**Improved vinyl acetate monomer (VAM) catalyst technologies**

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**Introduction**

Vinyl acetate monomer is a major industrial chemical with a worldwide production capacity of 6.5 million metric tons (mMT) in 2010 and average growth of 2 - 4 % annually. Approximately 800 MT of VAM catalyst is currently installed in VAM reactors worldwide. Evonik has been an active player in VAM catalyst technologies for the past 20 years and it is one of the major VAM catalyst producer.

The typical VAM catalyst formulation can vary from 0.50 – 1.5% Pd, and 0.20 – 1.5% Au and 4-10 wt% KOAc on a silica bead of around 5 nm diameter. Various catalyst formulations and preparative technologies have been developed to address customer requirements, for example plant capability for heat removal in order to meet the target performance.

One of the major expenses in VAM catalyst production is the capital investment in Au and Pd. The major technical challenge is to understand and produce the relevant AuPd structures required to achieve higher activity, higher VAM selectivity and extended lifetime. Evonik has been continuously developing such superior recipes to effectively decrease the precious metals loadings without sacrificing yield. The present contribution discusses the challenges as well as achievements in the development of improved VAM catalysts.

**Materials and Methods**

The catalysts have been prepared using Evonik’s proprietary recipes. [1-4] The catalysts were evaluated in a test system comprising two parallel plug flow reactors. This system is capable of continuous operation over extended time periods. The typical reaction condition ranges explored are 4-8 atm, 3,000-10,000 GHSV hr⁻¹ and 145-180°C.

**Results and Discussion**

The typical VAM catalyst has an egg-shell distribution of metals with AuPd surface alloy structures [5]. The Pd is considered as an active site to carry out oxidation process, while the Au atoms dilute the continuous Pd ensembles and limit the combustion of hydrocarbon to form carbon dioxide, thus improving VAM selectivity. The VAM catalysts prepared were thoroughly characterized to understand the correlation between metals arrangement with performance. Our results suggest the presence of various combinations of Au,Pd, structures with particle sizes ranging from 3 to 10 nm. In addition, the metal penetration depth also plays a critical role in achieving the desired activity and selectivity. The metal arrangement is shown by TEM-EDX in Figure 1. Au and Pd atoms were found to be closely associated to each other on the surface of the support bead.

The performance of VAM catalysts prepared using various methodologies were also compared. The new, improved recipes were shown to have a desired structure essential for VAM reaction: less metal penetration and hence lower bulk metal loadings to obtain equivalent performance.

**Figure 1**: TEM-EDX of cross-section of VAM catalyst prepared according to patent EP 0723810 A1

**Significance**

The present contribution evaluates the complex structure of the commercial VAM catalyst technologies and allows us to better understand the structure performance relationship in order to further develop improved VAM catalysts.

**References**