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LIQUEFACTION OF BITUMEN AND ITS MODEL COMPOUNDS IN SUPERCRITICAL WATER

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1. Introduction

Bitumen as a part of heavy oils is one of the world's largest petroleum resources. But, bitumen was an under-utilized resource because of its inherently poor quality. Generally, bitumen industrial application only concerned the road pavement and recently has been more dedicated to the inerting of waste. The utilization of bitumen is very interesting and the development process has been proposed to recover chemical compounds from bitumen.

Water under supercritical conditions is an environmentally acceptable solvent for a wide variety of chemical reactions. Supercritical water is a dense steam and can be miscible with light gases and hydrocarbons to form a homogeneous phase by the proper choice of temperature and pressure. C-C and C–O bonds, such as those found in ethers and esters, and the aliphatic C-H and C–S bonds are easily broken in supercritical water. Therefore, in these works, supercritical water will be used in the upgrading of bitumen and its model compounds.

2. Experimental Method

Experiments were conducted using a Hastelloy C-276 tube reactor. The reactor was loaded with bitumen which obtained from the industrial oil distillation process (Shell Canada) and pure water. Argon gas was used to purge the reactor before it was sealed. The reactor was placed into an electric furnace and heated up. After a given amount of time, the reactor was removed from the electric furnace and quickly quenched in a water bath at atmospheric conditions. In this study, the gaseous fraction was not collected. The same method was used for the bitumen model compounds experiments as the starting materials.

3. Result and Discussion

Bitumen was dissolved in aliphatic and aromatic solvents, such as *n*-hexane, chloroform, tetrahydrofuran (THF), and toluene to determine the solubility at room temperature. The amounts of the solvent are 40 times of bitumen in volume. They were mixed and shaken. The results showed that bitumen can dissolve completely in chloroform, THF, and toluene, but in *n*-hexane, the precipitation occurred.

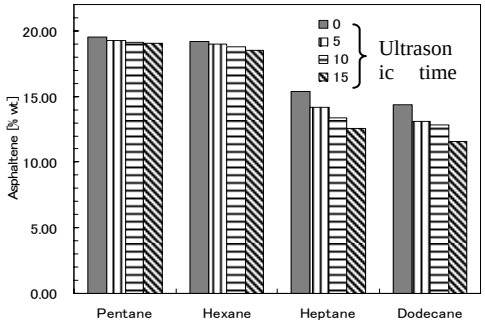

Fig. 1. The content of asphaltene in bitumen.

Next, the content of asphaltene in bitumen was determined by using the aliphatic solvents (alkanes) derived from petroleum. They are *n*-pentane, *n*-hexane, *n*-heptane, and *n*-dodecane. **Fig. 1**, the solubility of bitumen could approach to 88.40 (g of bitumen/40 g of solvent) with solvent *n*-dodecane. The solubility of bitumen in *n*-pentane and *n*-hexane was almost similar. Based on these results, *n*-hexane was decided as a solvent extraction.

The GC-MS analysis showed that the compunds in hexane contained a wide range of organic compounds. Among these, the aromatic compounds, i.e. benzene, toluene, alkylbenzene, anthracene, phenanthrene, carbazole and xylenes. The aliphatics compound such as alkanes and alkene were detected. The compounds had higher boiling point such as eicosane, benzopyrene, picene, coronene, and pyranthrene were not detected by GC-MS due to their high boiling point. Aromatic compounds have dominated as the degradation products of bitumen at these conditions. Thus, it is reasonable to assume that these products are derived from the cleavage of ether and e

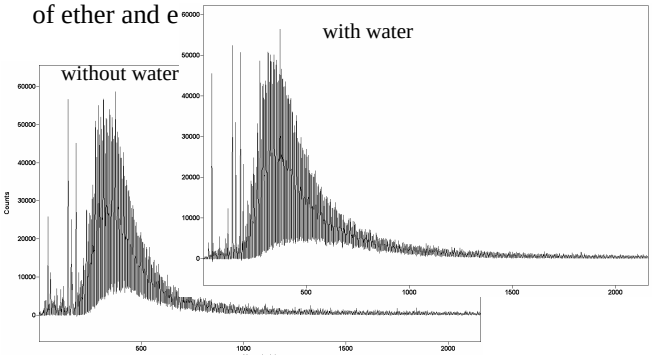

Fig. 2. MALDI-TOF MS chromatogram for bitumen after treatment at 673 K.

Most of the products of bitumen in liquid phase can be classified as aromatic compounds. **Fig. 2** shows the molecular weight of bitumen-derived compounds in *n*-hexane soluble was measured by MALDI-TOF-MS associated with m/z numbers, which is considered to give highly reliable information on polymer molecular weights. This figure shows that the decomposition of bitumen is almost completed under supercritical conditions, forming species of low molecular weight (200 to 700 amu). This result suggested that water had high influence to the decomposition of bitumen, which is probably because the degree of ionic dissociation of water at the same temperature.

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