

SPECIFICATION

Improvements in or relating to injection moulding

5 This invention relates to injection moulding and more particularly to a method of injection moulding plastics materials in which colour dispersion in the plastics materials is maximized and inclusion of visible carbonized particles is minimized. The invention also relates to a nozzle assembly for use with an injection moulding apparatus to carry out such a method.

5

At the present time a large number of plastics products are formed by the injection moulding of that family of plastics known as polyolefins. Included in this category are polyethylene, polypropylene, linear polyethylene, copolymers, and styrene. The injection moulding of such plastics products results in the generation of a large amount of scrap material which, at the present time is generally discarded as waste because of either one or both of two factors which would so impair the appearance of the products made from such material as to render them unsalable.

10

15 The first such factor concerns colour or dye dispersion. Should the scrap material contain pigments or any material having a colour that is noticeably different from the main colour of the product, then injection moulding will cause streaking, cloudiness, spotting, and blurring in the final product. Such colour dispersion can impair the appearance of the product to a degree which will render it unsalable.

15

The second factor is carbonization or the presence of small particles of carbon which can also impair the appearance of the final product to a degree which will render it unsalable. While the imperfect dispersion of colour is an important reason for a product rejection, the presence of carbon particles or specks is in general the main cause of product rejection. The test of whether or not carbon particles are of a size to result in product rejection is whether or not they are visible to the naked eye. If they are visible, then they are of a size which results in product rejection. It is estimated that carbon particles or specks of a size greater than 0.0006cm² (0.010 square inch) would be visible and therefore objectionable. It is an object of the invention to provide a method of injection moulding plastics materials in which the above mentioned disadvantages of present injection moulding methods with regard to the dispersion of colour in the plastics materials and the presence of carbon particles in the plastics material are diminished. It is also an object of the invention to provide an injection moulding nozzle assembly for use in such a method.

20

25

30 According to an aspect of this invention there is provided a method of injection moulding plastics materials, said method comprising the steps of introducing a plastics material containing carbon particles visible by the naked human eye into an injection moulding apparatus, heating the plastics material to a molten condition, forcing the plastics material in a molten condition and under pressure through a screen pack, comprising a breaker plate having relatively large apertures therein, and a fine screen having openings smaller than said apertures, at least some of the said openings each being adapted both to filter carbon particles and also to break up carbon particles so that the said visible carbon particles are broken up into smaller particles, and then through an injection nozzle for subsequent moulding.

30

35

According to another aspect of this invention there is provided a nozzle assembly for an injection moulding apparatus for plastics materials said nozzle assembly comprising nozzle means having in inlet aperture, a passageway extending therethrough and an ejection orifice and said nozzle means being adapted to be connected to a source of supply of molten plastics material so as to complete a through flow conduit from said supply to said ejection orifice, and a breaker plate and a fine screen each adapted to be mounted relative to said nozzle means so as to lie across said conduit when said nozzle means is connected to said source, said nozzle means being adapted to cooperate with said plate and screen to maintain them in position across said conduit, said breaker plate having a plurality of apertures formed therein and said fine screen having a plurality of openings formed therein, which are smaller than the apertures in said breaker plate.

40

45

The present invention concerns a method of and apparatus for aiding colour dispersion and eliminating the presence of carbon particles in the products of injection moulding. The plastics materials intended to be moulded are frequently scrap and are discarded as waste under present injection moulding conditions because in many instances colour irregularities and the presence of carbon particles in the products made from this scrap material would render them unsalable.

50

The particular plastics materials which it is proposed to use with the instant method and apparatus are plastics of the family of polyolefins and particularly polyethylene, polypropylene, linear polyethylene, copolymers, and styrene.

55

Advantageously the nozzle assembly comprises an injection nozzle having a cylindrical bore extending throughout a portion of its extent and terminating at one end in a jet orifice and at its other end in a frusto-conical recess. The end portion of the injection nozzle at the larger end of this recess is conveniently screw threaded and preferably the nozzle is formed with wrench-engaging means adjacent to the threaded portion.

60

Advantageously a screen pack retainer is provided which is formed with a socket, an end portion of which is internally screw-threaded and into which the threaded portion of the injection nozzle is screwed. Preferably the screen pack retainer is formed with a bore of reduced diameter as compared to the socket with a shoulder between this bore and the socket and advantageously this bore communicates with an inlet for molten plastics material by way of a frusto-conical recess and a second bore of smaller diameter.

65

Conveniently the breaker plate and fine screen may be mounted in the socket of the screen pack retainer between the shoulder therein and the screw threaded end of the injection nozzle. This breaker plate may advantageously have a circular recess in the face confronting the nozzle, the fine screen being snugly received in this recess, and preferably a second breaker plate may be provided to overlie the fine screen and marginal portions of the first breaker plate.

Advantageously when two breaker plates are provided there are mounted in the marginal portions of the first breaker plate and extending forwardly, that is, toward the injection nozzle, a pair of diametrically opposed dowel pins which are received in openings in apertures in the marginal portions of the second breaker plate. These dowel pins result in correct alignment of the breaker plates and fine screen when the injection nozzle is screwed into the screen pack retainer to clamp the breaker plates together, with the fine screen sandwiched therebetween.

Each breaker plate may conveniently be formed with 121 0.157 cm diameter (0.062 inch diameter) holes that allow flow through the screen pack. While the fine screen is subject to variation in the number and size of the openings therein, it is to be noted that a suitable screen pack for many applications may comprise two 20 x 20 mesh screens with one 24 x 110 mesh dutch weave screen sandwiched therebetween. The dimensions of 20 x 20 and 24 x 110 refer to the number and arrangement of openings per square 2.54 cms (per square inch) in each of these screen elements.

In performing a method using the above injection nozzle assembly, it is important that the injection nozzle be brought to a barrel temperature suitable for the particular plastics material to be injected. Moreover, the injection pressure which is applied to the molten plastics material should also be commensurate with the particular plastics material being used.

In order that the invention may be more readily understood and so that further features may be appreciated, the invention will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is an exploded perspective view of the elements of an injection nozzle assembly in accordance with one aspect of the invention and suitable for use in a method in accordance with another aspect of the invention.

Figure 2 is a longitudinal sectional view illustrating the elements of Figure 1 as assembled.

Referring now to the drawings and first more particularly to Figure 1, a nozzle assembly for an injection moulding apparatus for plastics materials comprises an injection nozzle 10, a screen pack retainer 11 a first breaker plate 12, a fine screen 13, and a second breaker plate 14.

Referring now to Figure 2, which may be considered along with Figure 1, it may be seen that the injection nozzle 10 comprises a cylindrical barrel 15 having a cylindrical longitudinally extending bore 16 formed therein. The barrel 15 terminates at one end in a round nose 17 formed with a jet orifice 18 which communicates with the cylindrical bore 16. The barrel 15 is enlarged by a conical shoulder 19 to provide a thickened portion 20 which in turn is integrally connected to a wrench-engaging portion 21 that is formed with flats 22. At the end remote from nose 17, nozzle 10 terminates in an end portion 23 which is externally threaded. A frusto-conical recess 24 extends from the end of bore 16 remote from nose 17 through threaded end portion 23.

The screen pack retainer 11 comprises a cylindrical body 25 that is formed with a pair of diametrically opposed flats 26 for wrench engaging purposes. The body 25 has a first end at 27 and a second end at 28. Opening onto the end surface at 27 is a socket 29, the end portion of which adjacent to end 27 is internally threaded as indicated at 30. Secured to end 28 of body 25 is an externally threaded nipple 31. Only a portion of this nipple is illustrated but it is to be noted that in use the nipple 31 is connected to a source of supply of molten plastic. Nipple 31 has an internal passage 32 which communicates with a cylindrical bore 33 which communicates with a larger cylindrical bore 34 by way of a frusto-conical passage 35. The cylindrical bore 34 opens into the wider diameter socket 29, a shoulder 36 thereby being defined at the interface of socket 29 and the bore 34.

Referring now more particularly to Figure 1, the first breaker plate 12 is shown as having a circular recess 37 opening onto its forward face. The rear face 38 of the breaker plate 12 is dimensioned to engage shoulder 36 when the breaker plate 12 is positioned in socket 29. Recess 37 is defined by a marginal portion 39 in which two dowel pins 40 are anchored in diametrically opposed relation. Extending between the rear face 38 and the front face of breaker plate 12 within the marginal portion 39 are a plurality of apertures 41.

In this particular embodiment there are 121 of these apertures 41 and each of them is 0.157 cms (0.062 inch) in diameter. Needless to say, they are equi-distantly spaced apart throughout the portion of the breaker plate 12 located radially inwardly of the marginal portion 39.

The fine screen 13 is disc shaped and is adapted to be snugly received in recess 37. The filter openings provided by screen 13 are small in size and more closely arranged than are the apertures 41 in breaker plate 12. It will be appreciated that the size and arrangement of the filter openings in this fine screen 13 will be determined by the particular job application for which the nozzle assembly is to be used. For example, in one embodiment of the nozzle assembly the fine screen 13 may be in the form of a screen pack which may include two 20 x 20 mesh screens with one 24 x 110 mesh dutch weave screen sandwiched between the two 20 x 20 mesh screens. In this connection it is noted that the numbers 20 x 20 and 24 x 110 identify the number and arrangement of the filter openings of the screen per square 2.54 cms (per square inch).

In further relation to fine screen 13, it is to be noted that the 3-layered construction above described is not

illustrated in the drawings because of the fact that this fine screen or screen pack may be made up from screens of various mesh sizes and arranged in various combinations to suit particular jobs. Of course a single fine screen could be utilised if appropriate.

The second breaker plate 14 is also circular and has an outside diameter which is the same as the outside diameter of the first breaker plate 12. It is also formed with a plurality of apertures 42 which correspond in number and size to the apertures 41 of the first breaker plate 12. Thus, it also contains 121 0.157 cms (0.062 inch) diameter holes in the portion which corresponds to the portion of the first breaker plate 12 lying radially inwardly of the marginal portion 39. The second breaker plate 14 is also formed with two diametrically opposed passages 43 which receive dowel pins 40 and thus accurately position second breaker plate 14 with respect to the first breaker plate 12 and fine screen 13.

Prior to use in an injection moulding apparatus a fine screen or screen pack such as indicated at 13 is first selected to meet the conditions of a particular job, such conditions being the particular plastics material being used, the temperature of the molten plastics material and the pressure which is applied thereto. The nozzle 10 is unscrewed from the screen pack retainer 11 and the first breaker plate 12 inserted in socket 29 so that it abuts shoulder 36. The selected fine screen or screen pack 13 is then positioned in recess 37 and the second breaker plate 14 is assembled over fine screen 13 and marginal portions 39 of first breaker plate 12 by causing the dowel pins 40 to be received in openings 43. The threaded portion 23 of nozzle 10 is then screwed into the threaded portion of socket 29 and nozzle 10 and screen pack retainer 11 are rotated relative to one another to cause the screw threads to clamp the breaker plates together with the fine screen 13 therebetween. In use of the nozzle assembly in a method in accordance with the invention, the nozzle assembly is connected to a conventional injection moulding apparatus by means of the nipple 31. A supply of molten plastics material is then forced, under pressure, into the nozzle assembly. The molten plastics material passes along the internal passage 32, the cylindrical bore 33 and the frusto-conical passage 35 to the cylindrical bore 34. The molten plastics material is then forced through the apertures 41 in the first breaker plate 12, through the fine screen 13 and subsequently through the apertures 42 in the second breaker plate 14. The passage of the molten plastics material through the breaker plates 12 and 14 and the fine screen 13 tends to break up or filter out any carbon particles present in the molten plastics material and to break up and disperse any agglomerated colour particles such as, for example, pigments or dyes.

After passing through the breaker plates 12 and 14 and the fine screen 13 the molten plastics material then passes into the frusto-conical recess 24 in the injection nozzle 10 and subsequently passes along the cylindrical bore 16 and out of the injection nozzle 10 via the ejection orifice 18.

Whilst in the embodiment described, first and second breaker plates 12 and 14 are provided and a fine mesh 13 is sandwiched between these plates, a second breaker plate 14 need not in certain circumstances be used.

It will be appreciated that the method is particularly intended to be used to facilitate the use of otherwise scrap plastics materials and in particular plastics of the polyolefin family, such as, for example, polyethylene, polypropylene, linear polyethylene, copolymers and styrene. By utilising the above described method and apparatus colour dispersion in the molten scrap plastics material is aided and carbon particles are filtered out from the molten plastics material by the fine screen 13.

Details of a series of tests in which the output of an injection moulding apparatus was monitored are given below, different plastics materials being used in various of the tests and the apparatus being run for a period without a filter nozzle of the type described above and being run for a period with such a filter nozzle. It will be apparent that in the majority of cases the output of the injection moulding apparatus was of improved quality when a filter nozzle in accordance with the invention was utilised.

It is to be noted that a number of fine screens or screen packs were available for the tests, finer screen packs having been tested when the screen pack initially selected proved ineffective.

TEST NO. 1

Material: High density polyethylene

Hours of Test: Every one hour for five hours

Results:

Moulding without filter nozzle: During a 24 hour production run, it recorded 5.2% scrap due to cylinder spots.

Moulding with filter nozzle: Scrap rate was reduced for first hour 0.7%, 2nd, 3rd and 4th hours - 0%; 5th hour - 0.7%.

Comments of Reporter:

It was our very first test applying a screen pack to the machine which was showing a high scrap rate. The screen pack immediately eliminated cylinder spots. As it was our first test, we opened the nozzle every one hour to replace the screen pack.

TEST NO. 2

Material: Polypropylene

Hours of test: One

5 Results:

Moulding without filter nozzle: A scrap rate of over 20% was recorded due to colour shade and colour spots. A nozzle with a 0.15 cms (0.06") orifice type disc tried but to no avail.

Moulding with filter nozzle: Screen pack No. 1 (20 x 200 x 20) was placed but did not help. Screen pack No. 2 (20 x 200 x 200) was then tested. As a result, the colour shade became lighter but it did not completely eliminate the colour shade nor colour spots.

Comments of Reporter:

The problem was caused by the design of the pellets which had pits. Titanium pigments adhered to the pits.

15 TEST NO. 3

Material: High density polyethylene

Hours of Test: 12 hours test 2 x (24 hours)

Results:

Moulding without filter nozzle: During a 24 hour production run, it recorded 5.2% scrap due to cylinder spots.

Moulding with filter nozzles: During the first 12 hours of operations, the scrap rate was lowered to 0.45% and only a few foreign substances were found in the screens. During the second 12 hours, the scrap rate decreased to 0.37% and the size of carbon spots found in the screens were all in similar size of approximately 0.1 cm (0.04").

Comments of Reporter:

This test was conducted to check the conditions of the screen pack every 12 hours.

TEST NO. 4

Material: High density polyethylene

Hours of Test: 24 hours + 12 hours (36 hours)

Results:

Moulding without filter nozzle: At Monday start-up when some material purged, it appeared almost brown due to cylinder spots.

Moulding with filter nozzle: After starting the machine with a screen pack, it first produced 32 pieces of the item with some cylinder spots but it did not last and, during a 24 hour run, the screen pack produced an excellent result by eliminating cylinder spots. The scrap rate for this run was 0.72%.

Comments of Reporter:

After a 24 hour run, the screen pack was taken out. Only several pieces of tiny spots found on the screen. Without cleaning the screw, we started the same machine and ran it for 8 hours without screen pack. The scrap rate for this 8 hour run recorded 8.5%. Then, a screen pack was put in. During a 12 hour run after putting the screen pack in, the scrap rate was only 0.82%. The screen pack and the screw both were checked then and we found the former very clean and the latter covered with a thick layer of burned material.

45 TEST NO. 5

Material: High density polyethylene

Hours of test: 1 hour

Results:

Moulding without filter nozzle: During a 2 hour production run, prior to the placement of a screen pack, it recorded 22.6% scrap due to colour spots. The stock temperature was 181°C (358°F) (average of 3 readings).

Moulding with filter nozzle: By placing a screen pack, it immediately lowered scrap to 0%. The stock temperature was 184°C (363°F) (average of 3 readings).

Comments of Reporter:

Use of the screen pack was effective 100% against pigment lumps of average size 0.1 cm (0.04")

TEST NO. 6

Material: Polypropylene

Hours of Test: 3

Results:

Moulding without filter nozzle: Recorded colour shades due to poor dispersion. A dispersion disc of 0.15 cm (0.06") orifice was placed but did not eliminate this problem. The back pressure was raised up to 83.9 MNm⁻² (565 lb/sq. in) with screw rotation of 85 rpm. The stock temperature was 190°C (375°F) (average)

Moulding with filter nozzle: With screen pack No. 1 (20 x 200 x 20) and stock temperature 193°C (380°F),

results as follows: Back pressure 0 MNm⁻² (0.1b/sq. in) screw 90 rpm. Slightly better than using dispersion disc. Back pressure 2.9MNm⁻² (565 lb/sq. in), screw 130 rpm - excellent, only occasionally light colour shade was noticed. With screen-pack No. 2 (20 × 200 × 200) and stock temperature 196°C (385°F) the results identical as using screen pack No. 1. However, with back pressure 3.9 MNm⁻² (565 lb/sq. in), screw 130 rpm, it almost eliminated colour shades completely.

Comment of Reporter:

In comparison with a 0.15 cm (0.06") orifice dispersion disc, the screen pack produces much better results. By placing a screen pack, we were able to eliminate colour shades up to the point that it only appeared occasionally.

Material: High Density Polyethylene
Hours of Test: 72

Results:

Moulding without filter nozzle: During two separate 12 hour production runs, it recorded, due to cylinder spots, 3.78% scrap and 7.68% scrap, respectively.

Moulding with filter nozzle: By placing a screen pack, it immediately lowered scrap rate as specified below: 1st 12 hours - 0.68%, 2nd 12 hours - 0.15%, 3rd 12 hours - 0.45% (numerous black substances found in the screens), 4th 12 hours - 1.29%, final 24 hours - 0.36%.

Comments of Reporter:

Every 12 hours the screen pack was removed for inspection. Up to 3rd 12-hour test, the scrap rate due to cylinder spots were very low. During the 4th 12-hour test, slightly carbonised cylinder spots were noticed. During the final 24-hour test, a yellow cylinder and carbon spots were noticed.

TEST NO. 8

Material: Polypropylene
Hours of Test: 1

Results:

Moulding without filter nozzle: The production run could not be continued due to carbonised cylinder spots.

Moulding with filter nozzle: By placing a screen pack the carbon spots were broken into granules; however, the items were still unacceptable.

Comments of Reporter:

The screen pack was inspected and it was found that carbonized materials were fully packed in the screens. Also, the screw was disassembled for inspection. A black burned material of approximately 0.1 cm (0.4") in thickness adhered to the screw in the area approximately 6.35 cm (2.5") from the front end. With carbonized materials, we were unable to obtain desirous results.

TEST NO. 9

Material: High Density Polyethylene
Hours of Test: 120

Results:

Moulding without filter nozzle: During the weekend shut down, numerous cylinder spots were noticed and at the Monday start-up, brown cylinder spots were observed in purged lumps of materials.

Moulding with filter nozzle: By placing a screen pack, the scrap rate for 120-hour production run were as follows: Monday - 0.02%, Tuesday - 0.03%, Wednesday - 0.02%, Thursday - 0.02%, Friday - 0.02%.

Comments of Reporter:

The use of the screen pack recorded a very good result. When the screw was disassembled for inspection, inside the cylinder head, a layer of dark brown and yellow burned materials were noticed. The screw head was covered with a layer of burned materials but none was observed on other parts of the screw. The screens were filled with burned materials of size approximately 0.2cm - 0.3cm (0.08" - 0.12").

TEST NO. 10

Material: High Density Polyethylene
Hours of Test: 32

Results:

Moulding without filter nozzle: During an 8-hour production run, it recorded 1.5% scrap due to carbon spots. Of this 48-hour run, the final 16-hour production run was made without the screen pack. The scrap rate, then recorded 6.8%.

Moulding with filter nozzle: A screen pack was placed for 32 hours out of a 48-hour production run, lowering the scrap rate, to 1.1%. However, at about the end of the production run. suddenly the scrap raised due to cylinder spots and contaminations.

Comments of Reporter:

The screens were checked and found to be in good order. The 200 mesh screen, however, was filled with carbon. It is believed that at an early stage of carbonizing the screen pack is very effective but once carbonization goes to far the material becomes too tough for the screen pack to handle.

5

TEST NO. 11

Material: High Density Polyethylene

Hours of Test: 96

Results:

10 Moulding without filter nozzle: During a previous 96 hour production run, it recorded a scrap rate of approximately 4.0% due to cylinder spots of early stage.

10

Moulding with filter nozzle: By placing a screen pack it lowered scrap rate as specified below: 1st 24 hours - 0.13%, 2nd 24 hours - 0.4%, 3rd 24 hours - 2.8%, 4th 24 hours - 0.4%.

Comments of Reporter:

15 The screen pack eliminated cylinder spots remarkably. The domestic screens were used on this test. The effectiveness of the screens are same as the U.S. screens but they lack durability. The 200 mesh screen failed during the 3rd 24 hour test run.

15

TEST NO 12

20 Material: High Density Polyethylene

Hours of Test: 120

Results:

Moulding without filter nozzle: Every once in a while, scrap due to contaminations and colour spots came out continuously.

20

25 Moulding with filter nozzle: By placing a screen pack, it recorded scrap rate as specified below: 1st 24 hours - 0.2%, 2nd 24 hours - 0.1%, 3rd 24 hours - 0.7%, 4th 24 hours - 0.3%, 5th 24 hours - 0.9%.

25

Comments of Reporter:

This test was conducted with a set of domestic screens to check their durability. The 200 mesh screen failed just before the 120 hour production run was completed. The domestic screens lack durability when compared to the U.S. screens.

30

30

TEST NO 13

Material: Polypropylene

Hours of Test: 112

Results:

35 Moulding without filter nozzle: During a 96 hour production run, it recorded 6.8% scrap due to cylinder and colour spots.

35

Moulding with filter nozzle: By placing a screen pack the scrap rate was lowered as follows:

40

	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
1st Shift:	-	2.5%	1.5%	0.6%	0.5%
2nd Shift:	0.7%	1.2%	0.6%	0.6%	0.5%
3rd Shift:	0.3%	0.6%	0.1	0.2%	0.3%

40

45

45

Comments of Reporter:

During this 112 hour production run, the scrap rate due to contaminations and cylinder spots averaged less than 1.0%, and absolutely no problems of colour spots. Although the screens were used for a continuous 5 days run, they remained in a good condition. When the screens were checked at the end of this run, many black substances were found on the 200 screen.

50

50

TEST NO. 14

Material: High Density Polyethylene

Hours of Test: 48 hours

Results:

55 Moulding without filter nozzle: The scrap rate was 7.9% due to cylinder spots and contaminations.

55

Moulding with filter nozzle: During the first 24 hours of the operations, the scrap rate was lowered to an average of 2.0% and during the second 24 hour run, the scrap rate averaged only 1.5%.

Comments of Reporter:

60 Since numerous carbonized substances were found in the screens it is believed that the scrap rate would have been much higher without a screen pack.

60

CLAIMS

65 1. A method of injection moulding plastics materials said method comprising the steps of introducing a

65

**Comments of Reporter:**

The screens were checked and found to be in good order. The 200 mesh screen, however, was filled with carbon. It is believed that at an early stage of carbonizing the screen pack is very effective but once carbonization goes to far the material becomes too tough for the screen pack to handle.

5

TEST NO. 11**Material:** High Density Polyethylene**Hours of Test:** 96**Results:**

10 Moulding without filter nozzle: During a previous 96 hour production run, it recorded a scrap rate of approximately 4.0% due to cylinder spots of early stage. 10

Moulding with filter nozzle: By placing a screen pack it lowered scrap rate as specified below: 1st 24 hours - 0.13%, 2nd 24 hours - 0.4%, 3rd 24 hours - 2.8%, 4th 24 hours - 0.4%.

Comments of Reporter:

15 The screen pack eliminated cylinder spots remarkably. The domestic screens were used on this test. The effectiveness of the screens are same as the U.S. screens but they lack durability. The 200 mesh screen failed during the 3rd 24 hour test run. 15

TEST NO 12**Material:** High Density Polyethylene**Hours of Test:** 120**Results:**

20 Moulding without filter nozzle: Every once in a while, scrap due to contaminations and colour spots came out continuously. 20

25 Moulding with filter nozzle: By placing a screen pack, it recorded scrap rate as specified below: 1st 24 hours - 0.2%, 2nd 24 hours - 0.1%, 3rd 24 hours - 0.7%, 4th 24 hours - 0.3%, 5th 24 hours - 0.9%. 25

Comments of Reporter:

30 This test was conducted with a set of domestic screens to check their durability. The 200 mesh screen failed just before the 120 hour production run was completed. The domestic screens lack durability when compared to the U.S. screens. 30

TEST NO 13**Material:** Polypropylene**Hours of Test:** 112**Results:**

35 Moulding without filter nozzle: During a 96 hour production run, it recorded 6.8% scrap due to cylinder and colour spots. 35

Moulding with filter nozzle: By placing a screen pack the scrap rate was lowered as follows:

40	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	40
1st Shift:	-	2.5%	1.5%	0.6%	0.5%	
2nd Shift:	0.7%	1.2%	0.6%	0.6%	0.5%	
3rd Shift:	0.3%	0.6%	0.1.	0.2%	0.3%	

45

Comments of Reporter:

During this 112 hour production run, the scrap rate due to contaminations and cylinder spots averaged less than 1.0%, and absolutely no problems of colour spots. Although the screens were used for a continuous 5 days run, they remained in a good condition. When the screens were checked at the end of this run, many black substances were found on the 200 screen. 50

TEST NO. 14**Material:** High Density Polyethylene**Hours of Test:** 48 hours**Results:**

55 Moulding without filter nozzle: The scrap rate was 7.9% due to cylinder spots and contaminations. 55

Moulding with filter nozzle: During the first 24 hours of the operations, the scrap rate was lowered to an average of 2.0% and during the second 24 hour run, the scrap rate averaged only 1.5%.

Comments of Reporter:

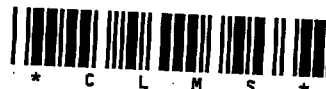
60 Since numerous carbonized substances were found in the screens it is believed that the scrap rate would have been much higher without a screen pack. 60

CLAIMS

65 1. A method of injection moulding plastics materials said method comprising the steps of introducing a 65



- plastics material containing carbon particles visible by the naked human eye into an injection moulding apparatus; heating the plastics material to a molten condition, forcing the plastics material in a molten condition and under pressure through a screen pack, comprising a breaker plate having relatively large apertures therein, and a fine screen having openings smaller than said apertures, at least some of the said openings each being adapted both to filter carbon particles and also to break up carbon particles so that the said visible carbon particles are broken up into smaller particles, and then through an injection nozzle for subsequent moulding. 5
2. A method according to claim 1 further comprising the step of forcing the plastics material through a second breaker plate having apertures larger than the filter openings of said fine screen, subsequent to forcing the plastics material through said fine screen but prior to forcing the plastics material through said injection nozzle. 10
3. A method according to claim 1 or claim 2 wherein said fine screen comprises an assembly of three fine mesh screens.
4. A method according to claim 3 wherein one of the fine mesh screens of said screen assembly is a dutch weave screen of finer mesh than the other two fine mesh screens and is sandwiched between said other two fine mesh screens. 15
5. A method according to any one of claims 1 to 4, wherein said plastics material is chosen from the polyolefin family including polyethylene, polypropylene, linear polyethylene, copolymers and styrene.
6. A nozzle assembly for an injection moulding apparatus for plastics materials, said nozzle assembly comprising nozzle means having an inlet aperture a passageway extending therethrough and an ejection orifice and said nozzle means being adapted to be connected to a source of supply of molten plastics material, so as to complete a through flow conduit from said supply to said ejection orifice, and a breaker plate and a fine screen each adapted to be mounted relative to said nozzle means so as to lie across said conduit when said nozzle means is connected to said source, said nozzle means being adapted to cooperate with said plate and screen to maintain them in position, across said conduit, said breaker plate having a plurality of apertures formed therein and said fine screen having a plurality of openings formed therein which are smaller than the apertures in said breaker plate. 20 25
7. A nozzle assembly according to claim 6 wherein said nozzle means comprises an injection nozzle having a barrel formed with a bore terminating in said ejection orifice at one end and an inlet for molten plastics material at the other end and defining said inlet aperture of said nozzle means and having a bore extending therethrough and a screen pack retainer having means for connecting it to a source of supply of molten plastics material said injection nozzle and said screen pack retainer being adapted to be connected to one another and further being adapted to cooperate to clamp said fine screen and said breaker plate in position across said conduit. 30
8. A nozzle assembly according to claim 6 or 7 together with a second breaker plate having apertures larger than the openings in said fine screen and being adapted to be mounted with said first breaker plate and said fine screen so as to lie across said conduit, said nozzle means being adapted to cooperate with both said screens and said fine filter to maintain them in position. 35
9. A nozzle assembly according to claim 8 in which said first breaker plate has a recess formed in one face thereof, the fine screen being received in said recess, and the second breaker plate overlying the fine screen and a marginal portion of the first breaker plate. 40
10. A nozzle assembly according to claim 7 or either of claims 8 and 9 as dependent thereon wherein said injection nozzle is externally threaded and said screen pack retainer is internally threaded.
11. A nozzle assembly according to claim 10 wherein wrench-engaging means are provided on said injection nozzle and on said screen pack retainer. 45
12. A nozzle assembly according to claim 7 or any claim dependent thereon in which said bore in said injection nozzle is cylindrical throughout a portion of said barrel and terminates in a frusto-conical recess at its inlet end.
13. A nozzle assembly according to claim 10 or either of claims 11 and 12 as dependent thereon in which the screen pack retainer is formed with a socket having said internal threads and a radially inwardly extending shoulder at the end of said socket which is adapted to engage said breaker plate or one of said breaker plates. 50
14. A nozzle assembly according to claim 8 or any claim dependent thereon wherein means are provided for aligning said breaker plates relative to one another so that the apertures in one breaker plate align with the apertures in the other breaker plate. 55
15. A nozzle assembly according to claim 14 in which said means for aligning the breaker plates comprises a pair of diametrically opposed dowel pins secured to one of said breaker plates and detachably received in openings in the other of said breaker plates.
16. A nozzle assembly according to claim 14 or 15 in which there are a plurality of apertures in each of said breaker plates with each aperture having a diameter of 0.157 cm (0.062 inch). 60
17. A nozzle assembly according to claim 16 wherein there are 121 apertures in each of said breaker plates.
18. A nozzle assembly according to any one of the preceding claims wherein said fine screen comprises two 20 × 20 screens as herein defined with a 24 × 110 screen as herein defined sandwiched therebetween. 65
19. A nozzle assembly according to claim 9 or any claim dependent thereon in which the recess in said



first breaker plate is circular and is defined by a ring-like marginal portion.

20. An injection moulding apparatus provided with a nozzle assembly according to any of claims 6 to 19.

21. A method of injection moulding plastics materials substantially as herein described with reference to the accompanying drawing.

5 22. A nozzle assembly substantially as herein described with reference to and as illustrated in the accompanying drawing.

5

23. An injection moulding apparatus provided with a nozzle assembly substantially as herein described with reference to and as illustrated in the accompanying drawing.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.