of accidental closure of valves for example, the circuit may have to sustain the full shut-off head of the coolant circulation pump(s).

We have found that it is possible to reduce further the thickness of the reactor wall for a given wall material by designing the reactor cooling system so as to minimise the maximum pressure which the jacket must be designed to withstand ("design pressure"). As explained above, the design pressure of the jacket is intended to ensure that in all operating conditions, including possible malfunctions, the (vertical) jacket can be maintained full of coolant without risk of damage or failure. Design pressure is a fundamental characteristic of any piece of equipment designed to operate at pressure, and is therefore always marked on all relevant parts of the reactor system for safety reasons. It can be defined as the pressure at the most severe condition of coincident internal or external pressure and temperature expected during normal service.

The present invention is based on the appreciation that since a tube of a given thickness can withstand a higher internal pressure than external pressure, the external jacket design pressure can often be the limiting factor when determining the minimum required thickness of the reactor wall, rather than the (higher) internal reactor design pressure. Therefore if the jacket design pressure is lower, the maximum external pressure to which the reactor wall may be subjected at any time is lower, and hence the thickness of the wall can be reduced. Thus unlike in US 5565175, in which a reduction in required wall thickness is accomplished by a different manufactucturing method and materials for the reactor wall, the present invention can achieve reduction in required thickness without changing the reactor wall construction.

Accordingly in a first aspect the present invention provides a tubular reactor for use in polymerisation reactions having a design pressure P_R of 40-65 barg, the reactor comprising a tube having a wall, at least a portion of the tube~~which~~ is oriented vertically and at least part of which vertical portion is surrounded by a concentric jacket for the passage of cooling fluid, wherein the design pressure in barg of the jacket P_J is less than $0.0018.P_R^{2.25}$.

By "oriented vertically" is meant that the relevant portion of the reactor has a longitudinal axis which is no more than 30 degrees from vertical, preferably no more than 10 degrees from vertical.

Embodiments of~~In an alternative aspect,~~ the present invention further provides a tubular reactor for use in polymerisation reactions having a design pressure P_R of 40-65 barg, at least a portion of

CLAIMS

1. Tubular reactor for use in polymerisation reactions having a design pressure P_R of 40-65 barg, at least a portion of which is oriented vertically and at least part of which vertical portion is surrounded by a concentric jacket for the passage of cooling fluid, wherein the design pressure in barg of the jacket P_J is less than $0.0018.P_R^{2.25}$.

2. Reactor according to claim 1, wherein the actual thickness of the reactor wall is either no more than 2mm greater and/or no more than 10% greater than the minimum wall thickness required to withstand the design pressure P_R as calculated according to the ASME Boiler and Pressure Vessel code.

3. Tubular reactor for use in polymerisation reactions having a design pressure P_R of 40-65 barg, at least a portion of which is oriented vertically and at least part of which vertical portion is surrounded by a concentric jacket for the passage of cooling fluid, wherein the actual thickness of the reactor wall is either no more than 2mm and/or no more than 10% greater than at least one of: either the minimum wall thickness required to withstand the design pressure P_R as calculated according to the ASME Boiler and Pressure Vessel code, or the wall design thickness t (mm) calculated according to the relationship $t = P_R.R/(10S\text{-}0.5\ P_R) + C + tol$ where R is the internal radius of the reactor tube in mm, S is the design stress intensity at the design temperature in MPa, C is the sum of the inside and outside corrosion allowances for the reactor wall in mm, and tol is the manufacturing tolerance in mm.

4. Reactor according to claim 3, wherein the design pressure of the jacket P_J is less than $0.0018.P_R^{2.25}$.

5. Reactor according to any preceding claim, wherein the design pressure of the jacket P_J is less than $0.0005.P_R^{2.52}$.

6. Reactor according to any preceding claim, wherein the actual thickness of the reactor wall is either no more than 1mm and/or no more than 5% greater than at least one of: the minimum wall thickness required to withstand the design pressure P_R as

calculated according to the ASME Boiler and Pressure Vessel code, and the wall design thickness t (mm) calculated according to the relationship $t = P_R.R/(10S-0.5 P_R) + C + tol$ where R is the internal radius of the reactor tube in mm, S is the design stress intensity at the design temperature in MPa, C is the sum of the inside and outside corrosion allowances for the reactor wall in mm, and tol is the manufacturing tolerance in mm.

7. Reactor according to any preceding claim, wherein the design pressure of the jacket P_J is greater than H/10 where H is the vertical height of the vertically oriented portion of the jacket in metres.

8. Reactor according to any preceding claim, wherein the design pressure of the jacket P_J is such that the wall thickness required to withstand the pressure P_J is equal to or less than the wall thickness required to withstand the internal reactor design pressure P_R.

9. Reactor according to any preceding claim, wherein the thickness of the reactor wall is greater at the lowest part of the reactor than at the highest part.

10. Reactor according to any preceding claim, wherein the reactor wall is constructed of a material having a tensile strength of at least 447 MPa, and preferably above 451 MPa.

CLAIMS

1. Tubular reactor for use in polymerisation reactions having a design pressure P_R of 40-65 barg, said reactor comprising a tube having a wall, at least a portion of the tube being oriented vertically and at least part of which vertical portion is surrounded by a concentric jacket for the passage of cooling fluid, wherein the design pressure in barg of the jacket P_J is less than $0.0018 \cdot P_R^{2.25}$.

2. Reactor according to claim 1, wherein the actual thickness of the reactor wall is either no more than 2 mm greater or no more than 10% greater than the wall thickness t (mm) calculated according to the relationship $t=P_R \cdot R/(10S-0.5P_R)+C+tol$ where R is the internal radius of the reactor tube in mm, S is the design stress intensity at the design temperature in MPa, C is the sum of the inside and outside corrosion allowances for the reactor wall in mm, and tol is the manufacturing tolerance in mm.

3. Reactor according to claim 1, wherein the design pressure in barg of the jacket P_J is less than $0.0005 \cdot P_R^{2.52}$.

4. Reactor according to claim 1, wherein the actual thickness of the reactor wall is either no more than 1 mm or no more than 5% greater than the wall design thickness t (mm) calculated according to the relationship $t=P_R \cdot R/(10S-0.5P_R)+C+tol$ where R is the internal radius of the reactor tube in mm, S is the design stress intensity at the design temperature in MPa, C is the sum of the inside and outside corrosion allowances for the reactor wall in mm, and tol is the manufacturing tolerance in mm.

5. Reactor according to claim 1, wherein the design pressure in barg of the jacket P_J is greater than H/10 where H is the vertical height of the vertically oriented portion of the jacket in meters.

6. Reactor according to claim 1, wherein the design pressure of the jacket P_J is such that the wall thickness required to withstand the pressure P_J is equal to or less than the wall thickness required to withstand the internal reactor design pressure P_R.

7. Reactor according to claim 1, wherein the thickness of the reactor wall is greater at the lowest part of the reactor than at the highest part.

8. Reactor according to claim 1, wherein the reactor wall is constructed of a material having a tensile strength of at least 447 MPa.

9. Reactor according to claim 8, wherein the reactor wall is constructed of a material having a tensile strength of above 451 MPa.