The 8th Green and Sustainable Chemistry Award Awarded by the Minister of Economy, Trade and Industry

Sumitomo Chemical Co., Ltd.

"Development of new propylene oxide process by cumene recycling"

Propylene oxide (PO) can be produced by conventional chlorohydrin or hydroperoxide process. Each conventional process has the unsolvable disadvantage, such as producing a large amount of valueless chloride salt or co-producing a huge amount of stylene or isobutene.

Sumitomo Chemical has developed a new PO only production process that does not produce any co-products. Cumene is used and recycled as a reaction medium like "oxygen carrier" through three reaction steps of oxidation, epoxidation and hydrogenation in the process (figure 1).

Most important problem was how to develop a highly active catalyst for the epoxidation using such a large molecule like cumene hydroperoxide with propylene. Microporous Ti-silicate zeolite such as TS-1 is well-known to be a very active epoxidation catalyst by the reaction with hydrogen peroxide, but it showed extremely low activity for the epoxidation with cumene hydroperoxide. The three factors are thought to be important for developing high performance catalyst, (1) to maximize tertrahedral titanium active sites highly dispersed in a silica matrix, (2) to have mesoporous structure (nano space) which a large molecule like cumene hydroperoxide can be easily diffused, and (3) to have sufficient hydrophobic property for high propylene affinity. As a result of challenging catalyst development especially focusing on how to make as many meso pores as possible, we have succeeded in finding and industrializing a high performance Ti-silica epoxidation catalyst, which have a characteristic "mesoporous structure". Figure 2 shows a reaction image with a mesoporous epoxidation catalyst. We think this is a first example of industrialized mesoporous catalyst.

In our process, all reaction steps proceed in especially high yields, and the usage of process energy is very low since all exothermic reaction heat of oxidation, epoxidation and hydrogenation is recovered and effectively utilized. Therefore, we think our PO cumene process is superior in raw material consumption and energy consumption to other processes including the hydrogen peroxide method. We can estimate that the energy saving effect of our new process against a conventional process is equivalent to the carbon dioxide reduction of about 300,000 tons/y, based on a PO 200,000 tons/y plant. Our new PO process is very economical and "green". The first plant using our new technology was built in Japan and started up in 2003, and the second plant at Petro Rabigh in Saudi Arabia is to start up this year.