444b Partial Hydrogenation of Vegetable Oil Using Membrane Reactor Technology

Devinder Singh, Brent Dringenberg, Peter Pfromm, and Mary Rezac

Partially hydrogenated vegetable oil is used in margarines and commercially baked and fried food products. U.S. consumption of partially hydrogenated vegetable oil is nearly 14 billion pounds per year. The conventional hydrogenation process used produces trans fatty acids (TFA), the content of which can be as high as 45-50% in some margarines. Dietary TFAs are associated with increased risk of ischemic heart disease and possible increased risk of colon cancer, type-2 diabetes and allergic diseases in children. FDA regulations require listing of the TFA content on food labels by 2006. So the design of a commercial hydrogenation process/technology that produces minimum amounts of TFA becomes essential. In the current technology catalyst particles are immersed in oil that contains small amounts of dissolved hydrogen which results in catalyst surface being hydrogen starved and thus promotes the isomerisation to TFA's. The approach used in our study relies on a fundamental modification of the mechanism of hydrogen addition while drawing on existing hydrogenation catalysts. In this approach, the multiple phase reactors currently employed are replaced by a membrane reactor capable of selectively supplying hydrogen to the catalyst surface at the rate of consumption. A membrane capable of selectively transporting hydrogen while acting to prevent any loss of liquid phase is incorporated in the reactor housing. Oil is pumped on one surface of the membrane where it comes into contact with the catalytic metal surface supported on the polymeric membrane support. The metal catalyst has a high hydrogen coverage that has diffused through the membrane due to an imposed chemical potential driving force. High concentrations of hydrogen on the catalyst surface, and the resulting decrease in temperature and pressure, promote the hydrogenation reaction at the expense of the cis to trans isomerization. The approach presented here is also compatible with existing hydrogenation technologies and requires no additional utilities. The presentation will discuss the concept and show data obtained from a bench scale study of the same process. The new and the conventional process will be compared under similar conditions and various factors that can have a significant impact on the conversion and on the amount of TFA will also be discussed.