Operation of methanol reactor with mixtures of fresh and partially deactivated catalyst

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Abstract

The operation of methanol reactor with mixtures of fresh and partially deactivated catalyst was studied using a dynamic reactor simulator. The sharp decay of fresh catalyst at intial times and its slower deacay as time goes on, are the reasons for catalyst recycling. In this way, the partially deactivated catalyst maintain an activity level that enables it to be used in the mixtures with fresh catalyst. The results of model shows that there is no substantial drop of cumulative production rates when the mixtures of fresh and partially deactivated catalyst are used instead of fresh catalyst. Two different strategies for mixing of fresh and partially deactivated catalyst are proposed and the performance of the reactor has been investigated. In the first strategy the fresh and partially deactivated catalyst are mixed in segregated layers while in the second strategy they are mixed homogeniously. The comparison of two strategies shows that the homogeneous manner of mixing gives substatial improvement in production rate and temperature profile along the reactor. Both strategies are carried out in different amounts of recycling ratios and the simulation results are compared.

Keywords: **Modeling; Catalyst; Recycling; Methanol; Deactivation**

1. Introduction

The Cu-based catalysts used for methanol synthesis was first used industrially by ICI in 1966. Development of this new catalyst brought many advantages to the process. Because this new catalyst was extremely active, methanol synthesis could be carried out at lower temperatures and pressures. Higher selectivity of this new catalyst resulted in higher purities, because by-products were gently reduced or completely eliminated. Besides of these advantages, deactivation is one of the future concerns. The catalyst deactivates because of poisons and mainly due to thermal sintering which is the loss of catalyst active surface area due to crystallite growth of either the support material or the active phase [1].

Typically, the loss of activity in a well-controlled methanol process occurs slowly. It is said that under normal operating conditions, catalyst deactivates in a period of 3-4 years [2]. Analyzing the deactivation data base on computer-based simulation, the following results obtained which brought the idea of recycling partially deactivated catalyst which has been obtained at the end of operating period and reuse it for the next period, in mixture with the fresh one. Analyzing the rate of deactivation of commercial low-pressure methanol synthesis catalysts, the following results obtained.

First, the catalysts doesn't completely deactivate in the operating period. After 1200 operating days, its activity decreases to 0.4. It means that the catalyst has a 40% ability to participate in the reaction compared to the fresh catalyst.

Secondly, the rate of deactivation is so fast in the first few months and then, it would be slow. So the process has not sensed catalyst freshness in a most part of operating period.