

SPECIFICATION

Moulding composition

5 This invention relates to thermoplastic moulding compositions and in particular to thermoplastic moulding compositions for forming moulded components intended for use in aqueous environments.

10 The invention particularly relates to the use of such compositions to form movable parts of fluid flow meters.

Generally in fluid flow meters a movable,

15 e.g. rotatable component located inside a measuring chamber unit is actuated by inflowing fluid and movement e.g. revolution of the component is detected and the quantity of fluid flowing through the meter estimated from the detected movement. The chamber

20 unit may for example, be formed from metal or moulded thermoplastic. For efficient, accurate functioning of the meter and to ensure a long life thereof both chamber and moving component should be formed of very wear-

25 resistant materials having low coefficients of frictional resistance. The movable component, which may, for example, be a piston or swashplate and also the chamber must be dimensionally stable in water with virtually no water absorption.

30 At present the movable components of fluid flow meters are manufactured from various different materials, which have various drawbacks. For example, hard rubber such as

35 Ebonite or Vulcanite is widely used and has the required physical properties of dimensional stability in aqueous environments and low coefficients of friction and movable components made from it are very resistant to wear in both metal and plastic chambers.

40 However, the raw material is expensive, and the cost of producing intricately shaped components is high since hard rubber cannot readily be moulded to form such shapes. Thus in practice, since hard rubber cannot be accurately moulded a rough blank is first produced by moulding and subsequent machining operations are necessary which can be time-consuming and expensive to carry out.

50 Two further materials which have been used are nylon and Noryl (RTM) (a compound of polyphenylene oxide). Both of these materials are cheaper than hard rubber and can be moulded to form intricate shapes, but their

55 properties are less suitable for the required application. Thus in water even low water adsorption grades of nylon increase in length by at least 0.5%. Similarly components compounded from PPO are stable in water but they are less wear resistant than hard rubber and have greater frictional resistance, resulting in lower metering accuracy at low flow rates.

65 Experiments were carried out using known moulding compositions to try to find a ma-

terial suitable for forming movable components of fluid flow meters by moulding, but none was found which fulfilled the requirements of (a) being a thermoplastic composition which can be moulded to a dimensional accuracy of 0.1%; (b) having a stability in aqueous environments such that the change in length of the moulded component due to water absorption is less than 0.1%; (c) the

70 ability to form a component which can function in water up to a temperature of 50°C and not degrade in tropical conditions; (d) having low frictional resistance and good wear resistance when used in typical chamber units,

75 and (e) having good strength and impact resistance.

We have now developed a moulding composition which enables intricately moulded components, such as movable components of

85 fluid flow meters to be moulded in a straightforward manner and which furthermore satisfies the above requirements to a greater extent than moulding compositions available hitherto.

90 Thus according to the present invention there is provided a thermoplastic moulding composition comprising a major proportion of a thermoplastic styrene based polymeric material having dispersed therein at least 5% by

95 weight, based on the total weight of the composition of PTFE particles, said PTFE particles being of a generally granular nature having an average particle size in the range of 1 to 10 μm with not more than 1% of the

100 PTFE particles having sizes greater than 50 μm and wherein the maximum transverse dimension of the PTFE particles does not differ significantly from their minimum dimension. Preferably, the composition contains between

105 5 and 30% by weight of PTFE particles. To obtain the combined advantages of cheapness and good wear and frictional resistance for components moulded from the composition the range should be 5 to 15%, and more

110 advantageously 8 to 12%. In order for components moulded from the composition to have particularly good wear and frictional resistance, PTFE with average size 2 to 10, preferably 5 to 7 μm , are not more than 1%

115 larger than 35 μm are dispersed throughout the styrene, which is preferably a high-impact grade.

Although the precise shape of the particles is not unduly critical, it is to be understood

120 that the PTFE particles used in preparing compositions according to the invention are of a shape such that the maximum transverse dimension of the individual particles does not differ significantly from their minimum dimension. Preferably the length/breadth ratio of each particle is not greater than 2:1, and most preferably is not greater than 1.5:1.

125 The preferred particles may thus be regarded as being granular in nature, i.e. in the form of irregular beads, spheres, cubes, etc.

Any gross departures from a granular nature can result in the moulding composition having undesirable flow properties, for example the heated composition may exhibit a degree of melt elasticity, which is undesirable since it can result in moulding inaccuracies.

Moulding compositions according to the invention may be produced by admixing the styrene-based polymeric material and the PTFE, heating the mixture to form a generally homogeneous plasticised mass of styrene-based polymeric material in which the PTFE particles are uniformly dispersed and granulating said mass.

Moulding compositions according to the invention are of particular utility in forming components of mechanisms adapted for operation in aqueous environments and such components form further aspects of the invention. Particular examples of such components are components of fluid flow meters, especially movable components thereof.

Thus according to a further aspect of the invention there is provided a fluid flow meter comprising a chamber through which in use of the meter fluid being metered passed and a movable component actuable by fluid flow located within said chamber characterised in that at least one of the chamber and the movable component is formed from a styrene-based polymeric material having dispersed therein at least 5% by weight, based on the total weight of the composition of PTFE particles. Preferably the movable component is formed from said styrene-based polymeric material.

The production and testing of moulding compositions according to the invention will now be described in the following Example.

EXAMPLE

High impact polystyrene in granule form was admixed with PTFE particles which were of a granular nature and had an average size between 5 and 7 μm , containing less than 1% larger than 35 μm . The length: breadth ratio of the particles was less than 1.5:1.

The PTFE granules were uniformly dispersed in the polystyrene and the admixture heated to form a homogeneous plasticised mass. This mass was passed into a screw extruder heated to a temperature above the softening point of the polystyrene. The resulting extrudate was cooled and chopped into granules suitable for use in moulding operations. Moulding compositions containing 5, 10, 15, 20, 25 and 30% of PTFE particles by weight of the composition were prepared in this way.

Each moulding composition was moulded in a conventional moulding apparatus to form pistons for use in water meters.

A typical piston is illustrated in Fig. 1 of the accompanying drawings and the piston is shown in cross section in Fig. 2. Fig. 3

illustrates a water meter with the piston located within. The piston, generally indicated by the numeral 1, comprises a unitary moulding consisting of a cylindrical peripheral portion 3 and a flat, circular, plate-like portion 5, lying midway between the ends of the cylinder perpendicular to the central longitudinal axis thereof. A short cylindrical moulded stem 7 extends from one side of the plate, in line with the central axis and a metal pin 8 extends on the opposite side of the plate in line with the moulded stem. The plate has a pear shaped opening 9 extending from an axially extending slot 11 formed in cylindrical portion 3, towards the central stem 7. The plate-like portion 5 is provided with a series of circular holes 15 arranged generally symmetrically with relation to opening 9 in a horse-shoe-like pattern. The cylindrical portion has four elongate holes 17, which lie in pairs on opposite sides of the longitudinal slot. These are generally rectangular in shape, with rounded ends, and have their straight edges parallel to the slot.

Measurement of the pistons revealed that all the moulding compositions could be moulded to an accuracy between than 0.1%, and furthermore the moulded pistons were suitable for use in water without the need for machining. The pistons were tested in a water meter to see whether they fulfilled the requirements (b) to (e) listed above.

The meter used for the tests is illustrated in Fig. 3 and comprises a chamber housing 38 provided with a water inlet 34. A pressure plate 39 is screwed to the chamber housing and a synthetic rubber 'O' ring seal is clamped between the two parts. A counter housing 36 is located over the pressure plate 39 and is retained by two plastic keys (not shown). The chamber housing 38 houses a thermoplastic chamber unit 40 having inlet and outlet ports (not shown) at the top and bottom of the chamber, respectively. A division shutter 42 within the chamber unit slots into the wall of the unit and extends into the pear shaped opening of piston 1. The pin 8 of the piston engages with a dog drive coupling 44. This in turn engages with a combined reduction gear unit and counter 46, located within the counter housing 36. Motion of the piston in use of the meter is thus transmitted to the counter, which may be read from a visual scale 48. The combined gear unit and counter 46 is brought into sealed engagement with the counter housing 36 by means of a second 'O' ring seal.

The operation of the meter will now be described with reference to Figs. 4 A-D of the accompanying drawings which diagrammatically illustrate water flow during a single cycle of the piston 1 in the chamber unit 40. The motion of stem 7 of the piston 1 is restricted by a guide comprising a cylindrical guide peg 50 and an outer cylindrical guide portion 52.

The guide is connected to and extends upwards from the floor of the chamber unit, and it will be seen that in each cycle the stem 7 of the piston moves in a complete circle around the cylindrical guide peg 50. Division shutter 42 slots into the chamber unit 40 and the guide portion 52, and passes through longitudinal slots 11 of the piston and into the pear-shaped opening of the plate portion. The chamber unit also has an inlet port 54 at the top of the chamber and an outlet port 56 at the bottom. In Fig. 4, water flowing into the chamber is shown dotted, water flowing out is shown hatched, and neutral water, i.e. water which is isolated from the inlet and outlet ports by the piston, is shown by the more lightly dotted shading. In Fig. 4A water flowing into the chamber through inlet port 54 causes the piston to start its eccentric rotary motion, sliding against division shutter 42 and the inner cylindrical wall of chamber unit 40. At the same time, water is expelled from the chamber through outlet port 56.

In Fig. 4B, the piston has moved through a quarter of a cycle. Water continues to flow into the piston, filling most of its volume, and also begins to fill part of the chamber unit, at 58. Water from the remainder of the chamber unit and piston is being expelled through the outlet port. In Fig. 4C, the piston has moved through half of its cycle. The piston is now filled with neutral water 60, and water is entering and leaving the chamber through inlet and outlet ports at sides 62 and 64 respectively of the shutter 42. When three quarters of the cycle has been completed, as shown in Fig. 4D, water is beginning to flow from the inlet port into the piston, leading up to completion of the cycle.

During each cycle of the piston a predetermined quantity of water passes into and out of the meter. The dog drive coupling engaging with the piston pin 8 transmits the piston motion to the reduction gear and counter, which therefore indicates the quantity of water passing through the meter.

As a result of the tests it was found that the pistons formed from each of the moulding compositions described above performed satisfactorily, giving accurate performance even at low flow rates. Also the pistons were resistant to wear and dimensionally stable in water.

Although the use of moulding compositions according to the invention has been particularly described with reference to water meters having movable pistons which execute eccentric rotary motion, other applications are of course possible. Thus, for example, the moulding compositions of the invention may be used in the construction of flow meters in which the fluid-actuated movable component is a swash-plate.

Also they may be used in the construction of other devices which operate in aqueous

environments such as for example, pumps.

CLAIMS

1. A thermoplastic moulding composition comprising a major proportion of a thermoplastic styrene-based polymeric material having dispersed therein at least 5% by weight, based on the total weight of the composition of PTFE particles, said PTFE particles being of a generally granular nature having an average particle size in the range of 1 to 10 μm with not more than 1% of the PTFE particles having sizes greater than 50 μm and wherein the maximum transverse dimension of the PTFE particles does not differ significantly from their minimum dimension.
2. A composition as claimed in claim 1 containing from 5 to 30% by weight, based on the total weight of the composition of PTFE particles.
3. A composition as claimed in Claim 1 containing from 5 to 15% by weight, based on the total weight of the composition of PTFE particles.
4. A composition as claimed in Claim 1 containing from 8 to 12% by weight, based on the total weight of the composition of PTFE particles.
5. A composition according to any preceding claim wherein the PTFE particles have an average particle size in the range of 2 to 10 μm .
6. A composition according to Claim 5 wherein the PTFE particles have an average particle size in the range of 5 to 7 μm and not more than 1% have particle sizes greater than 35 μm .
7. A composition according to any preceding claim wherein the length:breadth ratio of the particles is not greater than 2:1.
8. A composition according to Claim 11 wherein the length:breadth ratio of the particles is not greater than 1.5:1.
9. A composition according to any preceding claim wherein the styrene-based polymeric material comprises a high-impact grade of polystyrene.
10. A method of producing a moulding composition according to any preceding claim which comprises admixing the styrene-based polymeric material and the PTFE, heating the mixture to form a generally homogeneous plasticised mass of styrene-based polymeric material in which the PTFE particles are uniformly dispersed and granulating said mass.
11. A method according to Claim 10 wherein said mass is extruded and the extrudate chopped.
12. A moulded article formed by moulding a composition according to any one of Claims 1 to 9.
13. A mechanism adapted for operation in an aqueous environment characterised by having at least one component thereof formed by moulding a composition according to any one



The guide is connected to and extends upwards from the floor of the chamber unit, and it will be seen that in each cycle the stem 7 of the piston moves in a complete circle around the cylindrical guide peg 50. Division shutter 42 slots into the chamber unit 40 and the guide portion 52, and passes through longitudinal slots 11 of the piston and into the pear-shaped opening of the plate portion. The chamber unit also has an inlet port 54 at the top of the chamber and an outlet port 56 at the bottom. In Fig. 4, water flowing into the chamber is shown dotted, water flowing out is shown hatched, and neutral water, i.e. water which is isolated from the inlet and outlet ports by the piston, is shown by the more lightly dotted shading. In Fig. 4A water flowing into the chamber through inlet port 54 causes the piston to start its eccentric rotary motion, sliding against division shutter 42 and the inner cylindrical wall of chamber unit 40. At the same time, water is expelled from the chamber through outlet port 56.

In Fig. 4B, the piston has moved through a quarter of a cycle. Water continues to flow into the piston, filling most of its volume, and also begins to fill part of the chamber unit, at 58. Water from the remainder of the chamber unit and piston is being expelled through the outlet port. In Fig. 4C, the piston has moved through half of its cycle. The piston is now filled with neutral water 60, and water is entering and leaving the chamber through inlet and outlet ports at sides 62 and 64 respectively of the shutter 42. When three quarters of the cycle has been completed, as shown in Fig. 4D, water is beginning to flow from the inlet port into the piston, leading up to completion of the cycle.

During each cycle of the piston a predetermined quantity of water passes into and out of the meter. The dog drive coupling engaging with the piston pin 8 transmits the piston motion to the reduction gear and counter, which therefore indicates the quantity of water passing through the meter.

As a result of the tests it was found that the pistons formed from each of the moulding compositions described above performed satisfactorily, giving accurate performance even at low flow rates. Also the pistons were resistant to wear and dimensionally stable in water.

Although the use of moulding compositions according to the invention has been particularly described with reference to water meters having movable pistons which execute eccentric rotary motion, other applications are of course possible. Thus, for example, the moulding compositions of the invention may be used in the construction of flow meters in which the fluid-actuated movable component is a swash-plate.

Also they may be used in the construction of other devices which operate in aqueous

environments such as for example, pumps.

CLAIMS

1. A thermoplastic moulding composition comprising a major proportion of a thermoplastic styrene-based polymeric material having dispersed therein at least 5% by weight, based on the total weight of the composition of PTFE particles, said PTFE particles being of a generally granular nature having an average particle size in the range of 1 to 10 μm with not more than 1% of the PTFE particles having sizes greater than 50 μm and wherein the maximum transverse dimension of the PTFE particles does not differ significantly from their minimum dimension.

2. A composition as claimed in claim 1 containing from 5 to 30% by weight, based on the total weight of the composition of PTFE particles.

3. A composition as claimed in Claim 1 containing from 5 to 15% by weight, based on the total weight of the composition of PTFE particles.

4. A composition as claimed in Claim 1 containing from 8 to 12% by weight, based on the total weight of the composition of PTFE particles.

5. A composition according to any preceding claim wherein the PTFE particles have an average particle size in the range of 2 to 10 μm .

6. A composition according to Claim 5 wherein the PTFE particles have an average particle size in the range of 5 to 7 μm and not more than 1% have particle sizes greater than 35 μm .

7. A composition according to any preceding claim wherein the length:breadth ratio of the particles is not greater than 2:1.

8. A composition according to Claim 11 wherein the length:breadth ratio of the particles is not greater than 1.5:1.

9. A composition according to any preceding claim wherein the styrene-based polymeric material comprises a high-impact grade of polystyrene.

10. A method of producing a moulding composition according to any preceding claim which comprises admixing the styrene-based polymeric material and the PTFE, heating the mixture to form a generally homogeneous plasticised mass of styrene-based polymeric material in which the PTFE particles are uniformly dispersed and granulating said mass.

11. A method according to Claim 10 wherein said mass is extruded and the extrudate chopped.

12. A moulded article formed by moulding a composition according to any one of Claims 1 to 9.

13. A mechanism adapted for operation in an aqueous environment characterised by having at least one component thereof formed by moulding a composition according to any one



of Claims 1 to 9.

14. A fluid flow meter characterised by having at least one component thereof formed by moulding a composition according to any one of Claims 1 to 9.

15. A fluid flow meter as claimed in Claim 14 wherein said component is a movable part which in use of the meter operates in contact with the fluid being metered.

16. A fluid flow meter as claimed in Claim 15 wherein said component is actuated by the fluid being metered.

17. A fluid flow meter as claimed in Claim 15 wherein said component is a piston.

18. A fluid flow meter as claimed in Claim 15 wherein said component is a swash plate.

19. A fluid flow meter comprising a chamber through which in use of the meter fluid being metered passes and a movable component

actuable by fluid flow located within said chamber characterised in that at least one of the chamber and the movable component is formed from a styrene-based polymeric material having dispersed therein at least 5% by

weight, based on the total weight of the composition of PTFE particles, said PTFE particles being of a generally granular nature having an average particle size in the range of 1 to 10 μm with not more than 1% of the

PTFE particles having sizes greater than 50 μm and wherein the maximum transverse dimension of the PTFE particles does not differ significantly from their minimum dimension.

20. A fluid flow meter as claimed in Claim 19 wherein the movable component is formed from said PTFE-containing styrene-based polymeric material.

21. A fluid flow meter as claimed in Claim 19 wherein said movable component comprises a rotary piston.

22. A fluid flow meter as claimed in Claim 19 wherein said movable component comprises a swash plate.

23. A fluid flow meter as claimed in any one of Claims 19 to 22 wherein said movable component has a composition as defined in any one of Claims 2 to 9.