out at low concentration of one or more of the substrates. In particular there is a need for a device and a method which permits to perform reactions which are to be carried out in high dilution in reactors with a reduced volume, using reduced quantities of solvent, while providing a sufficiently high reaction yield and good selectivity to the desired reaction product. The present invention provides an answer to these needs.

SUMMARY ~~OF THE INVENTION~~

This problem is solved according to the present ~~invention~~ disclosure with a process as defined herein~~by the first claim~~.

In one aspect, there is provided a process for carrying out a chemical reaction of a substrate (X) in a diluted reaction mixture comprising a solvent (S), the reaction being selected from a cyclisation reaction, a polymerization reaction, an enzymatic reaction showing substrate inhibition, an enzymatic reaction showing product inhibition, a reaction showing precipitation of the substrate or of the reactant, and combinations thereof, the process comprising the steps of

a) supplying a diluted substrate-solvent mixture to the inlet (3) of a reactor (2),

b) causing the reaction medium in the reactor (2) to react,

c) discharging, from an outlet (4) of the reactor (2), reaction mixture comprising reaction product, solvent, and substrate that has not reacted,

d) conducting the reaction mixture to a first filtration membrane (6), with a retentate side (10) and a permeate side (11), whereby the first filtration membrane (6) is permeable to the solvent (S) and provided to be impermeable to the substrate (X), having a substrate rejection of 80%-100%,

e) returning retentate (R) comprising substrate (X) that has not reacted, from the retentate side (10) of the first filtration membrane (6) to the reactor (2),

characterized in that in step (a) said diluted substrate-solvent mixture is supplied to said inlet of said reactor from a diluting substrate feed system (5, 15) diluting a substrate from a substrate feed tank (18); and

characterised in that the process further comprises the step of returning solvent (S) which permeated the first filtration membrane (6) from the permeate side (11) of the first membrane (6) to said diluting substrate feed system (5, 15) to dilute the substrate in the diluting substrate feed system (5,15) thereby forming said diluted substrate-solvent mixture.

In an embodiment, the ~~invention~~ present disclosure provides a process for carrying out a chemical reaction of a substrate (X) in a diluted reaction mixture comprising a solvent (S), the reaction being selected from a cyclisation reaction, a polymerization reaction, an enzymatic reaction showing substrate inhibition, an enzymatic reaction showing product inhibition, a reaction showing precipitation of the substrate or of the reactant, and combinations thereof, the process comprising the steps of

a) diluting the substrate with solvent in a diluting substrate feed system to form a diluted substrate-solvent mixture, and supplying the diluted substrate-solvent mixture to the inlet of a reactor,

b) causing the reaction medium in the reactor to react,

c) discharging from an outlet of the reactor the reaction mixture comprising reaction product, solvent, and substrate that has not reacted,

d) conducting the reaction mixture to a first membrane with a retentate side and a permeate side, whereby the first membrane is permeable to the solvent (S) and provided to be impermeable to the substrate (X) and to at least one of the group consisting of the catalyst, the reactants which are caused to react with the substrate and combinations thereof,

e) returning solvent (S) which permeated the first membrane from the permeate side of the first membrane to the diluting substrate feed system to dilute the substrate in the diluting substrate feed system, and

f) returning retentate (R) comprising substrate (X) that has not reacted, from the retentate side of the first membrane to the reactor.

Thereto, the device used in the process of ~~this~~ the present disclosure~~invention~~ is characterized in that the reactor outlet is coupled to a first membrane or filtration membrane with a retentate side and a permeate side, in that the said first membrane is permeable to the solvent and provided to be impermeable to the substrate, in that the permeate side of the said first membrane is connected to the diluting substrate feed system to return solvent which permeated the said first membrane to the diluting substrate feed system to provide dilution of the substrate in the diluting substrate feed system, and in that the retentate side of the said first membrane is connected to the reactor to return retentate comprising substrate that has not reacted, to the reactor.

The present ~~invention~~ disclosure therewith makes use of a device which comprises

- a diluting substrate feed system by which a substrate – solvent mixture with a low substrate concentration may be supplied to the reactor, starting from a feed solution having a high substrate concentration in solvent and,
- a membrane or filtration membrane which is coupled to the reactor outlet to permit continuous, in-situ solvent recuperation and recycling of the solvent within the device.

The diluting substrate feed system enables the controlled supply of a substrate – solvent mixture having a low substrate concentration, fairly independently of what the substrate concentration is in the feed solution, which may be significantly higher. Because the high substrate dilution is only applied to the substrate volume which is actually supplied to the reactor, reactions which require high dilution of one or more to the substrates or reactants may be carried out using substantially reduced quantities of solvent, while relatively high reaction yields may be achieved, even in reactors having a relatively small volume. Thus, the present ~~invention~~ disclosure permits reducing the volume of solvent used in the process to 0.5 - 25 l/mol of substrate, while product yields achieved are typically as high as those achieved with reactions carried out at high dilution in large reaction volumes of 100-1000 l/mole of substrate. Typically the product yield is determined by the substrate