of the capital expenditures over the operating expenditures (capex/opex). It is an object to provide a process and apparatus that may be easier to clean and maintain. It is an object to provide a process and apparatus that does not lead to decomposition nor any other substantial modification of the properties of the polymer to be devolatilised.

## SUMMARY

The present disclosure thereto provides a process for reducing volatiles in a polymer melt feed in a devolatilization apparatus, the process comprising the steps of:

- providing a polymer melt feed to a devolatilization nozzle; the nozzle comprising an inlet part, a polymer distribution part comprising headers, and an outlet part comprising a number of apertures, wherein the polymer melt feed is provided to the inlet part at a temperature T;
- passing the polymer melt feed through the apertures, thereby forming polymer strands in a devolatilization vessel;
- collecting the polymer strands in a collector by letting the polymer strands drop over a strand drop height into the collector; thereby obtaining a devolatilised polymer in the collector and removed volatiles;
- recovering the volatiles through a gas outlet of the devolatilization vessel; and,
- recovering the resulting devolatilised polymer from the collector through a polymer outlet of the collector;

**preferably characterized in that**

the polymer melt viscosity at temperature T is at least 100 000 cP and at most 5 000 000 cP;

the average throughput per aperture is at least 5 g/h and at most 100 g/h;

the average aperture diameter is at least 0.5 mm and at most 8.0 mm; and,

the ratio of strand drop height / average aperture diameter is at least 0.5 m/mm to at most 6.0 m/mm.

In one aspect, the present disclosure thereto provides a process for reducing volatiles in a polymer melt feed in a devolatilization apparatus, the process comprising the steps of:

- providing a polymer melt feed to a devolatilization nozzle; the nozzle comprising an inlet part, a polymer distribution part comprising headers, and an outlet part comprising a number of apertures,

wherein the polymer melt feed is provided to the inlet part at a temperature T;

- passing the polymer melt feed through the apertures, thereby forming polymer strands in a devolatilization vessel;
- collecting the polymer strands in a collector by letting the polymer strands drop over a strand drop height into the collector; thereby obtaining a devolatilised polymer in the collector and removed volatiles;
- recovering the volatiles through a gas outlet of the devolatilization vessel; and,
- recovering the resulting devolatilised polymer from the collector through a polymer outlet of the collector;

**characterized in that**

the polymer melt viscosity at temperature T is at least 100 000 cP and at most 5 000 000 cP, wherein the polymer melt viscosity is measured using a capillary rheometer Rosand with a die of 1 mm diameter and 16 mm length;
the average throughput per aperture is at least 5 g/h and at most 100 g/h;
the average aperture diameter is at least 0.5 mm and at most 8.0 mm; and,
the ratio of strand drop height / average aperture diameter is at least 1.0 m/mm to at most 6.0 m/mm.

In some preferred examples, the polymer melt viscosity at temperature T is at least 200 000 cP and at most 2 500 000 cP, preferably at least 500 000 cP and at most 2 000 000 cP; preferably at least 750 000 cP and at most 1 500 000 cP; most preferably about 1 000 000 cP.

In some preferred examples, the average throughput per aperture is at least 10 g/h and at most 75 g/h; preferably at least 20 g/h and at most 50 g/h; most preferably about 25 g/h;

wherein the average throughput per aperture is calculated by dividing the total throughput by the number of apertures.

In some preferred examples, the pressure drop across the nozzle is least 2.0 bar and at most 30.0 bar; preferably at least 3.0 bar and at most 15.0 bar; more preferably at least 4.0 bar and at most 10.0 bar; most preferably about 6.0 bar.

In some preferred examples, the polymer temperature is at least 150 ˚C and at most 300 ˚C; preferably at least 170 ˚C and at most 280 ˚C; more preferably at least 190 ˚C and at most 260 ˚C; most preferably at least 200 ˚C and at most 240 ˚C.

In some preferred examples, the pressure in the devolatilization vessel outside the nozzle is at least 0.5 mbar abs and at most 500.0 mbar abs; preferably at least 1.0 mbar abs and at most 200.0 mbar abs; more preferably at least 1.2 mbar abs and at most 10.0 mbar abs; most preferably about 1.5 mbar abs.

In some preferred examples, the average aperture diameter is at least 0.5 mm and at most 8.0 mm; preferably at least 1.0 mm and at most 6.0 mm; more preferably at least 1.5 mm and at most 4.0 mm; most preferably about 2.0 mm.

In some preferred examples, the strand drop height is at least 1.0 m and at most 20.0 m; preferably at least 2.0 m and at most 10.0 m; more preferably at least 4.0 m and at most 8.0 m; most preferably about 6.0 m.

In some preferred examples, the ratio of polymer viscosity at temperature T / average aperture diameter is at least 50 000 cp/mm to at most 4 000 000 cp/mm; preferably at least 60 000 cp/mm to at most 2 500 000 cp/mm; preferably at least 80 000 cp/mm to at most 1 500 000 cp/mm; preferably at least 150 000 cp/mm to at most 1 200 000 cp/mm; preferably at least 200 000 cp/mm to at most 1 000 000 cp/mm; preferably at least 400 000 cp/mm to at most 600 000 cp/mm, preferably around 500 000 cp/mm.

In some preferred examples, the ratio of strand drop height / average aperture diameter is at least 0.5 m/mm to at most 6.0 m/mm; preferably at least 1.0 m/mm to at most 5.0 m/mm; preferably at least 2.0 m/mm to at most 4.0 m/mm; preferably about 3.0 m/mm.

In some preferred examples, the ratio of average distance between adjacent apertures / average aperture diameter is at least 0.5 to at most 10.0; preferably at least 1.0 to at most 5.0; preferably at least 1.5 to at most 4.0; preferably about 2.0.

In some preferred examples, the ratio of average throughput per aperture / average aperture diameter is at least at least 2.0 g/h/mm to at most 50.0 g/h/mm; preferably at least 5.0 g/h/mm to at most 30.0 g/h/mm; preferably at least 10.0 g/h/mm to at most 15.0 g/h/mm.

In some preferred examples, the polymer melt feed comprises polystyrene or polylactic acid.

The present disclosure thereto provides a devolatilization apparatus for removing volatiles from a polymer melt feed, the apparatus configured to perform the process as described here, and examples thereof.

More particularly, the disclosure provides in a devolatilization apparatus for removing volatiles from a polymer melt feed, the apparatus comprising:

- a devolatilization nozzle comprising an inlet part, a polymer distribution part comprising headers, and an outlet part comprising a number of apertures, configured to form polymer strands in a devolatilization vessel;
- a collector, configured to collect the polymer strands in the devolatilization vessel;
- a polymer outlet, configured to remove the collected polymer from the collector; and,
- a gas outlet, configured to remove the volatiles from the devolatilization vessel;

wherein the average aperture diameter is at least 0.5 mm and at most 8.0 mm; and,

wherein the ratio of strand drop height / average aperture diameter is at least 0.5 m/mm to at most 6.0 m/mm.

In a further aspect, the present disclosure thereto provides a devolatilization apparatus for removing volatiles from a polymer melt feed, the apparatus configured to perform the process as described herein; and wherein the apparatus comprises

- a devolatilization nozzle comprising an inlet part, a polymer distribution part comprising headers, and an outlet part comprising a number of apertures, configured to form polymer strands in a devolatilization vessel;
- a collector, configured to collect the polymer strands in the devolatilization vessel;

- a polymer outlet, configured to remove the collected polymer from the collector; and,
- a gas outlet, configured to remove the volatiles from the devolatilization vessel,

wherein the average throughput per aperture is at least 5 g/h and at most 100 g/h; wherein the average aperture diameter is at least 0.5 mm and at most 8.0 mm; and,
wherein the ratio of strand drop height / average aperture diameter is at least 1.0 m/mm to at most 6.0 m/mm.

In some preferred examples, the average aperture diameter is at least 0.5 mm and at most 8.0 mm; and the strand drop height is at least 1.0 m and at most 20.0 m.

The present disclosure thereto provides a devolatilised polymer, obtained through a process as described herein, and examples thereof, or with an apparatus as described herein, and examples thereof. The devolatilised polymer preferably comprises a residuals concentration of volatiles at the outlet of at most 3 000 ppm.

The present disclosure, and examples thereof, provides an improved process for reducing volatiles in a polymer melt feed, for example in a second step devolatilization, and an improved apparatus for removing volatiles from a polymer melt feed, for example in a second step devolatilization.

The polymer degassing is very efficient. The polymer distribution inside the nozzle is particularly optimised for efficient degassing. Furthermore, disadvantages of other stripping methods are avoided, swelling is minimised, and the strands are more stable.

The polymer degassing may be so efficient that there is no need for the use of blowing agents or for expanding the polymer during the degassing process, resulting in un-expanded polymer. Processes for degassing polymers without producing expanded polymers may be favourable as they do not require an extra melt step to obtain degassed un-expanded polymer.

Being able to work at optimised aperture diameters allows for simpler engineering, lower capex and opex.

Being able to work at reduced pressure drops allows for a reduced energy consumption and spares the mechanical integrity of the apparatus.

Being able to work at reduced temperatures allows for a reduced energy consumption and reduces the thermal degradation of the polymer.

The present apparatus also allows for easy cleaning and maintenance.

**DETAILED DESCRIPTION OF THE INVENTION**

When describing the invention, the terms used are to be construed in accordance with the following definitions, unless a context dictates otherwise.

As used herein, the singular forms "a", "an", and "the" include both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a resin" means one resin or more than one resin.

The terms "comprising", "comprises" and "comprised of" as used herein are synonymous with "including", "includes" or "containing", "contains", and are inclusive or open-ended and do not exclude additional, non-recited members, elements, or method steps. It will be appreciated