CLAIMS:

1. A process for oligomerising a hydrocarbon to form at least one co-monomer product, the process including

feeding a hydrocarbon reactant and organic liquid diluent solvent into an oligomerisation reactor which is at an elevated pressure above atmospheric pressure, said organic liquid diluent solvent having a normal boiling point below the normal boiling point of 1-hexene but above -20°C, or said organic liquid diluent solvent being in the form of a solvent admixture with at least 70% by mass of the solvent admixture constituting organic liquid diluent solvents having a normal boiling point below the normal boiling point of 1-hexene but above -20°C, and said oligomerisation reactor holding at least one co-monomer product formed in the oligomerisation reactor admixed with a catalyst system introduced into the oligomerisation reactor, said catalyst system including a catalyst dissolved in at least one catalyst solvent to facilitate introducing said catalyst system into the oligomerisation reactor;

oligomerising at least a portion of the hydrocarbon reactant in the reactor to form said at least one co-monomer product and polymeric by-product as part of a liquid product with the liquid product thus including organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product; and

withdrawing liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product from the reactor,

wherein, when there is only one catalyst solvent and only one organic liquid diluent solvent, said catalyst solvent and said organic liquid diluent solvent are not the same solvent, and when there is more than one catalyst solvent or more than one organic liquid diluent solvent, at least one of the catalyst solvents is not also used as organic liquid diluent solvent or at least one of the organic liquid diluent solvents is not also used at the catalyst solvent, and wherein the mass ratio of all organic liquid diluent solvent introduced into the oligomerisation reactor to all catalyst solvent introduced into the oligomerisation reactor over a selected time period is between 15:1 and 4500:1.

2. The process as claimed in claim 1, in which the mass ratio of all organic liquid diluent solvent introduced into the oligomerisation reactor to all catalyst solvent introduced into the oligomerisation reactor is between 150:1 and 1500:1.

3. The process as claimed in claim 1 or claim 2, which includes feeding the organic liquid diluent solvent into the oligomerisation reactor, such that the mass fraction of the organic liquid diluent solvent in said liquid product on a hydrocarbon reactant free basis is maintained between 0.4 and 0.8.

4. The process as claimed in any of claims 1 to 3, in which the organic liquid diluent solvent is selected to have an increased solubility of liquid ethylene as hydrocarbon reactant in the organic liquid diluent solvent compared to the solubility of liquid ethylene in propane, at the same temperature and pressure.

5. The process as claimed in any of claims 1 to 5, in which the organic liquid diluent solvent is selected from the group consisting of isobutane, isopentane, neopentane, 2-methylpentane, 3-methylpentane, 2,2-dimethylbutane, and mixtures of two or more thereof.

6. The process as claimed in any of claims 1 to 5, in which the catalyst solvent is selected from the group consisting of 1-hexene, 1-octene, cyclohexane, methylcyclohexane, methylcylopentane, methylenecyclopentane, and mixtures of two or more thereof.

7. The process as claimed in any of claims 1 to 6, in which the hydrocarbon reactant is ethylene, the process using a catalyst system which favours tetramerisation of ethylene so that at least 30% by mass of the liquid product formed is 1-octene.

8. The process as claimed in any of claims 1 to 7, which includes treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent, treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent including

flashing the withdrawn liquid product in at least one flash stage;

subjecting an overheads vapour stream from the at least one flash stage to at least one distillation operation; and

withdrawing the unreacted hydrocarbon reactant and diluent solvent as an overhead stream from the distillation operation.

9. The process as claimed in claim 8, in which the withdrawn unreacted hydrocarbon reactant and organic liquid diluent solvent are recycled together as a single stream to the oligomerisation reactor.

10. The process as claimed in claim 8 or claim 9, in which treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent includes subjecting a bottoms stream from said at least one flash stage to at least one further flash stage which is at a lower pressure than said at least one flash stage.

11. The process as claimed in claim 10, in which the bottoms stream from said at least one flash stage is heated to a temperature of at least 190°C before being flashed in said at least one further flash stage, and in which the heated bottoms stream from said at least one flash stage is flashed in said at least one further flash stage at a pressure which is at least 2 bar less than an operating pressure of said at least one flash stage so that said at least one further flash stage provides a concentrated polymer bottoms stream which includes most of the polymeric by-product and an overhead vapour stream which includes some unreacted hydrocarbon reactant, some vapourised organic liquid diluent solvent and some co-monomer product, the process further including condensing said overhead vapour stream from said at least one further flash stage and recycling the condensed overhead vapour stream to said at least one distillation operation where any unreacted hydrocarbon reactant and organic liquid diluent solvent are recovered and recycled to the oligomerisation reactor.

12. The process as claimed in claim 11, in which operating conditions of the at least one further flash stage are selected such that said overhead vapour stream from said at least one further flash stage is condensed at a pressure of less than 10 bar(a) with plant cooling water at a temperature of between 20°C and 40°C, with more than

95% by mass of the unreacted hydrocarbon reactant reporting to the at least one further flash stage being condensed.

13. The process as claimed in any of claims 1 to 12, in which the oligomerisation reactor is a bubble column reactor holding said liquid product as part of a bulk liquid phase, and in which

feeding a hydrocarbon reactant and organic liquid diluent solvent into the oligomerisation reactor includes feeding into the bulk liquid phase of the bubble column reactor fresh hydrocarbon reactant which has been condensed and said organic liquid diluent solvent and said catalyst system,

oligomerising at least a portion of the hydrocarbon reactant in the reactor to form said at least one co-monomer product and polymeric by-product includes allowing at least a portion of the hydrocarbon reactant and the organic liquid diluent solvent to vapourise to form bubbles rising through the bulk liquid phase, with the hydrocarbon reactant oligomerising to form as part of the bulk liquid phase said liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product, and with the evaporation of both the hydrocarbon reactant and the organic liquid diluent solvent effecting heat removal from the bulk liquid phase, and in which

withdrawing liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product from the reactor includes withdrawing some of the bulk liquid phase to maintain the bulk liquid phase at a desired level,

the process further including

allowing gaseous components comprising any unreacted vapourised hydrocarbon reactant and vapourised organic liquid diluent solvent and any oligomerisation product that reports to a vapour phase to disengage from the bulk liquid phase into a head space in the bubble column reactor above the bulk liquid phase;

withdrawing the gaseous components from the head space;

cooling the gaseous components withdrawn from the head space thereby at least partially to condense the gaseous components, forming a vapour fraction and a liquid fraction both of which include an admixture of unreacted hydrocarbon reactant, organic liquid diluent solvent and oligomerisation product;

recycling the condensed liquid fraction to the bulk liquid phase in the bubble column reactor; and

withdrawing the vapour fraction.

14. The process as claimed in claim 13, in which fresh gaseous hydrocarbon reactant and optionally recycled vapourised unreacted hydrocarbon reactant and optionally recycled vapourised organic liquid diluent solvent recovered from the withdrawn bulk liquid phase is combined and condensed with the gaseous components withdrawn from the head space before the gaseous components are cooled and condensed, and in which the organic liquid diluent solvent in the bulk liquid phase is selected and maintained at a mass concentration such that, at a bubble column reactor pressure of between 40 bar(a) and 80 bar(a) more than 99.5% by mass of the gaseous components from the head space, fresh gaseous hydrocarbon reactant, any recycled unreacted hydrocarbon reactant and any recycled organic liquid diluent solvent recovered from the withdrawn bulk liquid phase is condensed at a temperature below 35°C.

15. The process as claimed in claim 14, in which said condensation at a temperature below 35°C takes place at a pressure below the supercritical pressure of ethylene, using an absorption refrigeration system.

CLAIMS:

1. A process for oligomerising a hydrocarbon to form at least one co-monomer product, the process including

feeding a hydrocarbon reactant and organic liquid diluent solvent into an oligomerisation reactor which is at an elevated pressure above atmospheric pressure, said organic liquid diluent solvent having a normal boiling point below the normal boiling point of 1-hexene but above −20° C., or said organic diluent solvent being in the form of a solvent admixture with at least 70% by mass of the solvent admixture constituting organic diluent solvents having a normal boiling point below the normal boiling point of 1-hexene but above −20° C., and said oligomerisation reactor holding at least one co-monomer product formed in the oligomerisation reactor admixed with a catalyst system introduced into the oligomerisation reactor, said catalyst system including a catalyst dissolved in at least one catalyst solvent to facilitate introducing said catalyst system into the oligomerisation reactor;

oligomerising at least a portion of the hydrocarbon reactant in the reactor to form said at least one co-monomer product and polymeric by-product as part of a liquid product with the liquid product thus including organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product; and

withdrawing liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product from the reactor,

wherein, when there is only one catalyst solvent and only one organic liquid diluent solvent, said catalyst solvent and said organic liquid diluent solvent are not the same solvent, and when there is more than one catalyst solvent or more than one organic liquid diluent solvent, at least one of the catalyst solvents is not also used as organic liquid diluent solvent or at least one of the organic liquid diluent solvents is not also used at the catalyst solvent, and wherein the mass ratio of all organic liquid diluent solvent introduced into the oligomerisation reactor to all catalyst solvent introduced into the oligomerisation reactor over a selected time period is between 15:1 and 4500:1.

2. The process as claimed in claim **1**, in which the mass ratio of all organic liquid diluent solvent introduced into the oligomerisation reactor to all catalyst solvent introduced into the oligomerisation reactor is between 150:1 and 1500:1.

3. The process as claimed in claim **1**, which includes feeding the organic liquid diluent solvent into the oligomerisation reactor, such that the mass fraction of the organic liquid diluent solvent in said liquid product on a hydrocarbon reactant free basis is maintained between 0.4 and 0.8.

4. The process as claimed in claim **1**, in which the organic liquid diluent solvent is selected from the group consisting of isobutane, isopentane, neopentane, 2-methylpentane, 3-methylpentane, 2,2-dimethylbutane, and mixtures of two or more thereof.

5. The process as claimed in claim **1**, in which the catalyst solvent is selected from the group consisting of 1-hexene, 1-octene, cyclohexane, methylcyclohexane, methylcylopentane, methylenecyclopentane, and mixtures of two or more thereof.

6. The process as claimed in claim **1**, in which the hydrocarbon reactant is ethylene, the process using a catalyst system which favours tetramerisation of ethylene so that at least 30% by mass of the liquid product formed is 1-octene.

7. The process as claimed in claim **1**, which includes treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent, treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent including

flashing the withdrawn liquid product in at least one flash stage;

subjecting an overheads vapour stream from the at least one flash stage to at least one distillation operation; and

withdrawing the unreacted hydrocarbon reactant and diluent solvent as an overhead stream from the distillation operation.

8. The process as claimed in claim **7**, in which the withdrawn unreacted hydrocarbon reactant and organic liq-

uid diluent solvent are recycled together as a single stream to the oligomerisation reactor.

9. The process as claimed in claim **7**, in which treating the withdrawn liquid product to separate co-monomer product and any polymeric by-product from unreacted hydrocarbon reactant and organic liquid diluent solvent includes subjecting a bottoms stream from said at least one flash stage to at least one further flash stage which is at a lower pressure than said at least one flash stage.

10. The process as claimed in claim **9**, in which the bottoms stream from said at least one flash stage is heated to a temperature of at least 190° C. before being flashed in said at least one further flash stage, and in which the heated bottoms stream from said at least one flash stage is flashed in said at least one further flash stage at a pressure which is at least 2 bar less than an operating pressure of said at least one flash stage so that said at least one further flash stage provides a concentrated polymer bottoms stream which includes most of the polymeric by-product and an overhead vapour stream which includes some unreacted hydrocarbon reactant, some vapourised organic liquid diluent solvent and some co-monomer product, the process further including condensing said overhead vapour stream from said at least one further flash stage and recycling the condensed overhead vapour stream to said at least one distillation operation where any unreacted hydrocarbon reactant and organic liquid diluent solvent are recovered and recycled to the oligomerisation reactor.

11. The process as claimed in claim **10**, in which operating conditions of the at least one further flash stage are selected such that said overhead vapour stream from said at least one further flash stage is condensed at a pressure of less than 10 bar(a) with plant cooling water at a temperature of between 20° C. and 40° C., with more than 95% by mass of the unreacted hydrocarbon reactant reporting to the at least one further flash stage being condensed.

12. A process for oligomerising a hydrocarbon to form at least one co-monomer product, the process including

feeding a hydrocarbon reactant and organic liquid diluent solvent into an oligomerisation reactor which is at an elevated pressure above atmospheric pressure, said

organic liquid diluent solvent having a normal boiling point below the normal boiling point of 1-hexene but above −20° C., or said organic diluent solvent being in the form of a solvent admixture with at least 70% by mass of the solvent admixture constituting organic diluent solvents having a normal boiling point below the normal boiling point of 1-hexene but above −20° C., and said oligomerisation reactor holding at least one co-monomer product formed in the oligomerisation reactor admixed with a catalyst system introduced into the oligomerisation reactor, said catalyst system including a catalyst dissolved in at least one catalyst solvent to facilitate introducing said catalyst system into the oligomerisation reactor, in which the oligomerisation reactor is a bubble column reactor holding said liquid product as part of a bulk liquid phase, and in which feeding a hydrocarbon reactant and organic liquid diluent solvent into the oligomerisation reactor includes feeding into the bulk liquid phase of the bubble column reactor fresh hydrocarbon reactant which has been condensed and said organic liquid diluent solvent and said catalyst system;

oligomerising at least a portion of the hydrocarbon reactant in the reactor to form said at least one co-monomer product and polymeric by-product, in which the oligomerising includes allowing at least a portion of the hydrocarbon reactant and the organic liquid diluent solvent to vapourise to form bubbles rising through the bulk liquid phase, with the hydrocarbon reactant oligomerising to form as part of the bulk liquid phase said liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product, and with the evaporation of both the hydrocarbon reactant and the organic liquid diluent solvent effecting heat removal from the bulk liquid phase, and

withdrawing liquid product which includes organic liquid diluent solvent, said at least one co-monomer product, said catalyst system, unreacted hydrocarbon reactant and said polymeric by-product from the reactor including withdrawing some of the bulk liquid phase to maintain the bulk liquid phase at a desired level,

wherein, when there is only one catalyst solvent and only one organic liquid diluent solvent, said catalyst solvent and said organic liquid diluent solvent are not the same solvent, and when there is more than one catalyst solvent or more than one organic liquid diluent solvent,

at least one of the catalyst solvents is not also used as organic liquid diluent solvent or at least one of the organic liquid diluent solvents is not also used at the catalyst solvent, and wherein the mass ratio of all organic liquid diluent solvent introduced into the oligomerisation reactor to all catalyst solvent introduced into the oligomerisation reactor over a selected time period is between 15:1 and 4500:1;

the process further including

allowing gaseous components comprising any unreacted vapourised hydrocarbon reactant and vapourised organic liquid diluent solvent and any oligomerisation product that reports to a vapour phase to disengage from the bulk liquid phase into a head space in the bubble column reactor above the bulk liquid phase;

withdrawing the gaseous components from the head space;

cooling the gaseous components withdrawn from the head space thereby at least partially to condense the gaseous components, forming a vapour fraction and a liquid fraction both of which include an admixture of unreacted hydrocarbon reactant, organic liquid diluent solvent and oligomerisation product;

recycling the condensed liquid fraction to the bulk liquid phase in the bubble column reactor; and

withdrawing the vapour fraction.

13. The process as claimed in claim **12**, in which fresh gaseous hydrocarbon reactant and optionally recycled vapourised unreacted hydrocarbon reactant and optionally recycled vapourised organic liquid diluent solvent recovered from the withdrawn bulk liquid phase is combined and condensed with the gaseous components withdrawn from the head space before the gaseous components are cooled and condensed, and in which the organic liquid diluent solvent in the bulk liquid phase is selected and maintained at a mass concentration such that, at a bubble column reactor pressure of between 40 bar(a) and 80 bar(a) more than 99.5% by mass of the gaseous components from the head space, fresh gaseous hydrocarbon reactant, any recycled unreacted hydrocarbon reactant and any recycled organic liquid diluent solvent recovered from the withdrawn bulk liquid phase is condensed at a temperature below 35° C.

14. The process as claimed in claim **13**, in which said condensation at a temperature below 35° C. takes place at a pressure below the supercritical pressure of ethylene, using an absorption refrigeration system.