

Extrusion die

The subject of the present invention is an extrusion die, an extruder comprising at least one such die and a product capable of being obtained by
5 extrusion through such a die.

EP 0,169,126 (CLEXTRAL) describes a method and installation for manufacturing a composite food product from a single-screw or double-screw extrusion cooker,
10 in which a stream of material is processed in a first conventional processing zone of the extrusion cooker, this stream is divided in two in a second zone comprising two separate parallel processing chambers, the streams are processed, in particular coloured
15 differently, in their respective processing chambers, and the streams are combined during their extrusion through a die having a single outlet orifice or a coextrusion die.

The object of the present invention is to
20 provide an extrusion die making it possible, by extruding a unitary material, to produce a product which has an especially attractive three-dimensional shape, namely the general shape of a core surrounded by a ring.

25 For this purpose, the extrusion die according to the present invention comprises a feed diaphragm opening onto a distribution chamber communicating, on the one hand, with a generally conical convergent central extrusion duct by means of a circular central
30 pre-expansion and/or retarding diaphragm and communicating, on the other hand, with at least one generally conical convergent coaxial tubular extrusion duct by means of at least one annular pre-expansion and/or retarding diaphragm, the central and coaxial
35 tubular extrusion ducts having respective concentric central and annular outlet orifices.

The extruder according to the present invention also comprises an elongate sleeve, containing one or



two processing screws, and at least one such extrusion die.

Finally, the product according to the present invention, capable of being obtained by extrusion through such a die, has the general shape of a core surrounded by a ring.

In this description, by the term "diaphragm" is to be meant a pipe element, the diameter of which narrows to an orifice of reduced aperture and which may, in particular, take the form of an insert, in which an orifice is provided, to which a generally conical upstream wall converges and from which a generally conical downstream wall diverges.

The expression "pre-expansion and/or retarding" means preliminary expansion and/or retarding of a mass of material processed in an extruder, which takes place at an intermediate stage prior to emergence from the extrusion die. Such pre-expansion and/or retarding may be caused by the passage of the mass through a diaphragm opening onto a pre-expansion and/or retarding space or chamber, defined by a divergent wall, as mentioned above, or onto an even wider space provided, for example, immediately downstream of the diaphragm.

The expression "concentric central and annular outlet orifices" means a central outlet orifice, which is located in a plane generally perpendicular to the axis of the die and centred on this axis, and at least one annular orifice, likewise located in a plane generally perpendicular to the axis of the die and also centred on this axis. These orifices may have various shapes, such as a circle, oval, ellipse, heart, triangle, figure of eight, flower petals or their combinations, such as, for example, a daisy with a circular central orifice and a petal-shaped annular orifice.

By the expression "processing screw" is to be meant the extruder screw or screws which are driven in rotation within a bore or two secant bores provided in the sleeve and to which are fastened processing

members, such as threads wound helically about their axis. The configuration, pitch, depth and direction of such threads may be provided in various ways along the axis so as to define various processing zones, such as, for example, transport, moistening, mixing, shearing, compression and/or cooking. Such screws may be produced, for example, in one piece or by assembling elements slipped successively on to a shaft.

In a preferred embodiment of the present die comprising a coaxial tubular extrusion duct, the aperture of the pre-expansion and/or retarding diaphragms and/or of the outlet orifices and/or the distance between the planes of the outlet orifices can be adjusted, in such a way that simultaneously cutting off a central strand emerging from the central outlet orifice and a coaxial tubular strand emerging from a concentric annular outlet orifice produces a core surrounded by a ring integral with the periphery of the latter.

In another preferred embodiment of the die comprising a plurality of coaxial tubular extrusion ducts, the aperture of the pre-expansion and/or retarding diaphragms and/or of the outlet orifices and/or the distance between the planes of the outlet orifices can be adjusted, in such a way that simultaneously cutting off a central strand emerging from the central outlet orifice and a plurality of coaxial tubular strands emerging from a plurality of concentric annular outlet orifices produces a core surrounded by a plurality of concentric rings integral with the latter at intervals.

The adjustability of these apertures and distances may also make it possible to influence the texture of the product, in particular, for example, the degree of expansion of a cooked and extruded product.

It may be assumed that a suitable adjustment of these apertures and distances, which makes it possible to produce a core surrounded by a ring integral with the periphery of the latter or a core surrounded by a

plurality of concentric rings integral with the latter at intervals, is an adjustment which, for example, imparts appreciably different respective speeds to the strands emerging from the central orifice and from the concentric annular orifice.

In the present die, for example, the central extrusion duct may be delimited by the inner wall of an inner nozzle and a coaxial tubular extrusion duct may be delimited by the inner wall of an outer nozzle and by the outer wall of an inner nozzle.

The central outlet orifice may be delimited by the end of an inner nozzle and an annular outlet orifice may be delimited by the ends of inner and outer nozzles.

The aperture of the pre-expansion and/or retarding diaphragms may be adjustable by the substitution of inserts in which these diaphragms are formed.

The aperture of the outlet orifices may be adjustable by the substitution of inner and outer nozzles.

Finally, the distance between the planes of the outlet orifices may be adjustable by the relative axial displacement of inner and outer nozzles.

The extruder according to the present invention therefore comprises an elongate sleeve, containing one or two processing screws, and at least one extrusion die according to the present invention. It preferably comprises furthermore, cutting-off means which may, for example, take the form of a rotary knife rotating against the outlet orifices.

In a preferred embodiment of the extruder comprising a plurality of dies, a downstream part of the sleeve, the said part containing a downstream end of the processing screw or screws, terminates in a front plate which is integral with the sleeve and in which a pre-distribution orifice is provided, the said orifice opening onto a pre-distribution chamber

communicating with the distribution chambers of the dies by means of the feed diaphragms.

5 The pre-distribution orifice may open onto the pre-distribution chamber by means of a pre-distribution diaphragm which, for example, may be adjustable by the substitution of the insert in which it is formed.

10 The product according to the present invention, capable of being obtained by extrusion through the present die therefore has the general shape of a core surrounded by a ring.

15 Preferably, the product is obtained by the extrusion of a material intended as human or animal food and suitably processed by the processing screws of an extruder which, moreover, supply the mechanical energy necessary to cause the said material to pass through the die.

20 Various particular embodiments of the present product may be considered, such as, for example, cooked and extruded cereals, edible pastes, biscuits for domestic animals or granules for breeding animals, such as cattle, poultry or fish.

25 In a preferred embodiment, the present product is an expanded breakfast cereal capable of being obtained by the extrusion cooking of a mixture based on cereal flour and water in an extrusion cooker comprising one or more dies according to the present invention.

30 Such a mixture based on flour and water may, for example, comprise 7-20% water, up to 70% cornflour, up to 70% wheat flour, up to 12% saccharose, up to 10% oil, as well as salt, spices and trace elements. It is also possible, for example, to use flour of rice, oats, barley and/or potato and add to it other ingredients, such as starches, glucose, malt, fat, colouring agents and/or flavouring agents.

Extrusion cooking may be carried out in an extrusion cooker which, for example, has a ratio of length to diameter of the screws of about 10-14, with a rotational speed of the screws of 140-250 rpm, under a

pressure of 40-180 bar, at 105-180°C, and with a water content in the product on emergence from the die of between 5 and 12%.

5 The die, extruder and product according to the present invention are described below with reference to the accompanying drawing which is given as an example and in which:

10 Figures 1 and 2 are two views in axial section of the same embodiment of the die, corresponding to two different relative positions of the outlet orifices,

Figure 3 is a view in partial axial section of an embodiment of an extruder comprising a plurality of dies,

15 Figure 4 is a front view of an embodiment of the product,

Figure 5 is a side view of the embodiment of the product illustrated in Figure 4,

Figure 6 is a front view of different embodiments of the product,

20 Figures 7 and 8 are sectional views, along the line VI-VI, of two particular embodiments of the triangular product illustrated in Figure 6, and

Figure 9 is a front view of another embodiment of the product.

25 In the embodiment illustrated in Figures 1 and 2, the extrusion die comprises a feed diaphragm 6 opening onto a distribution chamber 1, communicating, on the one hand, with a generally conical convergent central extrusion duct 3 by means of a circular central pre-expansion and/or retarding diaphragm 2 and
30 communicating, on the other hand, with a generally conical convergent coaxial tubular extrusion duct 5 by means of an annular pre-expansion and/or retarding diaphragm 4, the central 3 and coaxial tubular 5
35 extrusion ducts having respective concentric central 7 and annular 9 outlet orifices.

The central extrusion duct 3 is delimited by the inner wall of an inner nozzle 70. The coaxial tubular extrusion duct 5 is delimited by the inner wall

of an outer nozzle 90 and by the outer wall of the inner nozzle 70. -

5 The inner nozzle 70 is integral with a positioning disc 71 having holes 72 which ensure communication between the distribution chamber 1 and the annular orifice 41 of the annular diaphragm 4.

10 The central outlet orifice 7 is delimited by the end of the inner nozzle 70. The annular outlet orifice 9 is delimited by the ends of the inner and outer nozzles 70 and 90.

15 The distance between the planes of the outlet orifices 7 and 9 can be adjusted by the relative axial displacement of the inner 70 and outer 90 nozzles. In this particular case, the axial displacement of the inner nozzle 70 in relation to the outer nozzle 90 can be adjusted by means of a compensating washer, such as the washer 73, which may be positioned behind (Figure 1) or in front of (Figure 2) the positioning disc 71.

20 Thus, in the position illustrated in Figure 1, the central 7 and concentric annular 9 outlet orifices are located in the same plane, whilst, in the position illustrated in Figure 2, the central outlet orifice 7 is set back from the concentric annular outlet orifice 9.

25 The aperture of the pre-expansion and/or retarding diaphragms 2 and 4 can be adjusted by the substitution of inserts in which these diaphragms are formed.

30 The aperture of the outlet orifices can be adjusted by the substitution of inner 70 and outer 90 nozzles.

35 In the embodiment illustrated in Figure 3, the extruder comprises an elongate sleeve (not shown) containing one or two processing screws (not shown), and a plurality of extrusion dies, as illustrated in Figures 1 and 2. The downstream part of the sleeve, the said part containing the downstream part of the processing screw or screws, terminates in a front plate 12 which is integral with the sleeve and in which a

pre-distribution orifice 121 is provided, the said orifice opening by means of a pre-distribution diaphragm 10 onto a pre-distribution chamber 11 communicating with the distribution chambers 1 of the dies by means of the feed diaphragms 6.

The extruder comprises, furthermore, cutting-off means which take the form of a rotary knife 13 rotating against the outlet orifices 7 and 9.

Figures 4 and 5 illustrate an embodiment of the product capable of being obtained by extrusion through a die, as illustrated in Figures 1 and 2, in which embodiment the core has the shape of a sphere 14. The ring 15 integral with the periphery of the sphere 14 gives the product an attractive appearance resembling that of the planet Saturn with its ring.

Figure 6 illustrates different embodiments of the product which are capable of being obtained by extrusion through a die similar to that illustrated in Figures 1 and 2, with the exception of the exact shape of the outlet orifices, in which embodiments the core is in the shape of a heart 141, a sphere 142, a five-leafed clover 143, a triangle 144, a figure eight 145 and an ellipse 146.

The rings integral with the periphery of these cores are in the corresponding respective shapes of a heart 151, a five-leafed clover 153, a triangle 154, a figure eight 155 and an ellipse 156, with the exception of a six-petal crown shape 152 which is integral with the periphery of a sphere 142 and which gives the cereal the appearance of a flower composed of six petals.

All these products have a particularly attractive appearance due to the presence of the ring integral with the periphery of the core.

Figures 7 and 8 illustrate two particular embodiments of the triangular product illustrated in Figure 6, in which embodiments the triangular core 144 appears in convex (Figure 7) or concave (Figure 8)

relief in the triangular ring 154 integral with the periphery of the latter.

Finally, Figure 9 illustrates another embodiment of the product capable of being obtained by
5 extrusion through a particular embodiment of the die comprising two coaxial tubular extrusion ducts, in which embodiment the core is in the shape of a sphere 14 surrounded by two rings 15 and 16 integral with the latter at intervals.

10 The following example illustrates how a preferred form of the present product, in this particular case an expanded breakfast cereal, is possibly obtained by the extrusion cooking of a mixture based on flour and water in an extrusion cooker
15 comprising a plurality of dies according to the present invention. In this example, as in this entire description, the percentages and parts are given by weight.

20 Example

With the aid of a double-screw extrusion cooker comprising a plurality of dies, as illustrated in Figure 3, expanded cereals are produced which take the
25 form of a sphere surrounded by a ring, as illustrated in Figures 4 and 5.

For this purpose, a mixture having the following composition is prepared:

30	water	13%
	cornflour	40%
	wheatflour	25%
	sugar	10%
	oil	5%
35	salt/spices	7%

This is extrusion-cooked under the following conditions:

Configuration of the dies:

- Diameter of the circular orifice of the pre-distribution diaphragm: 14 mm,
- 5 diameter of the circular orifice of the feed diaphragms: 8 mm,
- diameter of the circular orifice of the central pre-expansion and/or retarding diaphragms: 8 mm,
- 10 inside and outside diameters of the annular orifices of the annular pre-expansion and/or retarding diaphragms: 26/28 mm,
- diameter of the central outlet orifices: 8 mm,
- inside and outside diameters of the annular outlet orifices: 9/11 mm, and
- 15 distance between the planes of the central and annular outlet orifices: 1 mm.

Extrusion conditions:

- 20 Ratio of length to diameter of the screws: 10,
 rotational speed of the screws: 160 rpm,
 pressure: 120 bar,
 temperature: 150°C, and
 water content on emergence from the die: 7%.

25

Expanded cereals in the form of a sphere surrounded by a ring, having an attractive appearance resembling that of the planet Saturn with its ring, are thus obtained.



Claims

1. Extrusion die comprising a feed diaphragm (6) opening onto a distribution chamber (1) communicating, on the one hand, with a generally conical convergent central extrusion duct (3) by means of a circular central pre-expansion and/or retarding diaphragm (2) and communicating, on the other hand, with at least one generally conical convergent coaxial tubular extrusion duct (5) by means of at least one annular pre-expansion and/or retarding diaphragm (4), the central (3) and coaxial tubular (5) extrusion ducts having respective concentric central (7) and annular (9) outlet orifices.
2. Die according to Claim 1, comprising a coaxial tubular extrusion duct, in which die the aperture of the pre-expansion and/or retarding diaphragms and/or of the outlet orifices and/or the distance between the planes of the outlet orifices can be adjusted, in such a way that simultaneously cutting off a central strand emerging from the central outlet orifice and a coaxial tubular strand emerging from the annular outlet orifice produces a core surrounded by a ring integral with the periphery of the latter.
3. Die according to Claim 1, comprising a plurality of coaxial tubular extrusion ducts, in which die the aperture of the pre-expansion and/or retarding diaphragms and/or of the outlet orifices and/or the distance between the planes of the outlet orifices can be adjusted, in such a way that simultaneously cutting off a central strand emerging from the central outlet orifice and a plurality of coaxial tubular strands emerging from a plurality of concentric annular outlet orifices produces a core surrounded by a plurality of concentric rings integral with the latter at intervals.
4. Extruder, comprising an elongate sleeve, containing one or two processing screws, and at least one extrusion die according to one of Claims 1 to 3.
5. Extruder according to Claim 4, comprising a plurality of dies and a rotary knife (13) rotating



- 12 -

- against their outlet orifices, in which extruder a downstream part of the sleeve, the said part containing a downstream end of the processing screw or screws, terminates in a front plate (12) which is integral with
- 5 the sleeve and in which a pre-distribution orifice (12I) is provided, the said orifice opening onto a pre-distribution chamber (11) communicating with the distribution chambers (1) of the dies by means of the feed diaphragms (6).
- 10 6. Expanded cereal in the general form of a core surrounded by at least one ring, capable of being produced by extrusion through a die according to one of Claims 1 to 3.