

phorus acidic compounds removed from said reaction product fluid with one or more acid removal substances sufficient to remove at least some amount of the phosphorus acidic compounds from said water, is still considered to be essentially a "non-aqueous" process, which is to say, any water present in the hydroformylation reaction medium is not present in an amount sufficient to cause either the hydroformylation reaction or said medium to be considered as encompassing a separate aqueous or water phase or layer in addition to an organic phase.

Also, it is to be understood that another preferred hydroformylation process of this invention, i.e., the embodiment comprising preventing and/or lessening hydrolytic degradation of the organophosphite ligand and deactivation of the metal-organophosphite ligand complex catalyst by treating at least a portion of the hydroformylation reaction product fluid derived from the hydroformylation process and which also contains phosphorus acidic compounds formed during said hydroformylation process by introducing one or more acid removal substances into said at least one reaction zone and/or said at least one separation zone sufficient to remove at least some amount of the phosphorus acidic compounds from said reaction product fluid, is also considered to be essentially a "non-aqueous" process.

Thus, for example, water may be used to treat all or part of a reaction product fluid of a continuous liquid catalyst recycle hydroformylation process that has been removed from the reaction zone at any time prior to or after separation of the aldehyde product therefrom. More preferably said water treatment involves treating all or part of the reaction product fluid obtained after distillation of as much of the aldehyde product desired, for example, prior to or during the recycling of said reaction product fluid to the reaction zone. For instance, a preferred mode would be to continuously pass all or part (e.g. a slip stream) of the recycled reaction product fluid that is being recycled to the reaction zone through a liquid extractor containing the water just before said catalyst containing residue is to re-enter the reaction zone.

Thus it is to be understood that the metal-organophosphite ligand complex catalyst containing reaction product fluid to be treated with water may contain in addition to the catalyst complex and its organic solvent, aldehyde product, free organophosphite ligand, unreacted olefin, and any other ingredient or additive consistent with the reaction medium of the hydroformylation process from which said reaction product fluids are derived.

Moreover, removal of the desired aldehyde product can cause concentrations of the other ingredients of the reaction product fluids to be increased proportionately. Thus for example, the organophosphite ligand concentration in the metal-organophosphite ligand complex catalyst containing reaction product fluid to be treated by water in accordance with the process of this invention may range from between about 0.005 and 15 weight percent based on the total weight of the reaction product fluid. Preferably the ligand concentration is between 0.01 and 10 weight percent, and more preferably is between about 0.05 and 5 weight percent on that basis. Similarly, the concentration of the metal in the metal-organophosphite ligand complex catalyst containing reaction product fluid to be treated by the water in accordance with the process of this invention may be as high as about 5000 parts per million by weight based on the weight of the reaction product fluid. Preferably the metal concentration is between about 50 and 2500 parts per million by weight based on the weight of the reaction product fluid, and more preferably is between about 70 and 2000 parts per million by weight based on the weight of the reaction product fluid.

The manner in which the metal-organophosphite ligand complex catalyst containing reaction product fluid and water are contacted, as well as such treatment conditions, as the amount of water, temperature, pressure and contact time are not narrowly critical and obviously need only be sufficient to obtain the results desired. For instance, said treatment may be carried out in any suitable vessel or container, e.g. any conventional liquid extractor, which provides a suitable means for thorough contact between the organic reaction product fluid and water, may be employed herein. In general it is preferred to pass the organic reaction product fluid through the water in a sieve tray extractor column in a counter-current fashion. The amount of water employed by the subject invention and time of contact with the reaction product fluid need only be that which is sufficient to remove at least some amount of the phosphorus acidic compounds which cause hydrolytic degradation of the desirable organophosphite ligands. Preferably the amount of water is sufficient to at least maintain the concentration of such acidic compounds below the threshold level that causes rapid degradation of the organophosphite ligand.

For instance, a preferred quantity of water is the quantity which ensures that any degradation of the organophosphite ligand proceeds by the "non-catalytic mechanism" as described in "The Kinetic Rate Law for Autocatalytic Reactions" by Mata-Perez et al., *Journal of Chemical Education*, Vol. 64, No. 11, November 1987, pages 925 to 927, rather than by the "catalytic mechanism" described in said article. Typically maximum water concentrations are only governed by practical considerations. As noted, treatment conditions such as temperature, pressure and contact time may also vary greatly and any suitable combination of such conditions may be employed herein. For instance, a decrease in one of such conditions may be compensated for by an increase in one or both of the other conditions, while the opposite correlation is also true. In general liquid temperatures ranging from about 10° C. to about 120° C., preferably from about 20° C. to about 80° C., and more preferably from about 25° C. to about 60° C. should be suitable for most instances, although lower or higher temperatures could be employed if desired. As noted above, it has been surprisingly discovered that minimum loss of organophosphite ligand occurs when a hydroformylation reaction product fluid containing a metal-organophosphite ligand complex catalyst is contacted with the acid removal substances or is contacted with water and the contacted water thereafter treated with the acid removal substances even at elevated temperatures. Normally the treatment is carried out under pressures ranging from ambient to reaction pressures and the contact time may vary from a matter of seconds or minutes to a few hours or more.

Moreover, success in removing phosphorus acidic compounds from the reaction product fluid according to the subject invention may be determined by measuring the rate degradation (consumption) of the organophosphite ligand present in the hydroformylation reaction medium. The consumption rate can vary over a wide range, e.g., from about <0.6 up to about 5 grams per liter per day, and will be governed by the best compromise between cost of ligand and treatment frequency to keep hydrolysis below autocatalytic levels. Preferably the acid removal substance and water treatment of this invention is carried out in such a manner that the consumption of the desired organophosphite ligand present in the hydroformylation reaction medium of the hydroformylation process is maintained at an acceptable rate, e.g., <0.5 grams of ligand per liter per day, and more preferably <0.1 grams of ligand per liter per day, and most