POLYMERIZER APPARATUS

Filed Dec. 8, 1966

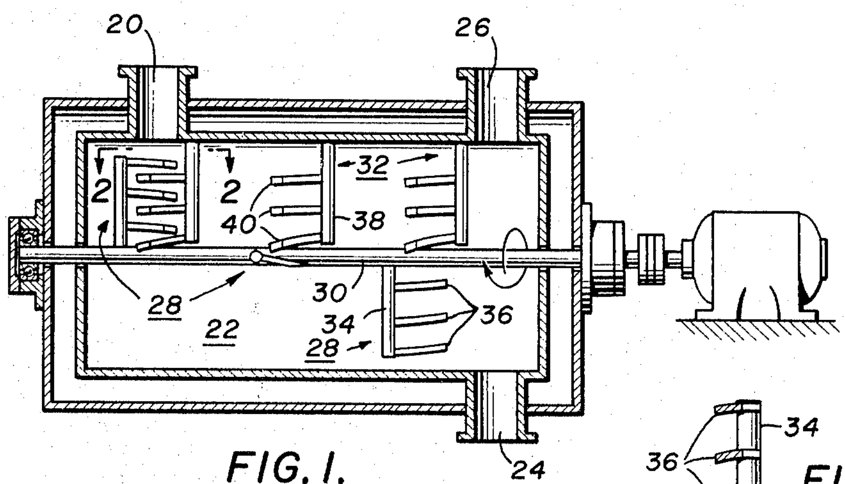

FIG. 1.

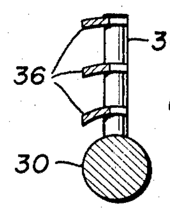

FIG. 3.

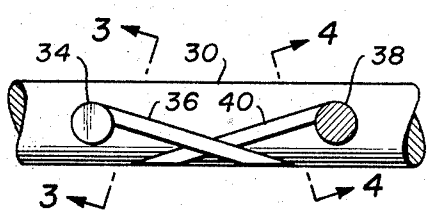

FIG. 2.

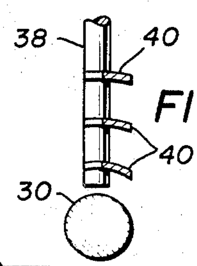

FIG. 4.

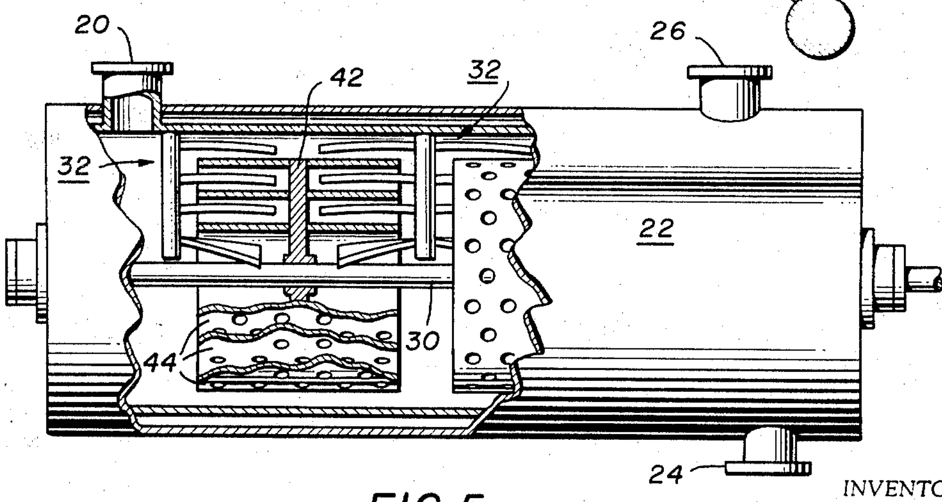

FIG. 5.

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3,476,523
Patented Nov. 4, 1969

3,476,523

POLYMERIZER APPARATUS

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Filed Dec. 8, 1966, Ser. No. 600,259
Int. Cl. B01j *3/00*
U.S. Cl. 23—285 7 Claims

ABSTRACT OF THE DISCLOSURE

Rotor fingers radially-spaced from a generally parallel horizontal axis about which they rotate lift polymer in films and streams above the liquid level. Stator members are mounted above the liquid level and within the cylindrical surface generated by the rotor fingers. The polymer films and streams fall from the rotor fingers to the stator members, and are thereafter stretched as the rotor fingers continue to rotate. This generates added polymer surface and aids in removing volatile components. The stator members are skewed so as to advance the polymer. In another embodiment the rotor fingers are replaced by perforated rotating cylinders.

The present invention relates to a polymerizer particularly designed to provide high film formation and efficient fluid transport, and which is particularly suitable for materials of high viscosity.

In polymerization of condensation polymers, the removal of volatile by-products and providing fluid transport from inlet to outlet is usually very difficult when extremely high viscosities are attained. The present invention provides for removal of volatile by-products by increasing film formation, which is accomplished by interleaved rotor and stator members. Fluid transport is achieved by raking one or both of the stator or rotor members, so that they form modified screw flights.

A primary object of the invention is to provide polymerization apparatus which promotes efficient removal of volatile by-products by the cooperation of interleaved rotor and stator members.

A further object is to provide polymerization apparatus which efficiently transports the polymerizing material from inlet to outlet end.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a more complete understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a schematic side elevation view, partly broken away, of a first embodiment of the invention;

FIGURE 2 is a view along line 2—2 in FIGURE 1 showing the pitch angles of the rotor and stator fingers;

FIGURE 3 is a view along line 3—3 in FIGURE 2, illustrating a preferred construction of the rotor fingers;

FIGURE 4 is a view along line 4—4 in FIGURE 2, showing a preferred construction of the stator fingers. and

FIGURE 5 is a side elevation view, partly broken away, of the preferred embodiment of the invention.

In the FIGURE 1 embodiment, a low molecular weight polymer is fed through line **20** to the inlet end of a generally horizontally extending vessel **22**, while high molecular weight polymer is withdrawn through line **24** at the outlet end of vessel **22**. The vaporous by-products are withdrawn through line **26**. As the reacting material moves through vessel **22** it is formed into a large number of films and strands by rotor assemblies **28** mounted

on shaft **30**, in cooperation with a like plurality of fixed stator assemblies **32** attached to the wall of the vessel.

Each rotor assembly **28** in the FIGURE 1 embodiment includes a radially extending support arm **34** attached to shaft **30** and supporting generally horizontally extending, radially spaced rotor fingers **36**. Fingers **36** thus generate concentric cylindrical surfaces as shaft **30** rotates on its axis.

Each stator assembly **32** includes a depending support **38** arm attached to the upper portion of vessel **22**. A plurality of horizontal stator fingers **40** extend from support **38** to the interior of the cylinders generated by fingers **36**. Fingers **36** and **40** are thus interleaved with one another as shaft **30** rotates. As the fingers interleave, the polymer trailing from fingers **36** is pulled therefrom by stationary fingers **40** in the form of films and strings. This creates a large surface area, promoting efficient removal of the volatile by-products. Preferably several cooperating pairs of assemblies **28** and **32** are provided and are staggered along the length of shaft **30**.

Stator fingers **40** should be above the normal liquid level in vessel **22**. Preferably the lowermost stator finger **40** almost scrapes shaft **30**, while the outermost rotor finger **36** almost scrapes those portions of the wall of vessel **22** which are beneath the liquid level, in order to minimize stagnant regions where the polymer might degrade.

In addition to the film-forming function of the interleaved rotor and stator assemblies, transport of the viscous mass longitudinally within vessel **22** can be achieved by proper orientation of fingers **36** and **40**. Thus fingers **36** and **40** are raked so that they extend helically about instead of parallel to the axis shaft **30**, as best shown in FIGURE 2. Fingers **36** thus constitute longitudinally-extending, radially-spaced segments of a screw flight of a given pitch. Advantageously, fingers **40** are raked to constitute complementary segments of a screw flight of opposite pitch, thus cooperating with fingers **36** in transporting the polymer. Either or both of fingers **36** and **40** may define a pitch angle between 0° and 80° with the axis of shaft **30**.

The clearance between fingers **36** and **40** as they interleave is not particularly critical. In a specific embodiment a clearance of about ¼" between adjacent interleaving fingers was found to be satisfactory, with ⅛" clearance between the lowermost stator finger **40** and shaft **22**, and with a ⅛" clearance between the outermost rotor finger **36** and the lowermost portion of vessel **22**. The surfaces of fingers **36** and **40** preferably are contoured to conform to segments of respective cylinders coaxial with shaft **30**, as shown in FIGURES 3 and 4.

FIGURE 5 shows the preferred embodiment of the invention, wherein the rotor fingers **36** of FIGURE 1 embodiment are replaced by perforated cylinders. Radial arms **42** extend outwardly from shaft **30** and support a plurality of perforated cylinders **44** arranged concentrically about shaft **30**. Outermost cylinder **44** almost scrapes those portions of vessel **22** which are beneath the liquid level. The stator assemblies **32** may be similar in form to those in the FIGURE 1 embodiment; fingers **40** are preferably raked to constitute longitudinally extending segments of a screw flight. In the illustrated FIGURE 5 embodiment, radial arms **42** extend through the centers of cylinders **44**, and those stator support arms **38** not adjacent the ends of vessel **22** carry opposed stator fingers **36** extending into the adjacent cylinders **44**. With reasonably high viscosities, apertures **46** in cylinders **44** may be circles with diameters between about ½ inch and about 6 inches, although the dimensions or shape of apertures **46** is not critical so long as the polymer being processed can sag through the orifices in time to be drawn into films and the like by stator fingers **40**. Selection of orifice size and rotor revolution rate, together with clearances between interleaving parts, etc. can readily be done for a given polymer viscosity. Generally, from 1 to 100 r.p.m. will encompass the range of appropriate rotor speeds.

In either the FIGURE 1 or the FIGURE 5 embodiment, other types of screw flights may be added if desired to assist in transporting the viscous mass through the finisher, although ordinarily this will not be necessary.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A polymerizer reactor comprising in combination:
(a) a generally horizontally extending shaft rotating about its axis,
(b) means mounted on said shaft for generating a plurality of radially-spaced cylinders as said shaft rotates,
(c) stationary walls defining a vessel, said walls including a generally cylindrical portion closely surrounding the lower half of the outermost of said generated cylinders,
(d) means extending from one of said stationary walls and supporting stator members between adjacent cylinders, said stator members extending within and closely adjacent said cylinders over most of the length of said cylinders, said stator members being positioned above the normal liquid level in said vessel,
(e) means for heating said vessel,
(f) means for introducing polymerizable material at one end of said vessel, and
(g) means for recovering polymerized material at the opposite end of said vessel.

2. The reactor defined in claim 1, wherein said stator members are raked to define helically extending screw flight segments radially spaced from said shaft.

3. A polymerizer reactor comprising in combination:
(a) a generally horizontally extending shaft rotating about its axis,
(b) a perforated cylinder supported at one end by said shaft, said perforated cylinder being concentric with and surrounding a portion of said shaft,

(c) a generally cylindrical stationary vessel surrounding said shaft and said perforated cylinder,
(d) stator means supported by said vessel and extending within and closely adjacent said cylinder above the normal liquid level over most of the length of said cylinder,
(e) means for heating said vessel,
(f) means for introducing polymerizable material at one end of said vessel, and
(g) means for recovering polymerized material at the opposite end of said vessel.

4. The reactor defined in claim 3, wherein said stator means are raked to define helically extending screw flight segments radially spaced from said shaft.

5. A polymerizer reactor comprising in combination:
(a) a generally horizontally extending shaft rotating about its axis,
(b) walls defining a stationary vessel, said walls including a generally cylindrical portion surrounding said shaft,
(c) means on said shaft supporting a plurality of rotor fingers at different radii about said shaft, said rotor fingers extending about said shaft at helix angles between 0° and 80°,
(d) means extending from one of said walls supporting a plurality of stator fingers interleaving with said rotor fingers as said rotor rotates about said axis,
(e) means for heating said vessel,
(f) means for introducing polymerizable material at one end of said vessel, and
(g) means for recovering polymerized material at the opposite end of said vessel.

6. The reactor defined in claim 5, wherein said stator fingers are raked at helix angles between 0° and 80° to define helically extending screw flight segments radially spaced from said shaft.

7. The reactor defined in claim 5, wherein said stator fingers are raked to define segments of a helix of opposite pitch from the helix defined by said rotor fingers.

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U.S. Cl. X.R.

23—290; 55—87, 178, 182, 203; 159—4, 6; 259—9, 10; 260—95