Cohesive Force Measurement Between Precipitated Asphaltene Solids

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Asphaltenes are the heaviest and most polar components of crude oils and may precipitate in reservoirs, wellbores and flowlines, due to the rapid decrease in fluid pressure during flow or through co-mingling of hydrocarbon streams. While the consequence of asphaltene deposition and build-up at the wall is well characterised, little is known about how precipitated asphaltene particles behave in flow. In this presentation, we discuss adaptations to a micromechanical force (MMF) apparatus that enable measurement of cohesive force between asphaltene particles. The results demonstrate that asphaltene cohesive forces may be up to twice those measured previously for the well -studied gas hydrate system, with solid-solid cohesion as the primary mechanism. MMF data provides further insight into the asphaltene particle surface free energy. The cohesive force data demonstrate that this free energy is very sensitive to the type of crude oil from which the asphaltenes were extracted, suggesting the potential for MMF-based studies to characterise the inherent activity of the asphaltene species within crude oil. In addition, co-precipitated resinous material on the surface of the asphaltene particles has been demonstrated to cause a uniform shift toward higher cohesive force, suggesting that these active resins may function to modify asphaltene surface free energy. The dependency of the inter-particle forces on the type of asphaltene (particle agglomeration size, agglomeration time, source crude oil, precipitation technique) will also be discussed.