Microcapsules for Next Generation Lubricants

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1. Introduction

Using a technology already utilized in the pharmaceutical, food and dye industries[1] we aim to increase the amount of additives within an engine oil. Microcapsules will act as a reservoir which will replenish the additive concentration in the oil as they are consumed. The work presented here demonstrates that it is possible to produce monodisperse poly(methyl methacrylate) (PMMA) microcapsules, containing an additive, which leads to a decrease in the coefficient of friction measured when compared to an oil containing no microcapsules.

2. Microcapsule synthesis

Microcapsules were synthesized via a dispersion polymerization in a non-aqueous continuous phase (dodecane)[2]. A methacrylate terminated polydimethyl siloxane stabilizer was used to sterically stabilize the particles produced.

A co-solvent (methanol) is used in order to produce a core shell microcapsule with the additive encapsulated within the core. This is possible due to the additive being soluble in the co-solvent but not in the continuous phase.

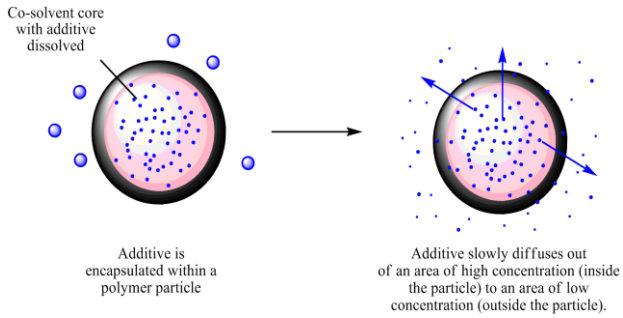


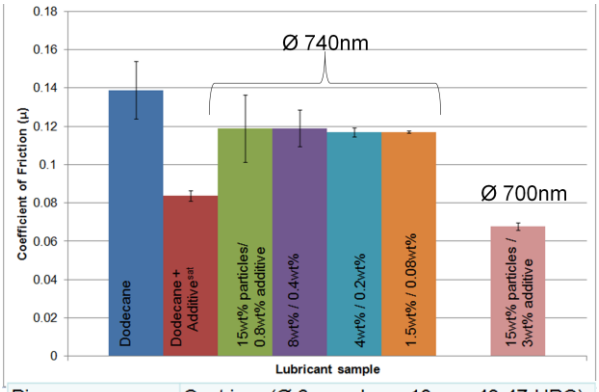
Fig.1 Particle morphology and proposed release mechanism

A range of PMMA microcapsules of different sizes and with different additive loads have been created in a systematic study altering each polymerization variable. Particles produced were tested to determine the effect on the friction reducing properties of pure dodecane.

3. Tribology testing

Tribology testing was carried out using a TE77 low speed reciprocating test machine[3]. The TE77 tribometer comprises of a pin attached to a reciprocating arm which moves across a stationary plate. Various lubricants or materials may be tested in this manner.

Additive containing microcapsules were tested at varying microcapsule concentrations (this also changed the overall amount of additive in the system).
All particle samples were compared to pure dodecane and also dodecane fully saturated with additive.



Pins	Cast iron (Ø 6mm, dome 10mm, 43-47 HRC)
Plates	AISI 52100 Steel (58-60 HRC)
Run conditions	80°C, 25Hz, 1.8Kg load, 100MPa

Fig.2 Coefficient of friction for various dodecane samples

All particle containing samples produced lower friction coefficients (μ) than those measured for pure dodecane. One sample tested has produced μ values below those measured for additive saturated dodecane. Further testing is being carried out to investigate this result.

4. Conclusions

- It is possible to encapsulate engine oil additives.
- All microcapsule samples tested have produced a μ value lower than dodecane containing no particles.
- It is possible to encapsulate enough additives to lower μ below values measured for dodecane fully saturated with additive.

5. References

[1] H.N. Yow & A.F. Routh, "Formation of Liquid Core-Polymer Shell Microcapsules," Soft Matter, 2, 2006, 940-949.

[2] S.M. Klein *et al.*, "Preparation of Monodisperse PMMA Microspheres in Nonpolar Solvents by dispersion Polymerization with a Macromonomeric Stabilizer," Colloid and Polymer Science, 282, 2003, 7-13

[3] Y. Perez Delgado *et al.*, "Impact of Wire-EDM on Dry Sliding Friction and Wear of WC-based and ZrO_2-Based Composites," 271, 2011, 1951-1961