Unraveling the Effect of Re as Promotor on Mo/ZSM-5 for Methane Dehydroaromatization Reaction

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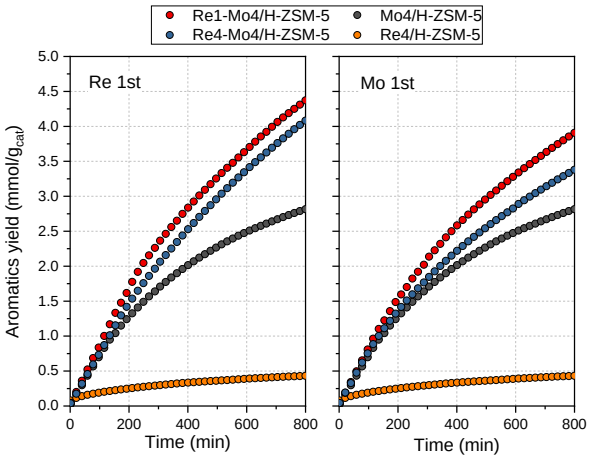
Non-oxidative catalytic methane dehydroaromatization (MDA) to benzene provides a potential route for direct production of benzene from methane resources. MDA was first reported more than 25 years ago by Wang et al., and since then several research works have been published on this topic in the last few decades, being the Mo/H-ZSM-5 system still the preferred catalyst for this reaction. However, methane dehydroaromatization presents some challenges: the reaction is thermodynamically limited with low methane conversion and even the best catalytic systems suffer rapid deactivation from coking. Several characteristics from this reaction are yet unknown, such as the mechanism and the species involved. Therefore, a deeper understanding of the process and the systems are required in order to improve the catalytic performance and to prevent the coke formation, some of the reasons that hinders the methane dehydroaromatization industrial application.

In this study, the promoting effect of rhenium addition as a co-dopant on Mo/H-ZSM-5 catalysts system has been analysed. Hence, bimetallic (Re-Mo/ZSM-5) catalysts have been synthesized using a sequential impregnation methodology and the catalytic performance for MDA reaction has been determined. The results are shown in Figure 1.



We have stated that the improving effect of Re incorporation is notably affected by the sequential impregnation. Thus, Re1-Mo4/ZSM-5 catalyst, in which rhenium has been incorporated first, the aromatic yield value and the stability against deactivation are higher than the values obtained for monometallic systems. The combination of characterization techniques such as TPR, XPS and STEM-HAADF have allowed us to determine that this catalytic enhancement is due to the important effect of Re presence and its incorporation sequence over Mo nature and location in the bimetallic systems.

Figure 1. Aromatics yields for Mo4/ZSM-5, Re4/ZSM-5 and bimetallic catalysts for Mo1st and Re1st series.