Chapter 10
Desulphurization of Fuel Oils Using Ionic Liquids

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ABSTRACT

Hydrodesulphurization (HDS) is a standard process for removing sulphur compounds in fuel oils in industry. HDS is effective to remove simple aliphatic sulphur compounds while less effective to remove thiophenes, dibenzothiophenes, and their derivatives because of sterically hindered adsorption on catalyst surface. Application of ionic liquids (ILs, a new class of compounds) substituting for traditional volatile organic solvents in extractive desulphurization (EDS) or oxidative desulphurization (ODS), have been being studied intensively in the latest decades, and many very promising results have been obtained, showing a good prospect as complement method to HDS. In this chapter, these fresh research results of EDS and ODS using ILs are summarized along with comprehensive discussions on diversified desulphurization factors along with some potential problems. It can be inferred that ILs are a class of potential ideal solvents to realize clean fuel oil in future although some problems come too.

INTRODUCTION[1]

Deep desulphurization of fuels has become a very important research subject worldwide, due to environmental concern and the upcoming stricter sulphur legislative regulation. Oil refineries are finding ways to get around a bottleneck caused by the presence of heterocyclic sulphur compounds in fuels, which emits oxides of sulphur (SOx) as environmental pollutants during combustion (Mei et al, 2003). The task to minimize sulphur content in fuel has hastened in recent years due to growing environmental awareness from the public and more importantly, demanding statutory limit of these compounds in fuels. Europe,

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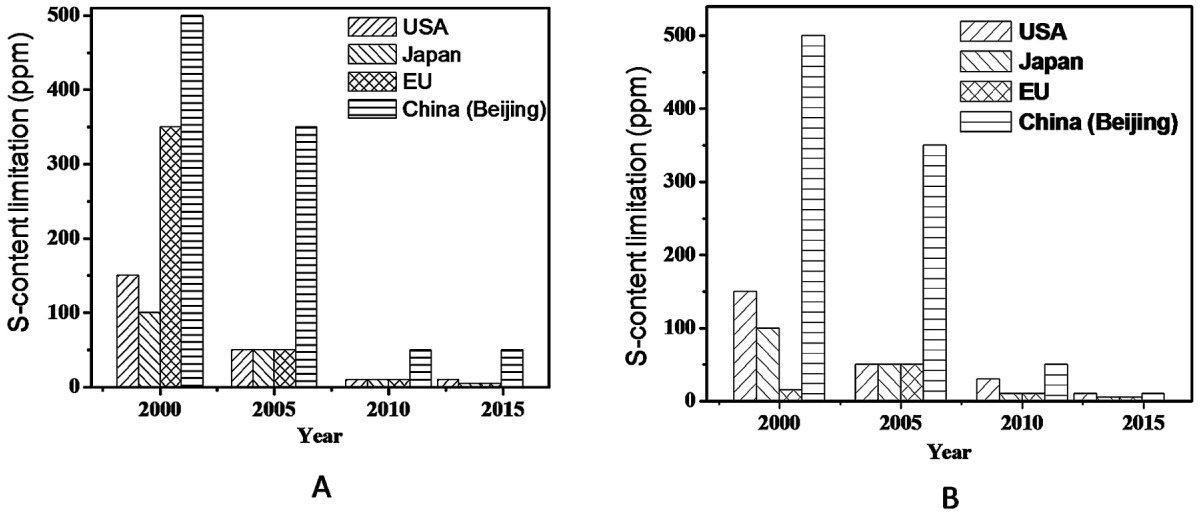
Figure 1. Previous, current, and proposed sulphur limitations in diesel (a) and gasoline (b) in different countries



the US and other mature economies have been forced to lower the content in fuel through legislation (Figure 1a and 1a for previous, current and proposed sulphur levels in diesel and gasoline in developed countries). In 1998, the European directive on transportation fuels limited the sulphur content to 150 ppm for gasoline and 350 ppm for diesel and just five years later, that number was reduced to 50 ppm. Now, it stands at <10 ppm. The United States and Japan have put tax on transportation fuel exceeding 10 ppm Sulphur content (Essar et al, 2004).

Fuel oils contain variety of sulphur compounds. These sulphur compounds are both aliphatic (thiols, sulfides, disulfides etc) and aromatic (TS, BT, DBT and their derivatives).The structures of those sulphur compounds are shown in the Figure 2.

The hydrodesulphurization (HDS) method is widely used in industry for the desulphurization of diesel fuels, where sulphur compounds are catalytically converted into H_2S and corresponding hydrocarbons, which are subsequently separated from oils and catalytically oxidized into elemental sulphur in the Claus

Figure 2. Sulphur compounds in fuel oils