Alkylation of Iso-butane with Butene-2 Using Highly Acidic Ionic Liquids

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The development in the manufacturing of gasoline has been forced by governmental requirements to produce more energy efficient and environmental friendly fuels. Hence, the product of the alkylation seems to be a very good blending component for gasoline since alkylate provides a high research octane number (RON) and has a very low content of sulfur and of aromatic hydrocarbons [1, 2]. Currently, technical alkylation processes still use sulfuric or hydrofluoric acid as catalysts. Due to the high toxicity (i.e. HF) and corrosiveness of these catalysts the alkylation process is restricted. Therefore, the development of new non or less-hazardous catalysts is of great importance.

Highly acidic ionic liquids could offer a promising goal as alternative catalysts. This class of ionic liquids (IL) combines the high acidity (which can be tuned) required for the alkylation reaction with some other interesting properties typical for ILs like a very low and practically not measurable vapour pressure and a low solubility for aliphatic hydrocarbons.

Therefore, the alkylation of iso-butane with butene-2 was studied with different acidic IL systems based on halogenoaluminates, e. g. [OMIM]Br/$AlCl_3$ and [Et_3NH]Cl/$AlCl_3$ [3]. The acidities of the ILs were tuned either by the amount of Lewis acids (i.e. $AlCl_3$, CuCl) or Brønsted acidic species (i.e. water, acidic sulfonated resins). The performance of the catalytic systems were compared mainly based on the research octane number of the product (RON) and the content of the high octane trimethylpentanes (TMP) (selectivity). The results were finally also compared with the product composition and RON if sulfuric acid is used as catalyst.

A trimethylpentane content of up to 72 wt-% and a RON of up to 98 was be obtained with copper chloride modified ionic liquids. This performance is comparable to the industrial used sulfuric acid. The IL systems show no deactivation in contrast to highly acidic solids like zeolites, and the activity was stable even if the IL was used up to eleven times with fresh feed.

[1] J. Weitkamp, Y. Traa, Catalysis Today 49 (1999), 193.

[2] S. I. Hommeltoft, Applied Catalysis A: General 221 (2001), 421.

[3] T. L. T. Bui, PhD thesis , University Bayreuth (in preparation).