9th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2012"

P-497

Enhanced Oil Recovery – Inno Oil

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Summary

The present paper presents a biological viscosity reducer, INNO Oil, which is refined from biodiesel based on soya beans. Besides the given specification, test results on the viscosity reducing potential are shown, explaining the measurement procedure together with basic fluid dynamic physics. A further outlook is given for its possible application and benefits.

Keywords*: Crude oil resources – reserves, peakoil, heavy crude oil, viscosity reducer, pour point depressant*

Introduction

Bioprocessing of crude oils to upgrade or improve its properties is under discussion since some time. Ongoing research on using micro-organisms or their enzymes and means to reduce intermolecular bonding forces have shown promising results.

There are three major focuses in bioprocessing of crude oil which are:

- Development of a desulfurizing biocatalysts which contain enzymes generated by micro-organisms that need sulfur for energy and growth. Specifically, these generated enzymes catalyze oxidative splitting of sulfur atoms from organic sulfides forming sulfate salts. These micro-organisms can be further genetically modified to remove different sulfur structure, or broader classes of compounds.

- Development of additives, which act as an oil based surfactant interacting with the hydrocarbon molecular structure reducing its interfacial strength and increasing molecular structure separation. This will decrease the viscosity due to weakening of forces that stabilize molecular structure. This will reduce fluid piping and transportation problems and costs.

- Shifting process location from the refinery to the field applying bioprocessing near the wellhead.

- "INNO Oil" is produced from soya beans and genetically modified. Chemical data and its registration codes are summarized. It is well shown in the literature that carboxylic acid ester, an important substance in "INNO Oil", is an excellent additive to improve liquid flow-ability at lower temperature.

Theory and/or Method

Method of Measurement

The measurement method is based on a rotation-rheometer of the type MCR300 from Anton Paar. The measurement procedure follows DIN 53019 / ISO 3219 which is described including basic physical equations in fluid dynamics focused on viscosity and relevant measurement data.

In a first test sequence, a German origin heavy crude oil sample is measured with respect to its viscosity relative to the controlled share rate. It shows a typical thixotropic behavior through the embedded hysteresis curve.

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In a second step, INNO Oil is being measured in the same way, showing it as a typical Newtonian fluid. Both results are shown in Fig.1.

The next measurements show the major important test result of a mixture of the heavy crude together with INNO Oil. Fig. 2 shows the drastic reduction in viscosity of the mixture in combination of a moderate temperature increase from 20^0C to 40^0C. The same mixture as in Fig. 2 sample has been further tested over a longer period of time, and we can recognize a slightly constant increase over the hours although the temperature was kept constant at 40^0C. So far, we are not able to explain such behavior whether some structural process has taken place or some chemical reaction changed the physical property.

Fig.3 summarizes all measured data including test equipment specific settings and other data.

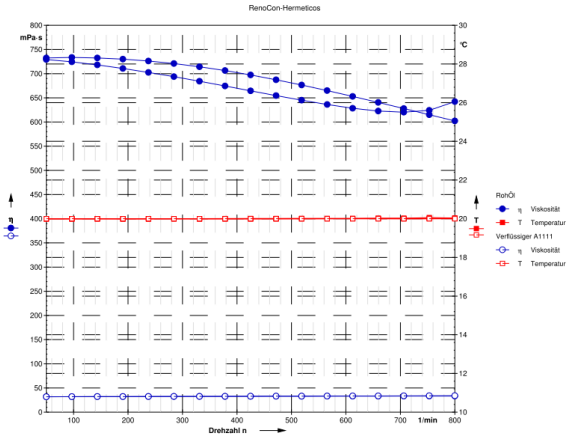


Figure 1: Viscosity of heavy crude and of viscosity reducer Inno Oil vs. rheometer rpm

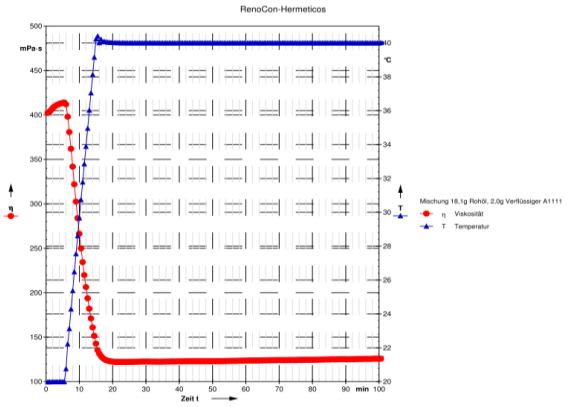


Figure 2: Viscosity of mixture vs time with dependancy of temperature

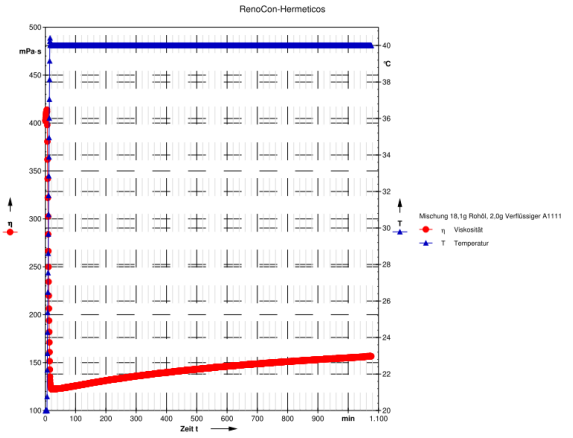
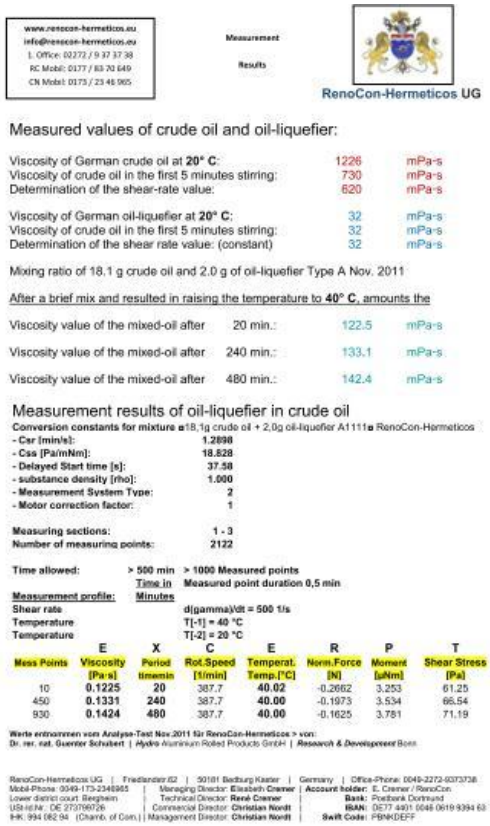


Figure 3: Same as Fig.2 but extended time

Examples of Applications

Aashmore is closely working with the producer of "INNO Oil", offering to customers a cooperative testing and development program for elaborating different applications focused especially on the high viscosity reduction property of INNO Oil. Such applications are:

- Organic cleaning of oil well which suffer from obstruction by deposits (emulsions) during their production period.
- Organic stimulation of mature field by injecting a mixture of "INNO Oil" diluted by gas oil or light crude. The gas oil or light crude is only required for an adequate spread of "INNO Oil" reaching largest possible surfaces.
- Improvement of the transportation capacity of the pipeline system and reducing cleaning intervals, and/or avoiding high energy cost for pipe heating.



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Measurement
Results

RenoCon-Hermeticos UG

Measured values of crude oil and oil-liquefier:

Viscosity of German crude oil at **20° C**:	1226	mPa·s
Viscosity of crude oil in the first 5 minutes stirring:	730	mPa·s
Determination of the shear-rate value:	620	mPa·s
Viscosity of German oil-liquefier at **20° C**:	32	mPa·s
Viscosity of crude oil in the first 5 minutes stirring:	32	mPa·s
Determination of the shear rate value: (constant)	32	mPa·s

Mixing ratio of 18.1 g crude oil and 2.0 g of oil-liquefier Type A Nov. 2011

After a brief mix and resulted in raising the temperature to **40° C**, amounts the

Viscosity value of the mixed-oil after	20 min.:	122.5	mPa·s
Viscosity value of the mixed-oil after	240 min.:	133.1	mPa·s
Viscosity value of the mixed-oil after	480 min.:	142.4	mPa·s

Measurement results of oil-liquefier in crude oil

Conversion constants for mixture ø18,1g crude oil + 2,0g oil-liquefier A1111ø RenoCon-Hermeticos

- Cw [min/s]:	1.2898
- Css [Pa/mNm]:	18.828
- Delayed Start time [s]:	37.58
- substance density [rho]:	1.000
- Measurement System Type:	2
- Motor correction factor:	1
Measuring sections:	1 - 3
Number of measuring points:	2122

Time allowed: > 500 min > 1000 Measured points
Time in Minutes
Measurement profile: Measured point duration 0,5 min
Shear rate d(gamma)/dt = 500 1/s
Temperature T[-1] = 40 °C
Temperature T[-2] = 20 °C

	E	X	C	E	R	P	T
Mess Points	Viscosity [Pa·s]	Period timemin	Rot.Speed [1/min]	Temperat. Temp.[°C]	Norm.Force [N]	Moment [µNm]	Shear Stress [Pa]
10	0.1225	20	387.7	40.02	-0.2662	3.253	61.25
450	0.1331	240	387.7	40.00	-0.1973	3.534	66.54
930	0.1424	480	387.7	40.00	-0.1625	3.781	71.19

Werte entnommen vom Analyse-Test Nov.2011 für RenoCon-Hermeticos > von:
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Figure 4: Physical data and instrument settings of test as in Fig. 1 and 2.

Conclusions

Tests have proven the high viscosity reduction potential of INNO Oil, a refined biodiesel based on soya oil and further genetically modified. We, Aashmore Private Limited Singapore, together with our European partner Innoway AG Switzerland, invite those organizations interested to jointly continue in elaborating the different possible applications especially for the enhanced oil recovery by stimulating mature fields.

References

Technische Universität Berlin, Fachgebiet Lebensmittelrheologie, www.Imr.tu-berlin.de/fileadmin/ …/Demoversuche/ ….. / scherversuch.ht……

Dipl.-Ing Lothar Gehm, www.rheologie.de

Rheologie disperser Systeme Prof. Dr. Rolf Clasen, Lehrstuhl fur Pulvertechnologie von Glas und Keramik, Universität des Saarlandes; www.uni- saarland.de / fak8 / powdertech

Acknowledgments

We acknowledge our partner Innoway AG in Switzerland for the supply of INNO Oil and allowing us to publish specific physical and chemical data of INNO Oil. At the same time, we also want to thank our partner RenoCon-Hermeticos UG Germany, who gave us the permission to publish test results.