

Die assembly

Field of the invention

The present invention relates to an extrusion
5 die and an extrusion installation comprising at least
one such die.

Background of the invention

In order to make twisted products in the field
10 of pasta, for example, special static dies are commonly
used in which a raw kneaded dough to be extruded,
having a high viscosity, is forced under the effect of
high pressure through feed-channels of complicated
design employing differentiated flow rates and pressure
15 zones.

Such static dies cannot be used to make twists
of coextruded products, especially filled pasta, the
twisting being braked by the filling. They do not lend
themselves either to the manufacture of twisted
20 products expanded by the cooking-extrusion of a
moistened flour, for example.

EP 44689 (UNILEVER PLC) describes a die which
can be used to manufacture an article of ice-cream
based confectionery composed of several strands twisted
25 together, for example, this die comprising a rotating
barrel in which a plurality of independent feed-
channels are made which emerge at a downstream end of
the barrel via outlet orifices, each having an
asymmetric shape or position with respect to the axis
30 of rotation of the barrel, inlet orifices of the feed-
channels provided at various levels in an upstream end
of the barrel being in communication with fixed rings,
for feeding with icecream, which encircle the barrel at
these various levels. The construction of such a die is
35 relatively complicated and becomes difficult to adapt
to the extrusion of plasticized masses of high
viscosity, at a high pressure, a high temperature
and/or with a high speed of rotation.

WO 93/03909 (UNILEVER PLC) describes an extrusion die which can be used to coextrude simultaneously at least two strands each formed by a tube containing a filling and to twist them together, this die comprising a barrel rotating about a fixed body, the barrel comprising at least two sets of two coaxial feed-channels parallel to the axis of the die, the fixed body comprising a central chamber for the feed of an inner feed-channel of each of said sets and an annular chamber for the feed of an annular outer feed-channel separated from the inner feed-channel of each of said sets by a tube integral with the barrel, a single central or axial feed-channel possibly being provided in the barrel and being fed via a tube, integral with said body, arranged coaxially in said central chamber. Such a die, which has especially annular seals applied against rotating walls of relatively fragile components such as tubes, is also relatively complicated and also becomes difficult to adapt to the extrusion of plasticized masses of high viscosity, at a high pressure, a high temperature and/or with a high speed of rotation.

Summary of the invention

The object of the present invention is to provide an extrusion die, which is preferably independent, able to be incorporated with or connected to an extruder or press, having a simple and robust construction suitable for the extrusion of plasticized masses of high viscosity, at a high pressure, at high temperature and/or with a high speed of rotation, and which can be used to prepare, especially, articles which are twisted and/or filled in their center with a filling, having one or more strands, of the pasta type or expanded cocktail snack type, for example.

For this purpose, the extrusion die according to the present invention comprises a fixed solid body in which there are at least one inlet channel for a plasticized, especially edible, mass of material and a

housing containing a rotating barrel in which there are at least one outlet channel and one distribution chamber having rotational symmetry communicating upstream with said inlet channel and downstream with
5 said outlet channel, an outer surface of said barrel interacting via an axial and radial bearing with a corresponding surface of said housing.

Preferably, the inlet channel communicates with said distribution chamber via a distribution
10 antechamber having rotational symmetry, provided in said body in the upstream extension of the distribution chamber, rotary annular sealing means being provided at the junction between said distribution chamber and said distribution antechamber.

15 The present die thus designed can in fact be used to produce, in particular, twisted multistrand expanded pasta or cocktail snacks, especially multistrand twisted spaghetti, for example, despite the particularly harsh conditions under which it may be
20 called upon to work as regards the viscosity and/or temperature of the mass to be extruded, the pressure transmitted by the extruder or press, and/or the speed of rotation of the barrel, it being possible for these conditions to be illustrated by values which can range
25 up to approximately 50000 mPa.s for the viscosity, up to approximately 200°C for the temperature and up to approximately 200 bar for the pressure, for a flowrate corresponding to a maximum speed of extrusion of approximately 1 ms^{-1} and a maximum speed of rotation of
30 the barrel of approximately 300 rpm, for example.

Preferably, said rotary annular sealing means comprise a flat sealing ring of generally rectangular cross section provided in an annular groove of generally corresponding cross section, an upstream
35 plane face of the groove being provided in the wall of said distribution antechamber and a downstream plane face of the groove being provided in the wall of said distribution chamber.

Preferably, said sealing ring has a cylindrical outer surface and a convex inner surface, especially an inverse semi-toroidal one, in other words it has a rectangular cross section in which the short side
5 facing the center is hollowed out, especially in the form of a semicircle.

Also preferably, a cylindrical outer surface of the groove is formed by an annular stop rim integral with the wall of the distribution chamber and a
10 cylindrical inner surface of the groove is formed by an annular protective rim integral with the wall of the distribution antechamber, an annular slot being left between a downstream end of this protective rim and said downstream plane face of the groove. Said
15 protective rim is intended to prevent friction of the ring on said plasticized material.

Still preferably, fixing tenons passing through the ring are provided, these being integral with the wall of the distribution chamber.

20 The ring may be made of any elastic material having a particularly low coefficient of friction. Preferably, it is made of polytetrafluoroethylene reinforced throughout its bulk with a stainless steel powder.

25 Surprisingly it has been found that annular sealing means of the type described hereinabove make it possible to solve particularly effectively the problem exhibited by the sealing of the present die, given the particularly harsh conditions under which it may be
30 called upon to work, as regards the viscosity and/or temperature of the mass to be extruded, the pressure transmitted by the extruder or press and/or the speed of rotation of the barrel.

Moreover, in one particular embodiment of the
35 present die, which can be used to produce twisted articles filled with a filling, in particular an edible filling, especially a filling of ground meat, tomato sauce and/or cheese for savory articles, or almonds, hazelnuts, chocolate and/or jam for sweet articles, for

example, this filling not imposing particularly harsh working conditions as regards the viscosity, pressure and/or temperature, it being possible for these conditions to be illustrated by values of a few
5 hundreds of mPa.s for the viscosity, a few bar to a few tens of bar for the pressure and approximately 20-60°C for the temperature, for example, said body may furthermore comprise at least one inlet conduit for a filling, communicating with at least one outlet conduit
10 passing through said barrel level with said outlet channel.

In this particular embodiment, the respective positions of the inlet channel for said plasticized mass of material and of the inlet conduit for said
15 filling may be chosen depending on convenience of use criteria, for example. If the present die is intended to be mounted vertically on a cart, provision may be made for said channel to extend transversely in said body and emerge laterally in a distribution
20 antechamber, such as described hereinabove, and for said conduit to extend axially in said body and be extended into said distribution antechamber and said distribution chamber in the form of a coaxial tube integral with the body, for example.

25 Depending on whether the present die is intended for the production of unfilled twisted articles or twisted articles filled with a filling, provision may be made for said barrel to comprise outlet channels and/or conduits arranged in various
30 ways and having cross sections of various shapes.

For the production of unfilled multistrand twisted articles, said barrel may comprise a plurality of outlet channels arranged symmetrically with respect to its axis, especially three channels of circular
35 cross section, these being arranged at vertices of an equilateral triangle centered on the axis, for example.

For the production of single-strand twisted articles filled with a filling, said barrel may comprise an axial outlet conduit for the filling,

having a circular cross section, and an outlet channel for the plasticized mass, surrounding said outlet conduit for the filling but having a cross section whose shape is not purely annular.

5 However, in the case where an axial outlet conduit for the filling should have a cross section which is not purely circular, but on the contrary a cross section having angles or irregularities, such as a triangular cross section for example, provision may
10 be made for an outlet conduit for the filling delimited by a rotating tube integral with said barrel and connected to said inlet conduit for the filling via a rotating seal.

 In order to be able to be rotated by driving
15 means, such as an electric motor, said barrel may have a downstream part extending out of said body and may comprise a pinion integral with this downstream part, for example. Advantageously, provision may be made for such a downstream part of the barrel to include a
20 removable insert which is easily accessible from the outside and in which are provided said at least one outlet channel for the plasticized mass and/or said at least one outlet conduit for the filling. A set of inserts may thus be provided which are easily
25 interchangeable from the outside and can be used to manufacture various products with various embodiments of the die.

 Finally, circuits suitable for circulating a coolant or a heating fluid may be provided in the body
30 and/or in the barrel.

 The present die is therefore designed as a die which is preferably independent and can be incorporated into or connected to an extruder or a press. It is most particularly intended for the production of products,
35 especially foodstuffs, by extrusion, cooking-extrusion or cooking-extrusion-expansion of a plasticizable mass of material through the effect of pressure and/or temperature and/or shear exerted on it in said extruder or said press.

The present die also lends itself advantageously to the production of an extrusion installation, lying within the scope of the present invention, which comprises an extruder or press
5 connected via a branch-off valve to at least one die according to the present invention, means for driving the barrel of the die and means for guiding the extruded twisted product to a station for receiving said product. This or these dies may be fixed onto one
10 or more carts, this cart also being able to carry said means for driving the barrel of the die and said guiding means.

Said branch-off valve is an important part of the installation, intended to make it possible,
15 especially, to connect up the die only when a production process has been started correctly or to disconnect the die without stopping the extruder or the press when it is desired to modify the configuration of the die during the course of production, for example.

20 Said guiding means themselves represent the first contact of the extruded product with a surface not integral with the barrel, by virtue of which contact the extruded product experiences the desired torsional movement by rotation of the barrel.

25

Brief description of the drawings

The die and the installation according to the present invention, as well as the products that they allow manufacture of, are described in more detail
30 hereinbelow with reference to the appended drawing in which:

- Figure 1 represents a diagrammatic view in longitudinal section of a first embodiment of the die;

- Figure 2 represents a diagrammatic view in
35 longitudinal section of a detail of the barrel of a second embodiment of the die;

- Figures 3 and 4 represent two transverse sections along the lines III-III and IV-IV of Figure 2;

- Figure 5 represents a diagrammatic view in transverse section of the barrel of a third embodiment of the die;

5 - Figure 6 represents an enlarged view in longitudinal section of the junction between the distribution chamber and distribution antechamber of the embodiment of the die represented in Figure 1;

10 - Figure 7 represents a diagrammatic side view of an embodiment of the installation comprising two dies;

 - Figure 8 represents a diagrammatic front view of the embodiment of the installation represented in Figure 7; and

15 - Figure 9 represents lengths of examples of products that can be manufactured with the embodiments of the die which are illustrated respectively in Figures 1, 2-4 and 5.

Description of the preferred embodiments

20 In its embodiment represented in Figure 1, the present die 1 comprises a fixed solid body 2 in which there are an inlet channel 3 for a plasticized, especially edible, mass of material and a housing 4 containing a rotating barrel 5 in which there are an outlet channel 6 and a distribution chamber 7 having rotational symmetry communicating upstream with the inlet channel 3 and downstream with the outlet channel 6, an outer surface 8, 9 of the barrel 5 interacting via an axial and radial bearing 10, 11 with a corresponding surface 12, 13 of the housing 4.

30 In this embodiment, the barrel 5 comprises an upstream part 40 and a central part 41, both parts contained in the housing 4 provided in the body 2 and a downstream part 30 extending out of the body 2. The upstream part 40 has a larger diameter and forms an annular plane cutback 9 with respect to the central part 41 of smaller diameter, this cutback 9 interacting via a radial bearing 11 with an annular plane shoulder 13 provided in the housing 4. The central part 41 has a

cylindrical outer surface 8 interacting via an axial bearing 10 with a cylindrical inner surface 12 provided in the housing 4. A pinion 31 integral with the downstream part 30 is provided.

5 The inlet channel 3 communicates with the distribution chamber 7 via a distribution antechamber 14 having rotational symmetry, provided in the body 2 in the upstream extension of the distribution chamber 7, rotary annular sealing means 15 being provided at
10 the junction between the distribution chamber 7 and the distribution antechamber 14.

 The body 2 furthermore comprises an inlet conduit 26 for a filling, especially an edible one, communicating with an outlet conduit 27 for the
15 filling, passing through the barrel 5.

 The inlet channel 3 for the plasticized mass extends transversely in the body 2 and emerges laterally in the antechamber 14. The inlet conduit 26 for the filling extends axially in the body 2 and is
20 extended into the antechamber 14 and the distribution chamber 7 in the form of a coaxial tube 28 integral with the body 2.

 The outlet conduit 27 for the filling is axial and has a circular cross section. The outlet channel 6
25 for the plasticized mass surrounds the outlet conduit 27 and has a cross section of not purely annular shape. The downstream part 30 of the barrel includes a removable insert 32 in which are provided this outlet channel 6 for the plasticized mass and this outlet
30 conduit 27 for the filling.

 A circuit for the circulation of a coolant or a heating fluid is provided in the barrel 5, which comprises, for this purpose, a cylindrical recess 43 between its outer surface and the distribution chamber
35 7, a fluid supply channel 44 leading to the recess 43 in its upstream part 40 and an annular fluid outlet opening 45 in its downstream part 30, said fluid supply channel 44 communicating with a fluid inlet channel 46

in the body 2 via an annular conduit-seal 47 provided in the wall of the housing 4.

As may be seen in Figure 6, in the embodiment of the die represented in Figure 1, the rotary annular sealing means 15 comprise a flat sealing ring 16 of generally rectangular cross section, provided in an annular groove of generally corresponding cross section, an upstream plane face 17 of the groove being provided in the wall of the distribution antechamber 14 and a downstream plane face 18 of the groove being provided in the wall of the distribution chamber 7.

The sealing ring 16 has a cylindrical outer surface 19 and a convex inner surface 20, in this case an inverse semi-toroidal surface.

A cylindrical outer surface of the groove is formed by an annular stop rim 21 integral with the wall of the distribution chamber 7 and a cylindrical inner surface of the groove is formed by an annular protective rim 22 integral with the wall of the distribution antechamber 14, an annular slot 24 being left between a downstream end 25 of this protective rim and said downstream plane face 18 of the groove.

Fixing tenons 23 passing through the sealing ring 16 are provided, these being integral with the wall of the distribution chamber 7. The sealing ring is made of polytetrafluoroethylene reinforced with a stainless steel powder, which confers on it both a low coefficient of friction, in this case on a polished stainless steel surface, and a suitable wear resistance.

In the second embodiment, in which Figures 2, 3 and 4 show a detail of the barrel in a longitudinal section and two transverse sections, the parts other than the barrel being similar to those of the embodiment shown in Figure 1, the present die has an outlet conduit 27 for the filling delimited by a central tube 42 integral with the barrel 5 and connected to the coaxial tube 28 extending the inlet conduit 26 via a rotating seal 29. The conduit 27 for

the filling and the outlet channel 6 for the plasticized mass have respective cross sections which are not purely circular or annular, in this case triangular cross sections

5 In the third embodiment, in which Figure 5 shows a detail of the barrel in transverse section, the die does not comprise an inlet conduit or an outlet conduit for the filling and its barrel 5 comprises two outlet channels 6 for the plasticized mass which are
10 parallel to and at an equal distance from the axis of the barrel, each channel having a circular cross section.

 In its embodiment shown in Figures 7 and 8, the present installation comprises an extruder 33 connected
15 via a branch-off valve 34 to two dies 1, means 35, 36, 37 for driving the barrel 5 of the dies 1, means 48, 49 for guiding the extruded twisted product 50 to a station, not shown, for receiving this product and a cart 39 carrying the dies 1, the driving means 35, 36,
20 37 and the guiding means 48, 49.

 The driving means comprise a motor 35, a drive shaft 36 and a driving pinion 37 transmitting the rotational movement to the coupled pinions 31 of the barrels 5.

25 The guiding means comprise pulleys 48 and their respective supports 49.

 Figure 9 shows lengths of three examples a), b) and c) of products that can be manufactured with the three embodiments of the die which are described
30 respectively with reference to Figures 1, 2-4 and 5.

 In a) may be seen a length of a single-strand twisted product filled with a filling. The outer part or casing 51 of this product has a cross section of generally but not purely annular shape, in this case a
35 cross section having asperities on its perimeter which form a twisted pattern in relief on the product. The inner part or filling 52 of this product has a circular cross section.

In b) may be seen a length of a single-strand twisted product filled with a filling. The inner part 52 of this product has a cross section which is not purely circular, in this case a triangular cross section which corresponds to the triangular cross section of the outer part 51 of the product.

In c) may be seen a length of an unfilled multistrand twisted product formed by two strands 53 of circular cross section.

10 The example below is given by way of illustration of a production carried out using the present die.

Example

15 Using an extrusion installation comprising an extrusion die as described with reference to Figure 1 and connected to a twin-screw extruder, a single-strand article filled with a filling is produced, as shown in Figure 9a).

20 In order to produce the outer part, the extruder is fed with a mixture of 80% of maize-based semolina and 20% of water. The mixture is plasticized and cooked in the extruder at 140°C at 120 bar at a speed of rotation of the screws of 260 rpm. The stream
25 of plasticized mass, which has a viscosity of 20000 mPa.s, is extruded at a rate of exit from the die of 1 ms⁻¹.

In order to produce the inner part, a marmalade, having a temperature of 45°C and a viscosity
30 of 800 mPa.s, is injected into the die at a pressure of 16-25 bar.

A single-strand product made of expanded cereal filled with a jam filling, the cylindrical surface of which has a twisted relief pattern, is thus obtained.



Claims

An extrusion die (1) comprising a fixed solid body (2) in which there are at least one inlet channel (3) for a plasticized, especially edible, mass of material and a housing (4) containing a rotating barrel (5) in which there are at least one outlet channel (6) and a distribution chamber (7) having rotational symmetry communicating upstream with said inlet channel (3) and downstream with said outlet channel (6), an outer surface (8, 9) of said barrel interacting via an axial and radial bearing (10, 11) with a corresponding surface (12, 13) of said housing.

2. The die as claimed in claim 1, wherein said inlet channel (3) communicates with said distribution chamber (7) via a distribution antechamber (14) having rotational symmetry, provided in said body (2) in the upstream extension of the distribution chamber, rotary annular sealing means (15) being provided at the junction between said distribution chamber and said distribution antechamber.

3. The die as claimed in claim 2, wherein said rotary annular sealing means (15) comprise a flat sealing ring (16) of generally rectangular cross section provided in an annular groove of generally corresponding cross section, an upstream plane face (17) of the groove being provided in the wall of said distribution antechamber (14) and a downstream plane face (18) of the groove being provided in the wall of said distribution chamber (7).

4. The die as claimed in claim 3, wherein said sealing ring (16) has a cylindrical outer surface (19) and a convex inner surface (20), especially an inverse semi-toroidal one.

5. The die as claimed in claim 3, wherein a cylindrical outer surface of the groove is formed by an annular stop rim (21) integral with the wall of the distribution chamber (7) and a cylindrical inner surface of the groove is formed by an annular



protective rim (22) integral with the wall of the distribution antechamber (14), an annular slot (24) being left between a downstream end (25) of this protective rim and said downstream plane face (18) of the groove.

6. The die as claimed in claim 3, wherein fixing tenons (23) passing through said sealing ring (16) are provided, these being integral with the wall of said distribution chamber (7), and the sealing ring is made of polytetrafluoroethylene reinforced with a stainless steel powder.

7. The die as claimed in claim 1, wherein said body (2) furthermore comprises at least one inlet conduit (26) for a filling, especially an edible one, communicating with at least one outlet conduit (27) for the filling, passing through said barrel (5).

8. The die as claimed in claims 2 and 7, wherein said inlet channel (3) for the plasticized mass extends transversely in said body (2) and emerges laterally in said antechamber (14), said inlet conduit (26) for the filling extends axially in said body (2) and is extended into the antechamber (14) and said distribution chamber (7) in the form of a coaxial tube (28) integral with the body.

9. The die as claimed in claim 8, wherein said outlet conduit (27) for the filling is axial and has a circular cross section, and said outlet channel (6) for the plasticized mass surrounds the outlet conduit (27) and has a cross section whose shape is not purely annular.

10. The die as claimed in claim 1, wherein said barrel (5) comprises a plurality of outlet channels (6) arranged symmetrically with respect to its axis.

11. The die as claimed in claim 8, wherein said outlet conduit (27) is delimited by a rotating tube (42) integral with said barrel (5) and connected to said coaxial tube (28) extending the inlet conduit (26) via a rotating seal (29).



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12. The die as claimed in claim 1, wherein said barrel (5) has a downstream part (30) extending from said body (2) and comprises a pinion (31) integral with this downstream part.

5 13. The die as claimed in claim 12, wherein said downstream part (30) of the barrel includes a removable insert (32) in which are provided said at least one outlet channel (6) for the plasticized mass and/or said at least one outlet conduit (27) for the filling.

10 14. An extrusion installation comprising an extruder or press (33) connected via a branch-off valve (34) to at least one die (1) as claimed in one of claims 1-13, means (35) for driving the barrel (5) of the die and means (37) for guiding the extruded twisted
15 product to a station for receiving said product.

15. The installation as claimed in claim 14, comprising at least one cart (39) carrying at least one die (1), said means (35) for driving the barrel (5) and said guiding means (37).