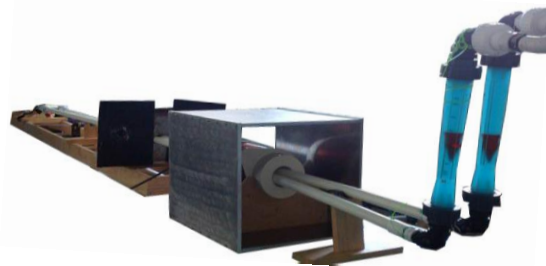
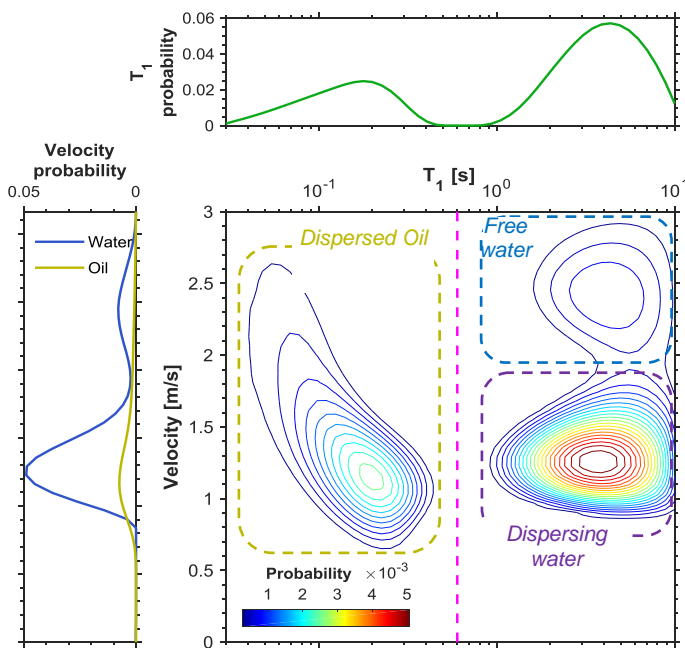


Multi-phase flow measurement using an Earth's field NMR flow meter

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We present a novel multiphase flow metering technique (photo of apparatus shown below) for simultaneous measurement of oil, gas and water volumetric flowrates. An Earth's field nuclear magnetic resonance (NMR) r.f. detection coil is applied to measure free induction decay (FID) signals of oil/water/gas flows. A dual polarisation technique is introduced utilising an upstream permanent magnet as well as an electromagnetic pre-polarising coil. FID signals with variable pre-polarising conditions are acquired and fit with a model for the NMR fluid signal using a 2D Tikhonov regularisation algorithm, allowing determination of a joint 2D velocity- T_1 probability distribution. Appropriate analysis of the measured velocity- T_1 distributions allows calculation of individual phase flowrates. The performance of the NMR flow measurement technique is examined for oil/water/gas flows which are visually observed to be in different flow regimes: stratified flow with mixing, dispersion of oil-in-water and water, and full oil-in-water emulsions – sample data is shown below for dispersed *oil-in-water* + *water* flow. Flow characteristic features such as velocity slip are examined for each flow regime. Finally the accuracy of the measurement system in each flow regime is validated against in-line rotameter measurements. Extensions to render a more robust instrument using a Q-switch, real time magnetic field mapping and multiple r.f. coils, as well as industrial validation using a large flow loop, will be briefly outlined.



References:

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