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(54) Paper machine felts.

(57) The present invention relates to an article of paper machine clothing formed from a fibrous material having a woven base and an optional batt layer attached thereto characterised in that said fibrous material comprises fibres of poly(undecanoamide) (polyamide 11) formed by the extrusion of a melt of polyamide 11 having an intrinsic viscosity of at least 1.0 dl/gram.

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PAPER MACHINE FELTS

This invention relates to paper machine felts. In a paper making machine, a slurry of paper making constituents referred to as "furnish" is deposited on a fabric or "wire" and the liquid constituents are drawn or extracted therethrough to produce a self-cohesive sheet which is then passed to the pressing and drying sections of the paper-making machine. In the pressing section, the paper sheet is transported by a felt to a pair of rollers where the felt and paper sheet pass between the nip of the rollers to dewater and to dry the paper sheet. The paper sheet itself may contain all types of chemical finishes and will be, at the same time, subjected to an elevated temperature to aid the dewatering and drying thereof. The paper making felt together with its sheet of paper tends therefore, to be subjected to immense pressure at elevated temperatures in a rigorous chemical environment.

Paper making felts are generally produced by needling batt fibre to a woven backing which then supports the forming paper sheet as it passes through the press. In the nip of the press rolls, the batt fibres are bent and deformed under great pressure and at great frequency and hence the mechanical properties of the batt fibre are of considerable importance in these processes.

Polyamide 6 and polyamide 6,6 (PA 6 and PA 6,6,) have been used extensively in the manufacture of paper machine felts. These polymers are readily formed as fibres and their fibre characteristics can be controlled to allow production into acceptable felts. Many prior art proposals for the use of polyamide materials in sheet and felt materials in general have been proposed. For example, in British Patent Specification No. 1304732, there is a reference to the use of polyamide such as nylon 6, nylon 6,6, nylon 6.10, nylon 6,7, nylon 8, nylon 9, nylon 11 and nylon 12. The specification is concerned with the manufacture of fibrous sheet materials and is not specifically concerned with paper machine clothing.

British Patent Specification No. 1329132 again relates to a known woven fabric for use, for example, as an interlining. Again, there is reference to the use of polyamide such as nylon 6, nylon 11, nylon 12 and copolyamides such as nylon 6,6 and copolymers of nylon 6 and nylon 6,6 with nylon 11 and nylon 12.

Prior British Specification No. 1585632 has been concerned with the manufacture of artificial leather and like materials and again the use of nylon 6, nylon 6,6, nylon 10 and nylon 11 and nylon 12 are disclosed together with various copolymers of different variations and combinations thereof.

In each of these cases, the nylon materials are used primarily for their inherent strength in a clothing or decorative assembly and would not be subjected to the agressive physical and chemical environment of a paper making machine.

European Patent Specification No. 000708 relates to a paper making machine felt comprising a woven heat set belt which in the machine and transverse direction comprises thermoplastic filaments, in which belt the filaments in at least one of the machine and transverse directions are co-extruded and in which monofilaments have a core of polymer selected from nylon 6,6, polyethylene terephthalate and tetrapolymer of tera or isophthalic acid and a sheet of copolymer selected from nylon 11, nylon 12, nylon 6, nylon 6,10, nylon 6,12, polybutylene terephthalate and a large number of other materials.

In European Patent Specification No. 0070708, the materials are being employed primarily for their well known properties of strength and abrasion resistance.

Our co-pending European Application No. 88303201.3 shows that nylon 12 can be used in the construction of a felt for use in a paper making machine. Our researchers have shown quite surprisingly, that nylon 11 has properties which compare favourably with nylon 12 although this would not have been expected from the normal structure thereof. Polyamide 11 (polyundecanoamide) referred to in this specification as "PA 11" is well known in polymer technology and as an article of commerce. Polyamide 11 was developed commercially for sources directed primarily to injection moulding applications. The polyamide 11 homopolymer without cross-linking additives may be extruded to form a large number of items and is ideally suited to the formation of monofilaments and fine denier continuous filament yarn. While it would not be expected that this material would provide satisfactory properties required in a paper machine batt to provide the surface properties required, the present Applicants, unexpectedly, have found that batt materials of polyamide 11 when used in paper machine felts have superior durability and enhance recovery from compression and resistance to fibrillation compared with felt materials currently employed. In addition there is a superior chemical resistance to hydrolysis and resistance to degradation of physical properties by hypochlorite and other oxidation and we have found surprisingly that polyamide 11 can exhibit a 50-100% greater lifetime use in particularly hostile chemical and abrasive environments in paper making.

According to one aspect of the present invention, therefore, there is provided an article of paper machine clothing formed from a fibrous material having a woven base and an optional batt layer attached thereto characterised in that said fibrous material comprises fibres of poly(undecanoamide) (polyamide 11)

formed by the extrusion of a melt of polyamide 11 having an intrinsic viscosity of at least 1.0 dl/gram.

In a further aspect of the present invention the melt to be extruded may contain 0.2 to 1.0% by weight of an anti-oxidant and more preferably, 0.4 to 0.7% by weight. The anti-oxidant may be selected from one or more of alpha-tocopherol, condensation products of diphenylamine and acetone and closely related structures derived from diphenylamine and compatible phenolic stablisers with amide functionality such, for example, as that made commercially available by Ciba Geigy under the trade name "IRGANOX 1098". Polyamide fibre containing approximately 0.5 to 0.6% by weight of anti-oxidant individually and separately or in combination results in a further enhancement of durability.

Polyamide 11 resin of the appropriate instrinsic viscosity may be compounded during extrus ion of monofilament or continuous filament by the addition of selected anti-oxidants. Polyamide 11 monofilament in accordance with the invention may be extruded at temperatures across the barrel between 220 ° C and 295 ° C. The spinneret may be maintained at temperatures of approximately 300 ° C. Monofilament may be extruded with the drawdown of between 2.0 X and 4.5X in order to provide monofilaments of 0.1 - 0.25 mm for manufacturing of Fourdrinier or other forming fabrics. A particular utility for improved durability against abrasion, polyamide 11 monofilament may be also used advantageously as shute filament and/or warp filament in single, double or triple layer of press fabrics.

Surprisingly, it has been found that the incorporation of polyamide 11 high molecular weight monofilaments may be employed in Fourdrinier forming fabrics as warp or machine direction monofilaments. It is possible in accordance with the invention to prepare high durability all polyamide forming fabrics and avoid a mix of materials presently employed in which polyamide filaments must be alternatively inserted with polyester monofilaments in the shute direction in order to provide a measure of enhanced abrasion resistance without the existence of dimensional instability which normally results from the use of polyamide 6 or polyamide 6,6 material. The paper machine felts in accordance with the present invention have a low moisture regain and are relatively insensitive to physical properties in the presence of water.

Monofilaments may be extruded with variations in the process to deliver this and other desirable tensile properties for the weaving of base materials for needled nonwovens employed in the pressing section of a paper making machine. Monofilaments in large diameters may be employed in both the warp and shute directions in dryer screen applications.

Fine denier monofilaments of high molecular weight polyamide 11 may be extruded with anti-oxidant employing barrel temperatures within the range 215 ° C to 277 ° C with a spinneret temperature of approximately 270 ° C. Continuous filament yarn of appropriate denier desirable for various layers of the batt of press felts can thus be extruded and later crimped and cut into staple fibre for batt manufacture and thereafter employed as a batt layer in press felts.

The advantage of the felts in accordance with the present invention is that such felts have superior durability due to enhanced resistance to fibre fibrillation and recovery from compression which result in compaction resistance. In addition to these advantages there is superior chemical resistance particularly resistance to hydrolysis and resistance to degradation of physical properties by hypochlorite and other oxidation. Such fibres in press felts exhibit superior durability against abrasion damage experienced with papers containing fillers especially including clay or crushed limestone. Such felts exhibit at least 50-100% greater lifetime in use in particularly hostile chemical and abrasive environments. These results are quite surprising and outstanding and would not have been expected from our previous experience with incumbent polyamide materials.

Following is a description by way of example only of methods and with reference to the accompanying drawings of carrying the invention into effect:-

In the drawings:-

Figure 1 is a photomicrograph of a compression test of a standard PA 6,6 fibre used in the manufacture of a paper machine felt.

Figure 2 is a photomicrograph of a fibre in accordance with the present invention.

EXAMPLE 1

Continuous filament of PA 11 was prepared according to the following procedure. Commercially available PA 11 was purchased as pellets from Rilsan Corp., New Jersey, having an intrinsic viscosity of 1.20 dl/g when determined in concentrated sulfuric acid. These polyamide pellets were vacuum dried at 80 ° C for 16 hours to a final vacuum measured outside the vacuum oven of 140 microns Hg. The pellets were transferred in a manner so as to avoid absorption of moisture from the air to a hopper of a single

screw extruder. The extruder was equipped with a 2.5 cm diameter low compression screw. The extruder was fitted with a filter pack of 55 micron nominal porosity. Downstream of the filter the extruder was fitted with a Zenith gear pump metering the melt to a spinneret. The spinneret had 30 holes, each hole of diameter 0.5 mm. The extruder had a temperature profile ranging from 243° C at the hopper throat to 271° C at the pump with 5 zones of independent temperature monitoring and control. The spinneret was maintained at 270° C. Filaments were extruded at approximately 195 ft/min with a maximum draw-down such that the radial change was approximately 7-8/1 between spinneret and the first Godet. Yarn was taken up on a cylinder attached to a Leesona winder after the Godet.

A typical fibre as-spun according to this procedure was drawn in two stages with a third stage of relaxation all with heat to provide an overall 2.3X draw ratio. The first temperature of drawing was at 110° C; relaxation occurred in the 2nd stage at 160° C. Fibre from such a process was prepared to be 12.8 dpf (denier per filament). Fibre thus prepared had 4.6 gpd tenacity with an initial modulus of 26 gpd and an elongation at break of 45%. The stress-strain curve exhibited a deflection at an elongation of 10% at 3.5 gpd specific stress.

Such fibre was crimped in a heated stuffer box crimper to provide continuous yarn with a variable random crimp with approximately 4 crimps/cm. It was cut into staple of approximately 7.0 cm length. Suoh fibre was carded, lapped and needled into a press felt to provide a batt structure at an overall batt weight of approximately 1000 g/m^2. A felt having such a batt structure exhibited at least 50% increased life in comparison to similar PA 6 felts when challenged with the same furnish on the same position on a paper machine.

EXAMPLE 2

Fibres were prepared as described in Example 1 with the following exceptions. Prior to drawing, pellets were tumbled with powdered Irganox 1098 (Ciba-Geigy) at a loading such that the blend would be 0.7% wt/wt. Pellets appeared to be uniformly coated with the powder antioxidant prior to transfer to the hopper. UV analysis of the as-spun fibre indicated a uniform concentration in several samples tested at a concentration of approximately 0.5% wt/wt.

EXAMPLE 3

Polyamide fibres produced in accordance with Example 1 were formed into a batt structure. Comparable filaments of a standard polyamide 6,6 currently used as an industry standard in the manufacture of paper machine clothing and commercially available under the trade reference T- 100 supplied by Dupont was formed into a similar batt. Each of the batts was then incorporated by needling to the backing of a test felt to be run on a compression test machine. The felt containing the two batt samples was installed on the test machine and the machine was run to pass the felt between a pair of nip rollers with a predetermined nip loading. The test felt was run on the compression tester for one million compressions. After the one million compressions, the felt was removed and the batt examined under an electron microscope.

The results are shown in Figures 1 and 2 of the accompanying drawings. The results were assessed on a scale of 1 to 5 by inspection and comparison against prepared standards and given a ranking accordingly. The DuPont polyamide 6,6 was given a ranking of 4.0 on a scale of 1 to 5 in which 5 is the worst. An examination of the photomicrographs will show extensive fibrillation and fracture of the flattened filaments. By comparison examination of the polyamide 11 candidate batt shows a marked lack of fibrillation of the fibres and with only flattening and some transverse fracture of some of the fibres. It was given a ranking of 3.3 on a similar scale as above.

The candidate fibre PA 11 was, therefore, in substantially better condition after a million compressions than the industry standard. This result was a significant improvement over and above that which would have been expected for polyamide 11 filaments.

Samples of commercial PA 6,6 fibre of instrinsic viscosity 1.36; commercial PA 6 fibre of instrinsic viscosity 1.46; staple fibre of Examples 1 and 2 above with fibre instrinsic viscosities of 1.05 and 1.12 respectively were each subjected to 35% hydrogen peroxide aqueous solution at pH2 and at 60° C for 24 hours. Retained IV results were as follows:

Candidates	Initial IV	Final IV	% Retained
Example 1 PA 11	1.05	0.87	83%
Example 2 PA 11/AO	1.12	0.97	87%
PA 6	1.47	0.49	31%
PA 6,6	1.36	0.62	47%

Claims

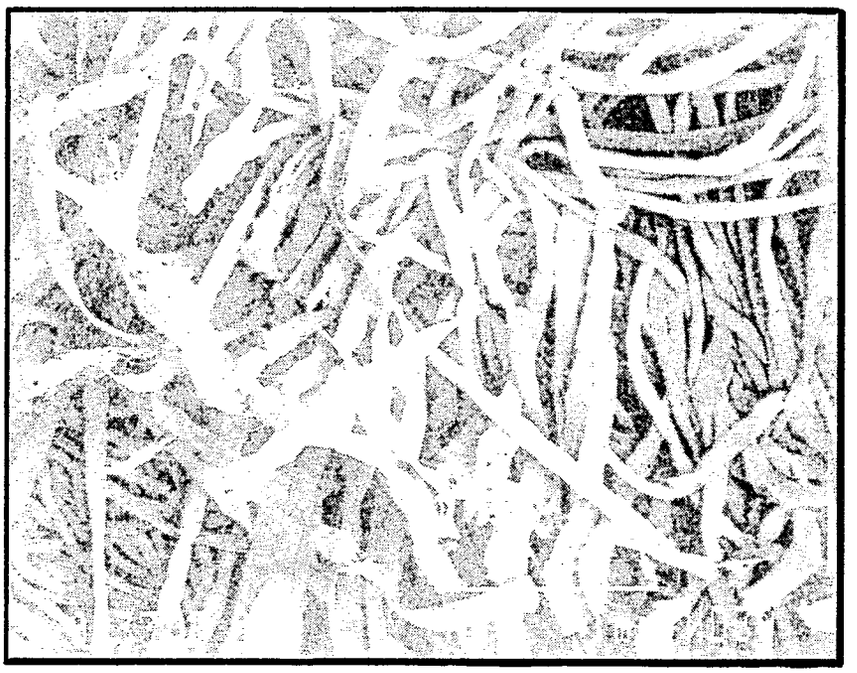
1. An article of paper machine clothing formed from a fibrous material having a woven base and an optional batt layer attached thereto characterised in that said fibrous material comprises fibres of poly-(undecanoamide) (polyamide 11) formed by the extrusion of a melt of polyamide 11 having an intrinsic viscosity of at least 1.0 dl/gram.

2. An article as claimed in claim 1 characterised in that the melt on extrusion contains 0.2 to 1.0% by weight of an anti-oxidant.

3. An article as claimed in claim 1 or claim 2 characterised in that the anti-oxidant is selected from one or more of alpha-tocopherol, condensation products of diphenylamine and acetone, condensation products of diphenylamine and compatible phenolic stabilisers with amide functionality.

4. An article as claimed in claim 2 or claim 3 characterised in that the anti-oxidant is present in an amount of 0.4 to 0.7% by weight.

5. A press felt as claimed in any preceding claim characterised in that said fabric comprises
a woven base and
a batt fibre structure attached thereto, said batt fibre structure comprising fibres of poly(undecanoamide) formed by extrusion of a melt having an intrinsic viscosity of at least 1.0 dl/gram and a fibre ranking after one million compressions in the compression test herein described of less than 3.6.

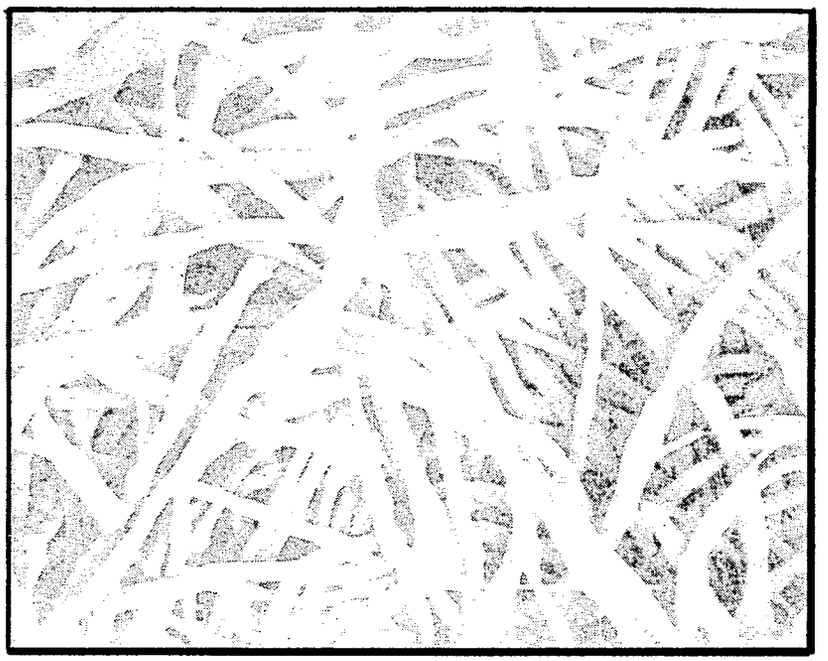


Standard PA 6,6
(DuPont T-100)

Test: GF #7
Damage after
1,000,000
compressions
Ranking=4.0

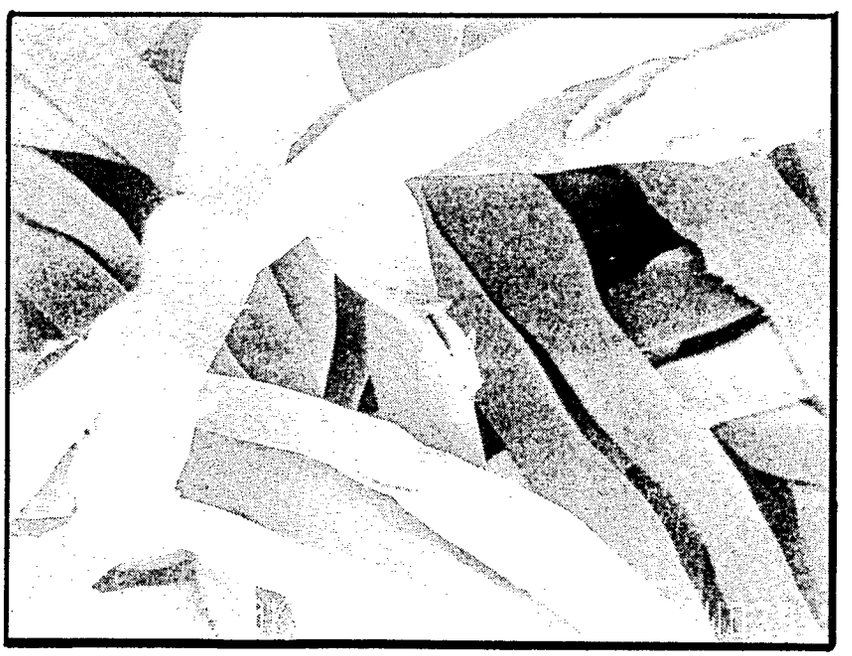
SEM Photomicrographs

FIG. 1



Candidate: PA 11

#3489-96-2



Test: GF #7
Damage after
1,000,000
compressions
Ranking=3.3

SEM Photomicrographs

FIG.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 31 2241

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	EP-A-0 070 708 (E.I. DU PONT DE NEMOURS)		D 21 F 7/08
D,A	EP-A-0 287 297 (ALBANY RESEARCH)		
A	BELA VON FALKAI: "Synthesefasern", 1981, Verlag Chemie, Weinheim, DE * Page 159, left-hand column, paragraph 2: "Polyamid 11" *		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
D 21 F D 01 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-02-1990	VAN GOETHEM G.A.J.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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