Abstract

IONIC LIQUIDS

(September 2004)

Ionic liquids (ILs) have generated a great deal of interest in the chemical industry. They represent a new class of solvents. The term ionic liquid (IL) is used loosely to describe an organic salt with a melting point below 100°C. Ionic liquids have been referred to as “room temperature molten salt”, “low-temperature molten salt” and “liquid organic salts.” Unlike conventional salts, they are typically fluid at room temperature.

Ionic liquids have relatively low viscosity and are very good solvents for a wide range of organic, inorganic, and polymeric materials. Some research studies have indicated that certain ionic liquids are capable of dissolving almost anything. They are good solvents for many catalyst systems because they are polar, non-coordinating solvents. Unlike water and organic solvents, they possess no appreciable vapor pressure. Volatile organic compounds (VOCs), therefore, will not be a problem. Because of the lack of measurable vapor pressure, easy recyclability, and nonflammability, ionic liquid solvents are viewed by many as “green” solvents. They can be used to redesign processes in order to reduce or eliminate loss of solvents particularly VOCs. The growth in development in ionic liquids is not only being driven by their potential as green solvents but also by potential improvement in process economics, reaction activity, selectivity, and yield. Applications using ionic liquids as solvents and catalysts are being developed in the chemical industry.

This report will review the technological development in ionic liquids particularly as it relates to the chemical industry. The production costs for different types of ionic liquid based on high production volumes are discussed. The process economics for two case studies involving chemical syntheses using ionic liquids are analyzed. The processes evaluated were an alkylation process using a chloroaluminate ionic liquid as a catalyst to produce ethylbenzene and a hydroformylation process using an ionic liquid as a solvent to produce isononal. The isononal is subsequently hydrogenated to produce isononyl alcohol. The resulting process economics are compared to those of the conventional processes. This report will be of interest to manufacturers and consumers of industrial solvents and individuals interested in alternative “green” processes. Because of potential improvement in chemical synthesis, this report will be of general interest to the chemical industry.
IONIC LIQUIDS

by SUSAN L. BELL

September 2004

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PROCESS ECONOMICS PROGRAM

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<td>alkyl-mim</td>
<td>1-alkyl-3-methylimidazolium</td>
</tr>
<tr>
<td>BETI</td>
<td>Bis(perfluoroethylsulfonyl)imide (N(SO$_2$CF$_2$CF$_3$)$_2$)$_2$(\cdot)</td>
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<tr>
<td>BINAP</td>
<td>2,2'-Bis(diphenylphosphino)-1,1′-binaphthyl (C$<em>{44}$H$</em>{32}$P$_2$)</td>
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<td>bmim</td>
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<td>Ionic liquid</td>
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<td>Isononyl alcohol</td>
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<tr>
<td>isoq</td>
<td>Isoquinoline</td>
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<tr>
<td>LHSV</td>
<td>Liquefied product space velocity, i.e. volume liquefied product per hour/volume of catalyst</td>
</tr>
<tr>
<td>Methide</td>
<td>(CF$_3$SO$_2$)$_3$C$^{-}$</td>
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<td>mmim</td>
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<td>omim</td>
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