458c Control of Hydrocarbon Cold Start Emissions: a Search for Potential Adsorbents

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Increasing emission of hazardous compounds has become an important problem for environmental protection, especially in industrialized countries. Hydrocarbons (HC's) emitted by an automobile, while the catalyst is cold, can comprise an appreciable fraction of the total air pollutants released into the atmosphere. The most common approach in controlling this problem involves the use of an adsorbent to trap the HCs, and to release them later on hot catalyst. Zeolites are often suggested as a HC trap materials due to their hydrothermal stabilities and relatively high adsorption capacities. However, premature release of light HCs before the catalyst reaches its light off temperature constitute a major draw back to this potentially useful strategy. The objective of this study is to explore the possibility of using one-dimensional molecular sieves to trap both heavy and light HC's before the catalyst reaches its working temperature. The underlying concept is based on single-file diffusion. It has been shown that when single file diffusion prevails, light HCs “sandwiched” between heavier, strongly adsorbed molecules within the pores of the adsorbent will be unable to desorb. This allows a proper overlap between desorption and working temperature of the catalyst. In this regard, a series of molecular sieves were synthesized and characterized by standard methods to determine textural properties. The adsorbents were further screened for the possible application by investigating their adsorption-desorption properties using a TPD analysis with ethylene and toluene as the light and heavy probe molecules, respectively. SAPO-41 and ZSM-12 were selected as candidate materials, because they showed exceptionally high performance in terms of adsorption capacity and appropriate desorption temperatures for both sorbates in their binary mixture. In addition, hydrothermal stability test performed on both adsorbents further showed that they were stable up to the temperature of 800 oC in the presence of water vapor, although some reductions in the adsorption capacities were also observed. Further analyses to mimic practical conditions for the intended application were carried by studying the ternary mixtures TPD profiles of the two promising candidate adsorbents. The result obtained showed a proper overlap of the two lighter components in ethylene-propane-toluene ternary mixture. However, an imposed desorption of ethylene by acetone was observed with ethylene-acetone-toluene ternary mixture. Qualitative hypotheses were proposed to explain these observations.