, wicks, gaskets, protective cloth-

ing and protective coverings for ironing boards, presses and the like. The process of this invention is particularly suited for making low-density and high porosity felt-like non-woven sheets of polytetrafluoroethylene useful as filter media and as substrates from impregnated articles.

The following examples are intended to illustrate the invention and not to limit it in any way. Parts and percentages are by weight unless otherwise indicated.

Example 1

Heat-retractable, 4½ inch, 6⅔-denier staple fibers formed from polytetrafluoroethylene filaments drawn to about 10 times their original length are placed in an oven and heated at 600° F. for 30 minutes. The resulting fibers are then carded and cross-lapped to form a non-woven batt consisting of about 20 to 30 slivers and weighing about 18 ounces per square yard. The resulting batt has excellent cohesiveness and does not pull apart or stretch significantly during normal handling. The batt is transferred to a needle loom and needle punched about 4,000 times per square inch during 18 passes through the loom. The resulting product is about 91 mils thick, has a weight of about 18.35 ounces per square yard and a Frazier porosity of 187 cubic feet per minute per squre foot determined in accordance with Federal Specification CCC–T–191b, Method 5450, issued May 15, 1951. When it is heated to 550° F., the non-woven sheet material shows substantially no shrinkage, and at 600° F., the product shrinks only about 4% in the area. This product is particularly useful as an air filter or substrate for impregnated sheet materials.

A control is run by carding and cross-lapping the polytetrafluoroethylene staple fibers described above directly into a non-woven batt weighing about 18 ounces per square yard. The resulting product is then needle punched about 4,000 times per square inch in 18 passes through a needle loom, then heat shrunk in an oven at 550° F. for 30 minutes. During this heat-shrinking step, the product shrinks about 25% in area and increases in weight to about 23 ounces per square yard. The product has a Frazier porosity of about 85.6 cubic feet per minute per square foot and a thickness of about 84 mils. Prior to needle-punching, the non-woven batt is easily pulled apart and distorted.

Example 2

1200-denier, continuous filament polytetrafluoroethylene yarn containing 180 filaments per thread drawn about 10 times their original length is run through a hot-air chamber at about 600° F. The dwell time in the chamber is about 20 minutes and the tension thereon is just sufficient to carry the yarn through the chamber. The resulting product is deposited randomly on a moving belt with an air jet to form a non-woven batt weighing about 50 ounces per square yard. The resulting batt is needle punched about 2,000 times per square inch to yield a heat-stable product useful, for example, as a substrate which can, for example, be impregnated with an aqueous dispersion of polytetrafluoroethylene to yield gasket or tank-lining material.

Example 3

Two-denier, 8-inch staple fibers formed from filaments of polytetrafluoroethylene drawn about 10 times their original length are heated at about 575° F. for about 30 minutes. Next, the fibers are carded and cross-lapped to form a non-woven batt weighing about 10 ounces per square yard. The resulting product is needle punched about 3,000 times in 12 passes through a needle loom to yield a product useful, for example, as a filter.

I claim:

1. A process which comprises heating heat-retractable fibers of polytetrafluoroethylene at a temperature of at least about 450° F. for a time sufficient to stabilize the fibers against shrinkage at temperatures below said temperature, forming the resulting fibers into a non-woven batt and needle punching the resulting product.

2. A process which comprises heating heat-retractable fibers of polytetrafluoroethylene at a temperature of about from 500 to 625° F. for about from 45 to 15 minutes, forming the resulting fibers into a non-woven batt and needle punching the resulting product.

References Cited in the file of this patent

UNITED STATES PATENTS

2,336,797	Maxwell	Dec. 14, 1943
2,396,166	Faucette	Mar. 5, 1946
2,604,689	Hebeler	July 29, 1952
2,764,506	Piccard	Sept. 25, 1956
2,821,457	Erlich	Jan. 28, 1958
2,840,881	Bateman	July 1, 1958
2,867,495	Meyers	Jan. 5, 1959
2,893,105	Lauterbach	July 7, 1959