How MRI can assist Rheology?

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How MRI can assist Rheology?

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Introduction

Rheology is the study of the flow of matter in response to an applied force. The studied fluids are often complex and the standard macroscopic rheology analysis is not sufficient to understand certain phenomena associated with flow or material heterogeneities. A local rheology analysis is then crucial. In addition, the MRI technique is a convenient solution especially when the fluid is opaque. Here are three examples of application.

Thixotropic suspension

The study of non-Brownian fiber suspension rheometry in a Taylor-Couette device is done thanks to the velocity profiles obtained by MRI measurements (flow encoding spin-echo protocol). The local rheological data are acquired for different shear rates and volumetric factions.

Temperature et velocity measurements

The study of thermal transfer by conduction and convection represents a wide field of industrial and environmental applications. We investigate the possibility to measure velocity and temperature profiles with MRI in a fluid layer submitted to heat transfer.

Wall slip mechanism

We carried out a series of experiments with the aim of completing our knowledge of wall slip characteristics. The study is based on internal measurements of the velocity profile of inverse emulsion into a capillary tube. They are acquired using a flow encoding spin-echo protocol with in addition bipolar gradient pulses in order to encode the phase shift arising from the flow.

Glycerol (Newtonian fluid)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Velocity</th>
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<tbody>
<tr>
<td>Conduction (T&lt; T&lt; )</td>
<td>Convection (T&gt; T&lt; ) Rolls</td>
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</tbody>
</table>

Rolls, hexagon structure or both depending on parameters

Xanthan (Shear Thickening fluid)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Velocity</th>
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<tbody>
<tr>
<td>Conduction (T&lt; T&lt; )</td>
<td>Convection (T&gt; T&lt; ) Rolls</td>
</tr>
</tbody>
</table>

Rolls, hexagon structure or both depending on parameters

150 mm diameter quadrature resonator (Doity)

Micro-imaging probe (MicWb40) Bruker

Flow rate-controlled syringe

glass capillaries of different diameters (0.6 to 2 mm).

Inverse emulsion 75%

Velocity profile

Average velocity profile at different flows

Slip velocity vs shear stress from IRM (Ø) and rheometer (Ø)