catalyst system under sufficiently mild conditions and therefore with retention of activity and/or the active catalyst systems cannot be retained to a sufficient extent. Particularly in the retention of an active catalyst system having a molar mass below 1500 g/mol, which is significantly lower than that of clustered catalyst species, there is the difficulty of separating components having a molar mass difference of less than 100 g/mol from one another using a membrane. At the same time, the membrane has to be sufficiently permeable for organic components to allow an economical process.

Since no satisfactory solution is known for the concentration of a catalyst system under mild conditions from process streams from the hydroformylation of higher olefins (C4 and higher), where the catalyst system comprises the metal complex catalyst and clusters thereof and also the free ligand, it is an object of the invention to develop a method which separates the process stream containing the catalyst system (e.g. reactor output or bottom product) into a stream enriched in the catalyst system and a stream depleted in the catalyst system and has a high degree of retention for the catalyst system, in particular for the metal component.

Summary

The technical object of the present disclosure ~~invention~~ is therefore to provide a method of concentrating a homogeneous catalyst, in which the catalyst system can be concentrated or separated off while retaining its activity, with the method having to have a high degree of retention for the catalyst system, requiring no diluents for the recovery and also displaying no clustering of the metal component of the catalyst or decomposition of the catalyst complex.

In one aspect, there is provided~~This technical object is achieved by~~ a method of concentrating a homogeneous catalyst from a process stream containing this homogeneous catalyst as constituent, wherein the process stream is passed over at least one membrane and the membrane consists entirely or partially of a polymer comprising planar polymer units which are connected to one another via a rigid linker, with the linker being intrinsically twisted so that at least one planar monomer unit is joined via the linker in a noncoplanar arrangement to at least one second planar polymer unit.

Description

These polymers will hereinafter be referred to as polymers having intrinsic microporosity (PIM).

It has surprisingly been found that both in the case of an organic reaction output from a metal-catalyzed reaction and also in the case of distillation bottoms which have been produced from the reaction output and are enriched with high boilers and contain high boilers, metal complexes, clusters thereof and also free ligands, it is possible to separate high boilers, product and starting materials from the catalyst system by means of one or more membrane(s), with the retention for the metal component per membrane being greater than 70% and that for the free ligands being greater than 60%, when the separation is carried out over membranes containing polymers having intrinsic microporosity (PIM).

The method is preferably carried out at a separation limit of from 400 to 2000 g/mol in the temperature range from 40 to 150°C and in a range of the transmembrane pressure (differential pressure across the membrane) of from 5 to 60 bar.

Even at concentrations of high boilers of over 50% by mass, no addition of a diluent is necessary since even at high concentrations of high boilers, the permeate