Ok, here is my first time to do the presentation in English, and my topic is about the new method to estimate volume fraction of emulsion.

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So, at first. What is the emulsion?

You maybe heard that in petroleum inductry, oil often mixed with a lot of groundwater. And you must know the tonkotsu soup and cream. They are common in our daily life. And they are all emulsions.

There are many kinds of emulsions. Such as O/W emulsion means the emulsion which oil-phase dispersed in the water-phase. And W/O means water-phase dispersed in the oil.

You can call they the simple emulsion.

And the emulsions which the droplets itself contains one or many small droplets inside.

We call them multiple emulsion or double emulsion.

So let’s back to the topic, How to estimate the volume fraction of simple emulsion?

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First, I think we need a viscosity model which relative to volume fraction.

There is a two-parameter model for simple emulsion propose by pal，

where ur means relative viscosity of emulsion，λ is viscosity ratio between dispersed phase and continuous-phase.

Phi means the volume fraction. and phi\_m means the maximum volume fraction at which the droplets have no deformation and maintain a spherical shape shown on the right. phi\_m depend on the distribution of droplet size

The right hand of the equation is from the model of the particle suspension.

And the pictures at the bottom shows that this form of model can predict the emulsion viscosity well in usual.

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Next, let's assume that there are only two sizes of droplets in the emulsion, as the right picture.

The graphs at the bottom show the relationship between viscosity of the emulsion predicted by the model and the volume fraction and the distribution of droplet size.

Each graph corresponds to a different viscosity ratio and droplet size ratio

**Emulsion viscosity predicted by model is nearly independent of the droplet size distribution when the volume fraction is less than 30 percent.**

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Then ，we set thedroplet size as a constant，So that the phi\_m will also become a constant.

The two-parameter model is reduced to a one-parameter model, so that we can derive the right equation which we need.

The viscosity ratio has already known. So if we can measure the viscosity, we can estimate the volume fraction of the emulsion.

For example. We can

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If we choose Roscoe's equation as the right-hand term of the equation emulsion model.

We can derive the following equation

The figure below is the result of the viscosity values measured by the ultrasonic rotary rheometer at different volume rates. The emulsion is a Newtonian fluid at a low shear rate, which is consistent with the description in the model.

The figure on the right is a comparison of the experimental and predicted values, indicating that 15%-30% volume fraction can be well estimated by this method

However, there is a large error between the predicted value and the experimental value at 10%, which I think is caused by the error with USR. Because the gradient of the model is relatively large at this time, if the measured viscosity error is greater than 30mPa.s, it will lead to a prediction error of about 4%.

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I will move on to the pipeline experiment after finished two works