Synthesis and Characterization of Oil-Soluble Dispersants

Yu Shen, Jean Duhamel

Institute of Polymer Research, Department of Chemistry, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, N2L 3G1, Canada

Abstract
Dispersants are important additives in the oil industry. A type of oil-soluble dispersants consisting of a polyamine and two polyisobutylene chains will be synthesized and their efficiency for stabilizing carbon-rich particles found in engine oils will be investigated. This efficiency can be described as “associative strength”, which represents the dispersant ability to self-associate in solution into reverse micelles. It will be characterized by determining the critical micelle concentration (CMC). These studies are expected to provide a correlation between the structure and the efficiency of the dispersants.

Introduction
Over time, carbonaceous deposits composed of carbon-rich particles are produced during the normal operation of the engine. The role of a dispersant is to adsorb onto the polar surface of the particles and reduce the driving force towards aggregation. As two particles coated with dispersant get close, interpenetration of the shells occurs, resulting in the non-polar layer losing disorder which is thermodynamically unfavorable. This further leads to interparticle repulsion, or in other words, stabilization of the particles.

Proposal
In this project, a family of succinimide dispersants will be studied. They are BAB triblock copolymers synthesized by reacting polyamines with polyisobutylene terminated with one succinimide anhydride at one end (PIBSA).

Characterization of the Associative Strength of the Dispersant
The ratio of the fluorescence intensity $I/I_0$ is a parameter sensitive to the polarity of the environment of the chromophore.

Fig. 4 Steady-state fluorescence spectrum of 1-pyrenemethanol excited at $\lambda_{ex} = 344$ nm

At CMC, a sudden change occurs in the fluorescence spectrum due to the partial association of the chromophore with the reverse micelles.

Fig. 5 Determination of the CMC of the dispersant with 1-pyrenemethanol

Characterization of Dispersant

(a) Mono succinimide

(b) Bis succinimide

(c) Tris succinimide

Fig. 3 Mono-, bis-, and tris-succinimide derivatives

Characterization of Succinimide Content by FT-IR

The succinimide content of the dispersant can be determined by a calibration curve correlating the absorption ratio (1717 cm$^{-1}$ / 1390 cm$^{-1}$) with the concentration of methyl succinimide.

Fig. 7 Determination of PIB units by FT-IR

Characterization of Primary Amine Content by UV-vis Absorption

The model compound (I) will be used to determine the extinction coefficient of benzylidene.

Fig. 8 Determination of PIB units by $^1$H NMR through methylation

Characterization of Dispersant (p=0-3)

Scheme 1

Characterization of Succinimide Derivatives

Scheme 2

Conclusion

- The number of isobutylene units in polyisobutylene succinimide anhydride has been calculated.
- There is no polar microdomain generated in hexane by the dispersant PIB-DETA.

Acknowledgements

Imperial Oil

www.basf.com/automotive-oil


Mathew, A. K., Internal Report to Imperial Oil, Nov. 17, 1999