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(54) Filaments and hot gas filter.

(57) Melt-spun filaments are provided of a polymer capable of retaining its strength at a temperature of 170 °C. The filaments contain 5 to 25% by volume of an electrically conductive filler such as carbon. They can be used to form a filter for hot gases, for example as a fabric formed from a mixture of such filaments and filaments from such a polymer which do not contain conductive filler.

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FILAMENTS AND HOT GAS FILTER

This invention relates to filaments, and to filters and fabrics formed of such filaments and suitable for use in high-temperature filtration, especially the filtration of hot gases to remove solid particulate matter.

There may be an explosion risk in the filtration of hot gases, either because the gas is explosive in itself or because of a high dust level in the gas. The gas may be derived from a high-temperature chemical process or from heating apparatus, for example power station boilers, where the hot gas is filtered to remove fly ash. In some cases filters are manufactured from metal filaments or formed from fabrics which incorporate metal filaments to reduce static electric charge accumulation.

In GB-A-2,001,901 there is described an electrically conducting composite filament in which the conducting material is in the form of a radially extending portion (when seen in cross-section). However, the filament is only a low-temperature fibre such as a polyamide, polyester, polyvinyl, polyolefin, acrylic polymer, polyurethane or the like (see page 2 lines 40 to 52). None of these fibres is capable of withstanding temperatures much in excess of 140° C on a continuous basis.

In GB-A-2,077,182 there is described a composite filament which is given electrical conductivity by the incorporation of conductive metal oxides. Although a wide variety of polymers is described as binders for the conductive metal oxide particles, such as polyamides, polyethylene terephthalate, polybutylene terephthalate, polyethylene oxybenzoate, polyolefins, polyethers, vinyl polymers, polycarbonates and copolymers and mixtures of such polymers, none of these is capable of operating at elevated temperatures above 170° C. Particular crystalline forms of the polymers are identified on page 1 lines 40-53.

In GB-A-2,003,084 there is described bifilar (side-by-side) filaments in which one of the filament portions contains an electrically conducting filler. The filaments are, however, formed of low temperature material such as normal polyamide, polyester, polyalkene, poly(mod)acrylic, wool or cotton - see page 1 lines 5 to 9.

In GB-A-2,036,638 there is described an antistatic multicomponent conjugate fibre structure, typically formed of a polyester or a polyamide.

Filaments according to the invention are melt-spun filaments of a polymer capable of retaining its strength at a temperature of 170° C and are characterised in that the filaments contain 5 to 25% by volume of an electrically conductive filler.

A filter according to the invention for hot gases is formed from filaments of a polymer capable of retaining its strength at a temperature of 170° C and containing 5 to 25% by volume of an electrically conductive filler.

Preferably, the filaments are capable of retaining strength at temperatures in the range 170° C to 270° C. The filaments are preferably resistant to mineral acids, steam, organic solvents and oxidising agents.

The polymer from which the filaments are formed is preferably a polyether ether ketone, for example that sold by Imperial Chemical Industries plc as PEEK, a polyether imide, for example that sold under the trademark "Ultem", a polyether ketone, a polyether sulphone, a polyphenylene sulphide or a liquid crystal aromatic polyester, for example that sold under the trademark "Vectra". The polymer may alternatively be a polyketone, for example that sold under the trademark "Zyex" by Imperial Chemical

Industries plc, or a polyimide, for example that sold under the trademark "P84" by Lenzing AG. The maximum temperature of continuous use of these polymers, i.e. the maximum temperature at which they retain their strength, is generally in the range 170 to 270° C. The temperature of 170° C has been selected as being approximately 10° C above the maximum dew point of sulphurous acid, the acid formed by the solution of SO_2 in water and a common component in acid hot gases to be filtered.

The electrically conductive filler is preferably carbon black used at 10 to 40% by weight, preferably 20 to 33% by weight. The particle size of the carbon black is preferably in the range 0.5 to 10 nm. Other particulate conductive materials such as metal powders can be used as filler. The use of an electroconductive filler reduces the risk of a spark giving rise to an explosion.

Polyether ether ketones containing electroconductive filler can be melt-spun at a temperature of 380 to 430° C as described in Disclosures Nos. 216001 and 216002 in the magazine "Research Disclosures". Polyether imides can be melt-spun at a temperature of 360 to 440° C. Polyether ketones can be melt-spun at a temperature of 420 to 500° C. Polyether sulphones can be melt-spun as described in US-A-3373720. Polyphenylene sulphides can be melt-spun as described in GB-A-1420176. "Vectra" liquid crystal aromatic polyester can be melt-spun at a temperature of 280 to 340° C. The filled polymers can be melt-spun using the apparatus described in EP-A-298,767, particularly if they contain 10% or more by volume of the filler.

The filaments are preferably of non-circular cross-section, for example trilobal Y-shaped and other multilobal filaments. Such multilobal cross-section fibres have improved filtration efficiency. They can be formed by extrusion through a spinnerette having appropriately shaped orifices.

The filaments can be bicomponent filaments, for example with a sheath of polyether ether ketone, which has very good chemical and heat resistance, and a core of a less-expensive heat-resistant polymer such as polyether imide. The sheath of a core/sheath bicomponent yarn should contain conductive filler in the amount specified. The core may or may not contain conductive filler. Similarly a polyether ether ketone coating can be applied to a fibre of another temperature-resistant polymer. In this case both core fibre and coating preferably contain conductive filler.

By way of example embodiments of the present invention will now be described with reference to the accompanying drawing, which is a perspective view of a filter bag in use.

With enhanced concern for environmental emissions, increasingly, emissions of gases are having to be filtered prior to release into the atmosphere. In some cases the gases are at ambient temperature and contain only non-aggressive materials such as stone dust. However, there are certain cases in which the gases are at well above ambient temperature and may additionally contain aggressive chemicals in vapour form as well as particulate material to be filtered out.

It is well known that both moving gases and moving particles can generate static electricity. In many cases the amount of static electricity generated is small, so small as to be insignificant. In some cases although larger quantities of static electricity are generated neither the gases nor the particles in the gas are explosive or inflammable, in which case no action needs to be taken other than merely filtering the gas.

There are, however, certain circumstances in which either the particulate material to be filtered is potentially explosive or the gas itself passing through the filter is potentially explosive. In these circumstances either the filter material itself has to be formed as electrically conducting or, commonly, electrically conducting fibres of metal are intermingled into the filter cloth to produce a filter capable of discharging static electricity.

It will be appreciated that with a non-woven filter material, such as a needle felt, spun-bonded or hydroentangled fabric, the electrically conductive fibres of stainless steel can be incorporated into the cloth during the fabrication stage. Because of the potentially chemically aggressive environment in which the filter operates, it is necessary to use stainless steel fibres and these fibres are both expensive and relatively stiff and difficult to handle. Furthermore, unless great care is taken to ensure that the stainless steel fibres are uniformly distributed through the fabric there is a possibility that in certain areas the fabric could be deficient in conducting fibre or even possibly completely lacking conducting fibre.

The accompanying drawing shows in general terms a pipe 1 through which gas to be filtered flows in two streams ?5 in the direction of arrows 2, 3. The converging gas streams are then passed outwardly through a further pipe 4 which forms a tee from the pipe 1. The arrangement is such that the gas streams pass through a stub 5 and a filter bag 6 prior to entering a main chamber 7 of the pipe 4.

It can be seen, therefore, that by the provision of the filter bag 6 the dust entrained in the gas at 2, 3 can be removed before it enters the tube 4.

By manufacturing the filter 6 from a filament or fibre of a temperature-resistant material, for example filament or fibre capable of resisting temperatures in the range 170 to 270° C, the filament or fibre having electrically conducting properties, the risk of static build-up can be avoided.

A preferred fibre material for the filaments comprises a polyphenylene sulphide containing carbon particles. The polyphenylene sulphide material is chosen for its resistance to the chemicals found in gases conventionally filtered and its ability to retain a sufficient strength at elevated temperatures for continuous operation to be possible at temperatures up to 190° C.

By incorporating carbon particles in the polyphenylene sulphide (PPS), the filaments or fibre can be made electrically conducting to such an extent as to enable filters to be formed from it which are able to conduct away or dissipate static electricity and prevent the build-up of an electrical charge on the filter bag. Typically, carbon black is used for the filler material, although other forms of carbon such as microfine graphite or delaminated graphite can be used. Delaminated graphite can be formed by boiling graphite in concentrated sulphuric acid and filtering off the delaminated graphite particles. If required, the delaminated graphite can be ground to a sufficient level of fineness for easy incorporation into the melt-spun polymer material.

In addition to retaining strength at appropriate operating temperatures of the filter it is important that the filament or fibre be resistant to the materials normally encountered during the use of a filter. Thus the alkali resistance, the acid resistance and the oxidation resistance of the materials are important, as is the organic solvent resistance. Additionally, because a filter material will be subject to impact by the particles contained in the gas being filtered, the abrasion resistance of the material is important. It will also be appreciated that the filament or fibre should have sufficient tensile strength to enable it to be incorporated in filter bags without the filter bags being of unacceptable weakness.

Thus some fibre materials which might be thought to be suitable for filter bags such as glass fibre, are in fact unsuitable, either because they cannot incorporate an electrically conducting filter such as carbon or because their abrasion resistance is poor.

Following a long analysis of all of the potential fibre materials, those which are preferable are listed in the Table below, which is a Table of fibre materials and a list of properties including maximum operating temperature, alkali resistance, acid resistance, oxidation resistance, organic solvent resistance, abrasion resistance, and tensile strength. In some cases information about the properties is not available and gaps in the Table indicate that either information is absent or test results are not available.

The filter can be in the form of a woven, knitted or non-woven fabric and can be formed from continuous filaments or staple fibres. Examples of non-woven fabrics are air-laid, water-laid, needle-felted, spun-bonded and hydroentangled fabrics. The filaments containing electrically conductive filler need not be the only fibres or filaments in the fabrics, for example a woven fabric can include yarns which do not contain conductive filler or a non-woven fabric can contain filaments or fibres which do not contain conductive filler. Such non-conductive yarns, fibres or filaments used in the filters of this invention will generally also be formed of a polymer capable of retaining its strength at a temperature of 170° C, for example the polymers described above.

TABLE

Fibre material	Maximum Operating Temp. °C	Alkali Resistance	Acid Resistance	Oxidation Resistance	Organic Resistance	Abrasion Resistance	Tensile Strength
Polyphenylene Sulphide	190°	Good	Good	Average	Good	Good	Very Good
Polyether imide	170°	Average	Average	Average	Average		Very Good
Polyketone	240°	Good	Good	Good	Good		
Polyimide	195°	Average	Good	Good	Good		
Liquid Crystal aromatic Polymer	190°	Good	Good		Good		Very Good
Polyether ether ketone	250°	Good	Good	Good	Good	Good	Excellent
Polyether Ketone	260°	Good	Good		Good		

Claims

1. Melt-spun filaments of a polymer capable of retaining its strength at a temperature of 170 °C, characterised in that the filaments contain 5 to 25% by volume of san electrically conductive filler.

2. Filaments as claimed in claim 1, characterised in that the maximum temperature at which they retain strength is in the range 170 to 270 °C.

3. Filaments as claimed in claim 2, characterised in that the polymer is selected from polyether ether ketones, polyether imides, polyether ketones, polyether sulphones, polyphenylene sulphides, polyketones, polyimides and liquid crystal aromatic polyesters.

4. Filaments as claimed in any of claims 1 to 3, characterised in that the filaments are core/sheath bicomponent filaments in which the sheath contains 5 to 25% by volume of an electrically conductive filler.

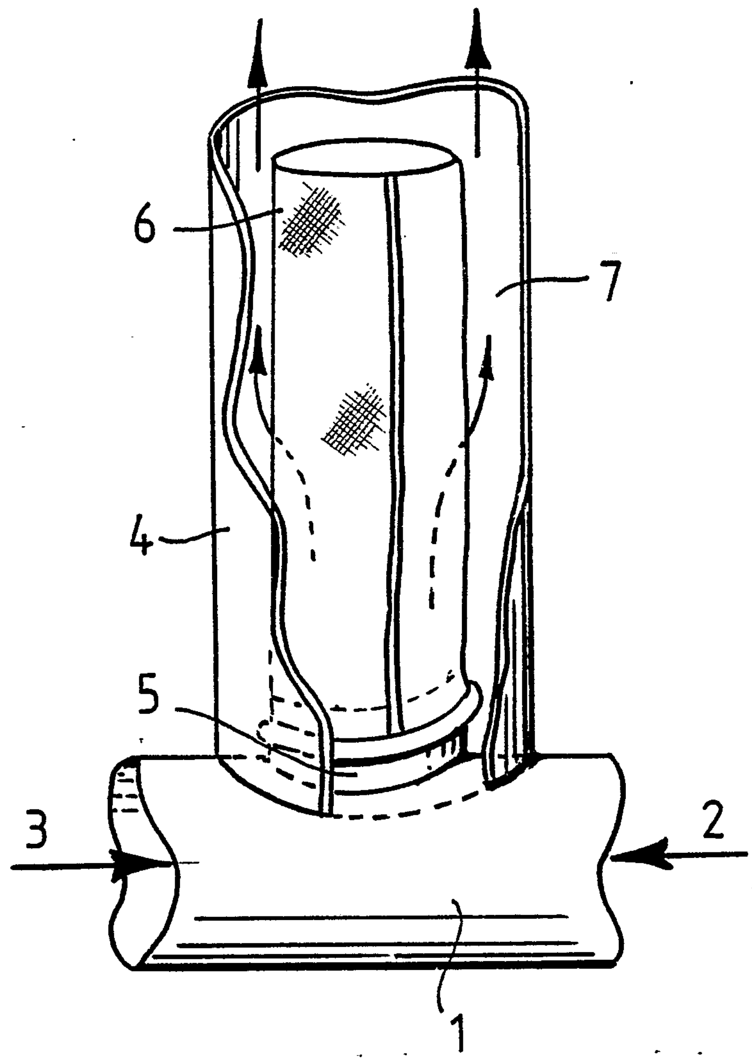
5. Filaments as claimed in any of claims 1 to 4, characterised in that the electrically conductive filler is carbon black.

6. A filter for hot gases, characterised in that it is formed from filaments of a polymer capable of retaining its strength at a temperature of 170 °C and containing 5 to 25% by volume of an electrically conductive filler.

7. A filter as claimed in claim 6, characterised in that the filter is a fabric formed from a mixture of the said filaments containing electrically conductive filler and filaments of a polymer capable of retaining its strength at a temperature of 170 °C which do not contain electrically conductive filler.

8. A filter as claimed in claim 6 or 7, characterised in that the filaments containing electrically conductive filler are filaments in accordance with any of claims 2 to 5.

9. A filter according to any of claims 6 to 8, characterised in that the filaments containing electrically conductive filler are formed of polyphenylene sulphide containing carbon particles.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