***Typed on the letterhead of Gartenberg Gelfand Hayton LLP**
15260 Ventura Boulevard, Suite 1920
Sherman Oaks, CA 91403*

FOIA Confidential Treatment Requested Pursuant to Rule 83

January 14, 2016

Via Edgar and FedEx

United States Securities and Exchange Commission
Division of Corporation Finance
Mail stop 4628
100 F Street, N.E.
Washington, D.C. 20549-4561
ATTN: Parhaum J. Hamidi, Attorney-Adviser

Re: QS Energy, Inc.
Form 10-K for Fiscal Year Ended December 31, 2014
Filed March 16, 2015
File No. 0-29185

Dear Mr. Parhaum:

We are submitting this letter on behalf of our client, QS Energy, Inc. ("QS Energy" or "Company"), in response to the staff's comment letter, dated December 30, 2015 ("Comment letter"), concerning the above-referenced filing of the Company.

Because of the commercially sensitive and confidential nature of certain of the information requested in the staff's Comment Letter related to the business, potential customers and technology of QS Energy, this submission is accompanied by a request for confidential treatment for such information. Toward this end, we have filed a separate letter with the Office of Freedom of Information and Privacy Act ("FOIA Office") in connection with the confidential treatment request, pursuant to Rule 83 of the Securities and Exchange Commission's ("Commission") Rules on Information and Requests [17 C.F.R. Section 200.83]. For the staff's reference, we have enclosed a copy of our letter ("Request Letter") to the FOIA Office with this correspondence. The Company is also enclosing herewith for the staff's review, in un-redacted form, the materials filed via Edgar in redacted form.

In accordance with Rule 83, the Company requests confidential treatment of : (a) the marked-redacted portions of this response letter; and, (b) the accompanying Request Letter (collectively, the "Confidential Material"). Please promptly informed the undersigned of any request for disclosure of the Confidential Material made pursuant to the Freedom of Information and Privacy Act or otherwise so that the undersigned may substantiate the foregoing request for confidential treatment in accordance with Rule 83.

In accordance with Rule 83, this letter has also been marked with the legend "FOIA Confidential Treatment Requested by QS Energy, Inc." and each page of this letter containing redacted marks is identified as numbers "QS-012 through QS-015" and certain sections of Exhibits 6,7 and 8, attached hereto.

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Pursuant to Rule 83, the Request Letter (but not this letter) is being delivered to the Commission's FOIA Office.

The numbered paragraphs below correspond to the numbered paragraphs of the staff's December 30, 2015, Comment Letter. For your convenience, we have incorporated the staff's comments into this response. The Company hereby responds and states, as follows:

Form 10-K for Fiscal Year Ended December 31, 2014

Business, page 3

COMMENT 1. You state at page 3 that your "intellectual property portfolio includes 47 domestic and international patents and patents pending . . . ." Please revise to clarify how many of the 47 patents you have actually obtained, and how many of them are actively pending. For example, if all 47 patents relate to your AOT technology, revise to so state. If any relate to technologies which no longer form an active part of your business, provide the details to clarify this.

RESPONSE 1
As summarized in the table below, QS Energy is currently maintaining and licensing from Temple University 47 domestic and international patents, which have either been granted or have been published and are pending subject to final approval by the respective patent agency. Each of these intellectual properties are related to QS Energy's AOT, Joule Heat and Fuel Injector technologies. The AOT and Joule Heat technologies are being actively developed and marketed by the Company. Active development of QS Energy's fuel injector technology was suspended in 2013, but the Company continues to maintain a license agreement with Temple University the all underlying patents with respect to the underlying patents, and is considering its options to re-start commercialization, sublicense the technology, or terminate the fuel injector license agreement with Temple.

Descriptions and details of these intellectual properties follow.

Summary of QS Energy Patents
Granted and Pending

Description of Patent	Granted	Pending	Total
Device for Saving Fuel and Reducing Emissions	9	5	14
Electric-Field Assisted Fuel Atomization System and Method of Use	4	3	7
Method and Apparatus for Treatment of a Fluid	7	6	13
Increasing Fluidity of a Flowing Fluid	1	–	1
Electrical Interconnect and Method	–	1	1
Joule Heating Apparatus and Method	–	1	1
Apparatus and Method for Reducing Viscosity	–	2	2
Method for Reduction for Crude Oil Viscosity	6	2	8
	27	20	47

Summaries of each of these patents is as follows:

Summary of QS Energy Patents
Granted and Pending

Device for Saving Fuel and Reducing Emissions
- This patent is related to QS Energy's fuel injector technology.
- Owned by QS Energy.
- A copy of the U.S. patent can be found at https://www.google.com/patents/US6901917

Electric-Field Assisted Fuel Atomization System and Method of Use
- This patent is related to QS Energy's fuel injector technology.
- Owned by Temple University; licensed to QS Energy under an exclusive worldwide license agreement.
- A copy of the published, pending U.S. patent can be found at https://www.google.com/patents/US20100024783

Method and Apparatus for Treatment of a Fluid
- This patent is related to QS Energy's AOT technology.
- Owned by Temple University; licensed to QS Energy under an exclusive worldwide license agreement.
- A copy of the U.S. patent can be found at https://www.google.com/patents/US8173023?dq=11/596,198

Increasing Fluidity of a Flowing Fluid
- This patent is related to QS Energy's AOT technology.
- Owned by QS Energy.
- A copy of the U.S. patent can be found at https://www.google.com/patents/US8616239?dq=8,616,239

Electrical Interconnect and Method
- This patent has applications in both QS Energy's AOT and Joule Heat technologies.
- Owned by QS Energy.
- A copy of the published, pending U.S. application can be found at https://www.google.com/patents/US20150184887

Joule Heating Apparatus and Method
- This patent is related to QS Energy's Joule Heat technology.
- Owned by QS Energy.
- A copy of the published, pending U.S. application can be found at https://www.google.com/patents/US20150163858

Apparatus and Method for Reducing Viscosity
- This patent is related to QS Energy's AOT technology.
- Owned by QS Energy.
- A copy of the published, pending U.S. application can be found at https://www.google.com/patents/US20140318946

Method for Reduction for Crude Oil Viscosity
- This patent is related to QS Energy's AOT technology.
- Owned by Temple University; licensed to QS Energy under an exclusive worldwide license agreement.
- A copy of the U.S. patent can be found at http://www.google.com/patents/US8156954

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Details of each of these patents is as follows:

QS Energy Patent Details
Granted and Pending/Published

Device for Saving Fuel and Reducing Emissions				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
US	Granted	10/275,946	6,901,917	06/07/05
Australia	Granted	2001258057	2001258057	07/07/05
Czech Republic	Granted	PV2002-4092	PV2002-4092	12/27/07
Croatia	Granted	P20020982A	P20020982	02/28/06
India	Granted	IN/PCT/2002/1523/KOL	IN/PCT/2002/1523/KOL	05/11/08
New Zealand	Granted	523,113	523,113	12/08/03
Japan	Granted	2008517269	4,778,046	07/08/11
China (People's Republic)	Granted	200680030300.0	200680030300.0	06/16/10
European Patent Office	Granted	2006741262	1,899,188	09/07/11
Patent Cooperation Treaty	Pending	PCT/AU01/00585		
Israel	Pending	152,902		
South Korea	Pending	1020027015531		
PCT	Pending	PCT/AU2006/000861		
Australia	Pending	2006261578		

Electric-Field Assisted Fuel Atomization System and Method of Use				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
Russian Federation	Granted	2009120461/06	2,469,205	12/10/12
Mexico	Granted	MX/A/2009/004631	300,245	06/14/12
Canada	Granted	2,688,157	2,668,157	05/21/13
European Patent Office	Granted	2007839854	2007839854	04/20/11
Japan	Pending	2009-534705		
Patent Cooperation Treaty	Pending	PCT/US07/22939		
US	Pending	12/513,019		

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Method and Apparatus for Treatment of a Fluid				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
China (People's Republic)	Granted	ZL200580023369.3	200580023369	03/30/11
China (People's Republic)	Granted	201110022400.0	ZL201110022393.2	06/12/13
Eurasian Patent Organization	Granted	200,602,114	010773	08/04/08
Egypt	Granted	24,703	024703	05/13/05
United Kingdom	Granted	0624025.3	GB2432193	02/06/08
Mexico	Granted	PA/a/2006/013206	272650	12/10/09
US	Granted	11/596,198	8,173,023	05/08/12
Gulf Cooperation Council	Pending	GCC/P/2005/5066		
Brazil	Pending	0510871-3		
Indonesia	Pending	IDP0024534B		
Libya	Pending	3560/2008		
Norway	Pending	20,065,632		
Canada	Pending	2,566,739		

Increasing Fluidity of a Flowing Fluid				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
US	Granted	13/762,017	8,616,239	12/31/13

Electrical Interconnect and Method				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
US	Pending	61/920,879		

Joule Heating Apparatus and Method				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
US	Pending	61/912,917		

Method for Reduction for Crude Oil Viscosity				
Country	**Application Status**	**Application No.**	**Pat. No.**	**Issue Date**
US	Granted	11/792,553	8,156,954	04/17/12
Nigeria	Granted	360/07	RP17009	11/26/07
United Kingdom	Granted	711091.9	2,434,800	07/29/09
Indonesia	Granted	W00200701842	IDP0025477	04/13/10
Mexico	Granted	MX/A2007/007339	284,467	03/08/11
Russian Federation	Granted	2007126828	2,461,767	09/20/12
Brazil	Pending	P10517184-9		
Norway	Pending	20,073,617		

COMMENT 2. Please [provide] us with support for your statement that “AOT has been proven in U.S. Department of Energy tests and other independent tests…to increase the energy efficiency of oil pipeline pump stations.”

RESPONSE 2
U.S. Department of Energy tests:

Results of the U.S. Department of Energy (DOE) test of QS Energy’s AOT technology were provided by the DOE in its final report dated April 4, 2012. As described in this report’s abstract,

> “The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the STWA in-line viscosity reduction device at the Naval Petroleum Reserve No. 3 (NPR-3) located 35 miles north of Casper in Natrona County, Wyoming. The in-line viscosity reduction device is designed to reduce the line-loss and increase the flow rate of crude oil traveling through a commercial pipeline, thereby reducing the energy required for crude oil transportation. Reductions in line-loss and gains in pump operation efficiency (i.e., reduced power consumption) were observed on the 4.4 mile 6” schedule 80 metal buried pipeline test loop.”

Detailed test results provided in Fig. 1 and Fig. 2 of the DOE final report indicated pressure loss and viscosity were each reduced by 40% as follows:

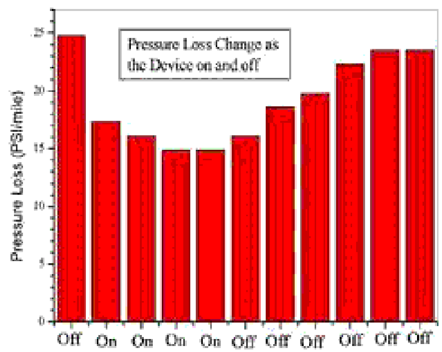

Fig.1 When the AOT device is turned on, the pressure loss is reduced by 40%, from 24.8 psi/mile down to 14.87 psi/mile. After the device turned off, the crude oil in the section was replaced by untreated crude oil and the pressure loss returns to the original value.

Figure 1: Source, DOE Final Report dated 4/4/12

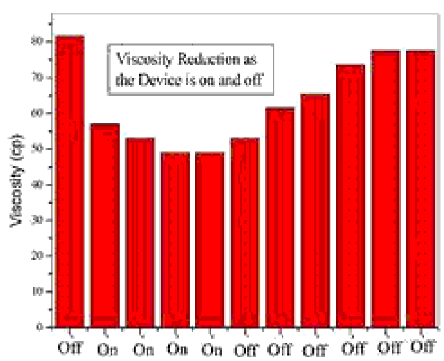

Fig.2. The original viscosity was 81.6 cp. After the AOT device was turned on, it was reduced by 40%, down to 48.95cp. After the AOT device was turned off, the crude oil in the section was gradually replaced by untreated crude oil and the viscosity returned to the original value.

Figure 2: Source, DOE Final Report dated 4/4/12

A complete copy of the U.S. Department of Energy final test report is attached as Exhibit 1, and is available on the QS Energy website at: https://qsenergy.box.com/DOE-STWA-RMOTC-Report

Other Independent Tests:
Independent tests were performed by ATS Rheosystems™, a division of CANNON™ (ATS) during test operations run on a QS Energy AOT device installed on TransCanada's Keystone pipeline. Tests were performed during typical full-scale pipeline operations. ATS provided two versions of its final report on these tests: a detailed report dated October 6, 2014 ("ATS Detailed Report", attached as Exhibit 2); and a summary report providing summaries of tests performed, results, and ATS's independent interpretation of the test results dated February 5, 2015 ("ATS Summary Report", attached as Exhibit 3).

The following observations were provided in the ATS Detailed Report:

> "As can be observed from the data, the viscosity of the <WCS> crude oil is reduced by the AOT device treatment. A drop in viscosity from 215.75 cP before treatment to about 167 cP after treatment is observed. This is approximately a 23% decrease in viscosity in the case of the treated oil, up to time, t = 3 hours. At time, t = 13 hours the reduction in viscosity is approximately 11% and after 22 hours after the treatment the crude oil viscosity gets back to its original viscosity before treatment. This trend indicates that the effect of the treatment at 5 kV and 50 mA electric field lasts several hours." (ATS Detailed Report, page 2)
>
> "The data indicates an approximately 10% decrease in viscosity in the case of the SHB crude and an approximately 8% decrease in viscosity in the case of the MKH crude oil due to the AOT treatment." (ATS Detailed Report, page 2)
>
> "In conclusion, this study finds that the AOT technology appears to cause a decrease in viscosity of the crude oils flowing through the pipeline. In order to achieve the maximum decrease in viscosity and take full advantage of the AOT technology, the applied electric field would need to be increased to appropriate levels." (ATS Detailed Report, page 3)

The ATS Summary Report concluded:

> "The treated oil samples consistently showed lower measured viscosity than the untreated oil. This was true for all three grades of oil. Samples for one of the oil grades were measured over duration of 22 hours. These measured viscosity values showed a persisting attenuation of the viscosity for several hours followed by an increase with time until at 22 hours they had approached near to the viscosity of the untreated oils." (ATS Summary Report, page 2)

A complete copy of the ATS Detailed Report is available online at: https://qsenergy.box.com/ATS-AOT-Detailed-Report

A complete copy of the ATS Summary Report is available online at: https://qsenergy.box.com/ATS-AOT-SummaryRpt

In 2012, PetroChina Pipeline R&D Center ("PetroChina") performed a series of independent tests on a prototype AOT unit at its facility in China. As summarized in its report dated June 26, 2012 ("PetroChina Report", attached as Exhibit 4), PetroChina concluded,

> "The above series of tests show that it is very effective to use AOT to reduce the viscosity of crude oil. We can see that AOT has significantly reduced the viscosity of Daqing crude oil, Changqing crude oil, and Venezuela crude oil, and greatly improved its flow rate." (PetroChina Report, page 15)

A complete copy of the PetroChina Report is available online at: https://qsenergy.box.com/PetroChina-STWA-Report

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COMMENT 3. Provide us with support for all assertions in your document regarding the purported efficacy or "proven" status of your technology, including your claim at page 5 that you "have proven our ability to build, deliver and operate our AOT equipment on a high volume commercial pipeline…." Provide us with all test results and reports which you claim "prove" your technology. Provide comparable support for your statements later about your Joule process.

RESPONSE 2
We have proven our ability to build, deliver and operate AOT equipment on a high-volume commercial pipeline by manufacturing, delivering, installing and operating on two North American high-volume commercial pipelines. The first commercial deployment of AOT occurred on the Keystone Pipeline in Udall, Kansas in May 2014, utilizing four AOT pressure vessels in parallel for a cumulative capacity of 600,000 barrels per day. See Form 8-K filed on August 2, 2013 (TransCanada Lease and Option to Purchase Agreement).

4-Unit AOT installed on TransCanada's Keystone Pipeline, cumulative capacity of 600,000 barrels per day.

Independent tests performed by ATS Rheosystems™, a division of CANNON™ (ATS) confirmed operations under normal Keystone pipeline operating conditions. ATS provided a final report dated February 5, 2015 ("ATS Summary Report", attached as Exhibit 3), summarizing its procedures, test results, findings and observations, which concluded:

> "Viscosity measurements of crude oils were acquired on-site at a North American oil pipeline. Oil samples were taken from the pipeline under normal operating conditions before and after exposure to the electric field generated by the AOT." (ATS Summary Report, page 1)

A copy of the ATS Summary Report is available online at: https://qsenergy.box.com/ATS-AOT-SummaryRpt

The second AOT commercial installation was performed in March 2015 on the Kinder Morgan Crude & Condensate pipeline (KMCC), a 200,000 barrel per day pipeline providing takeaway for the Eagle Ford Shale in South Texas, primarily delivering crude oil condensate. Delivery and installation of this unit further demonstrates our proven ability to build, deliver and operate our AOT equipment on a high volume commercial pipeline. This prototype was installed and passed all safety and pre-start inspections as required by KMCC. See Form 8-K filed on July 21, 2014 (KMCC Lease and Option to Purchase Agreement).

Single-Unit AOT installed on KMCC's pipeline, capacity of 200,000 BBL/Day.

KMCC operations were fully disclosed in the Company's 2015Q3-10Q:

> "In June 2015, QS Energy engineers performed a series of tests and internal inspections on the AOT unit, which identified other potential design issues that could impact electrical impedance. Based on these findings, a number of internal components of the AOT were retrofitted or remanufactured to improve both efficacy and efficiency. The remanufactured AOT unit was delivered to Kinder Morgan facility in Texas and was installed in its new vertical configuration in July 2015. Installation and pre-start safety tests were successfully completed and preliminary testing initiated in August 2015. Initial results were promising, with the unit operating generally as expected. However, voltage dropped as preliminary tests continued, indicating decreased impedance within the AOT pressure vessel. QS Energy personnel and outside consultants performed a series of troubleshooting assessments and determined that, despite modifications made to the AOT, conductive materials present in the crude oil condensate continue to be the root cause of the decreased impedance. Based on this result, QS Energy and Kinder Morgan personnel mutually agreed the best course of action was to hold on final acceptance of equipment under the lease and temporarily suspend in-field testing to provide time to thoroughly test samples of Kinder Morgan's crude oil condensate in a laboratory setting." (QS Energy 2015Q3-10Q, page 17)

No statements have been made regarding our ability to build, deliver and operate the Joule Heat technology. This technology is in early prototype development, and its efficacy has not yet been established. Our first Joule Heat prototype unit was tested under operating conditions in June of 2015. Findings of this test were inconclusive. This is consistent with our 2015Q3-10Q disclosure regarding the commercial status of the Joule Heat technology:

> "The Company's first Joule Heat prototype was installed for testing purposes at the Newfield facility in June 2015 and the system is operational; however, changes to the prototype configuration will be required to determine commercial effectiveness of this unit." (page 17, 2015Q3-10Q)

AOT Efficacy and Reports

The efficacy of our AOT equipment has not been established. This is consistent with statements made in the Company's Form 10-K and Form 10-Q filings. As reported in the Company's 10-K for the year ended December 31, 2014, filed March 16, 2015 ("2014-10K"):

> "While more testing is required to establish the efficacy of our AOT technology, we are encouraged by the findings of our independent research laboratory." (page 12, 2014-10K)

The same statement is made on page 16 of our most recent Form 10-Q for the quarter ended September 30, 2015, filed November 9, 2015 ("2015Q3-10Q"). A number of independent reports support this statement:

I. ATS Rheosystems™, a division of CANNON™ ("ATS") field test report dated October 6, 2014 ("ATS Detailed Report", attached as Exhibit 2)
   a. ATS provided a summary report of tests performed on the AOT system installed on TransCanada's Keystone pipeline, providing their test procedures, summary results and findings, including data protected by a non-disclosure agreement between QS Energy and TransCanada.
   b. This independent report provides specific viscosity measurements before and after treatment by the AOT, with measured viscosity reductions ranging from 8% to 23%. It was known in advance of the test that the power supply installed on the AOT was undersized. As reported by ATS, test results indicated that a larger power supply would be needed to provide optimal results.
   c. ATS report states:
      "In conclusion, this study finds that the AOT technology appears to cause a decrease in viscosity of the crude oils flowing through the pipeline. In order to achieve the maximum decrease in viscosity and take full advantage of the AOT technology, the applied electric field would need to be increased to appropriate levels." (ATS Detailed Report, page 3)
   d. This statement is consistent with disclosures in our 2014-10K, including:
      "Among other things, the Report determined that data indicated treatment of the crude oil flowing through the TransCanada pipeline using our AOT Technology reduced the viscosity of the crude oil. The Report also determined that the efficacy of our AOT Technology was constrained due to the limitations of the electric field applied by the power supply installed on our equipment, concluding that maximum viscosity reductions could be achieved by modifying the installed power supply. We are encouraged by the results and data analysis arising from the testing of our AOT Technology under commercial operating conditions." (2014-10Q, page 4)
   e. A copy of this summary report is available online at: https://qsenergy.box.com/ATS-AOT-Detailed-Report

II. ATS Summary Report dated February 5, 2015 ("ATS Summary Report", attached as Exhibit 3)
   a. ATS provided a summary report of tests performed on the AOT system installed on TransCanada's Keystone pipeline, providing their test procedures, summary results and findings.
   b. Findings of this summary report state:
      "The treated oil samples consistently showed lower measured viscosity than the untreated oil. This was true for all three grades of oil. Samples for one of the oil grades were measured over duration of 22 hours. These measured viscosity values showed a persisting attenuation of the viscosity for several hours followed by an increase with time until at 22 hours they had approached near to the viscosity of the untreated oils." (ATS Summary Report, page 2)

  c. A copy of this summary report is available online at: https://qsenergy.box.com/ATS-AOT-SummaryRpt

III. PetroChina Pipeline R&D Center report dated June 26, 2012 ("PetroChina Report", attached as Exhibit 4)
  a. PetroChina reported on a series of tests run on a prototype AOT unit installed at their facility located in China.
  b. The PetroChina Report concluded:
     "The above series of tests show that it is very effective to use AOT to reduce the viscosity of crude oil. We can see that AOT has significantly reduced the viscosity of Daqing crude oil, Changqing crude oil, and Venezuela crude oil, and greatly improved its flow rate." (PetroChina Report, page 15)
  c. A full copy of the PetroChina Report is available online at: https://qsenergy.box.com/PetroChina-STWA-Report

IV. U.S. Department of Energy Rocky Mountain Oilfield Test Center ("RMOTC") report dated April 4, 2012 ("RMOTC Report", attached as Exhibit 1)
  a. A prototype AOT unit was installed at tested RMOTC. As described in the RMOTC Report Abstract:
     "The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the STWA in-line viscosity reduction device at the Naval Petroleum Reserve No. 3 (NPR-3) located 35 miles north of Casper in Natrona County, Wyoming. The in-line viscosity reduction device is designed to reduce the line-loss and increase the flow rate of crude oil traveling through a commercial pipeline, thereby reducing the energy required for crude oil transportation. Reductions in line-loss and gains in pump operation efficiency (i.e., reduced power consumption) were observed on the 4.4 mile 6" schedule 80 metal buried pipeline test loop." (RMOTC Report, Abstract)
  b. As detailed in Fig 1. And Fig 2. Of the RMOTC Report, the prototype AOT device reduced pressure loss and viscosity each by 40% (RMOTC Report, page 4).
  c. The RMOTC Report concluded:
     "Test results indicate that the viscosity reduction device operated successfully and that the AOT 1.2H prototype delivers improved performance over the original AOT prototype tested in October 2011. Pipeline line-loss and pump motor power consumption were reduced for a given flow rate during the observed test. The device may hold potential for energy savings and increased pipeline flow rates for the oil production and transportation industry." (RMOTC Report, page 6)
  d. A complete copy of the RMOTC Report is available online at: https://qsenergy.box.com/DOE-STWA-RMOTC-Report

Joule Heat Efficacy and Reports

Due the Joule Heat technology's early development stage, limited test data and reports are available. Southern Research Institute ("SRI") performed tests on a prototype Joule Heat unit in September 2015, which showed promising results in which the Joule Heat prototype was observed to increase crude oil temperatures. These tests were observed by both SRI and QS Energy personnel. Shortly after these tests were performed, and prior to submission of a final report, SRI shut down certain labs and laid off staff responsible for SRI testing and analysis of the Joule Heat unit. Subsequent to these events, Robert Strange, the SRI project engineer responsible for running and analyzing the Joule Heat tests provided an independent report of his observations and findings ("JH Test Report", attached as Exhibit 5), specifically detailing observed temperature increases due to operations of the small-scale Joule Heat device.

> "For the flow through experiment using the small prototype we were able to observe a temperature increase of approximately 3^{o}F. For the static testing we were able to observe a temperature increase of approximately 10^{o}F after a minute of applied power to a static crude oil sample." (JH Test Report, page 1)

These test results are consistent with disclosures provided in the Company's 2015Q3-10K:

> "QS Energy has provided a scaled-down version of the commercial Joule Heat unit for static and flow-through testing at Southern Research Institute (SRI). Testing performed by SRI in September 2015 demonstrated the ability the Joule Heat technology to deliver significant temperature increases in the laboratory setting." (2014Q3-10Q, page 17)

A copy of the JH Test Report is available online at: https://qsenergy.box.com/JH-RD-Report

COMMENT 4. Explain the basis for your claim at page 5 that "key players in the pipeline industry continue to demonstrate strong interest in our technologies." Identify those "key players" and explain how they have demonstrated their "strong interest."

RESPONSE 4

We are working actively with the following companies: [**The material below identified as redacted has been omitted and provided separately to the staff of the Securities and Exchange Commission pursuant to a request for confidential treatment under Rule 83.**]

Kinder Morgan Crude and Condensate ("KMCC")

Our AOT technology is currently installed on its 200,000 barrel per day pipeline providing takeaway for the Eagle Ford Shale in South Texas. As discussed in our response to Item 3, KMCC continues to work cooperatively with QS Energy to resolve known issues in operating the AOT with condensate fuel. Subject to final acceptance of a modified AOT device, KMCC has agreed to lease the AOT equipment at a cost of $20,000 per month, with an option to purchase the equipment. See QS Energy's Form 8-K filed July 21, 2014.

<REDACTED>

QS Energy is in current negotiations with **<REDACTED>**, a crude oil transportation and storage company (**<REDACTED>**) to enter into a Joint Development Agreement to test the efficacy of QS Energy's AOT equipment on **<REDACTED>**'s high-volume crude oil transportation infrastructure. If successful testing is achieved, **<REDACTED>** has expressed an interest to acquire additional AOT units. Price has not been determined, but **<REDACTED>** is aware of prices previously established in QS Energy's TransCanada and Kinder Morgan leases with options to purchase transactions, with purchase prices of approximately $1MM per unit. These leases have been filed in the Company's Form 8-Ks filed on August 2, 2013 and July 21, 2014. **<REDACTED>** and QS Energy personnel met the week of January 4, 2015 at Temple University's laboratory facilities to observe testing protocols and discuss results of laboratory tests performed by Dr. Tao of Temple University on crude oil samples provided by **<REDACTED>**. Preliminary tests reported by Dr. Tao in his summary report dated December 8, 2015 ("Tao **<REDACTED>** Report", attached as Exhibit 7) demonstrated viscosity reductions of up to 46%. A copy of the confidential Tao **<REDACTED>** Report is attached. Current tests at Temple University are ongoing, and continue to provide encouraging results. **<REDACTED>**continues to demonstrate interest.

<REDACTED>

QS Energy is working with an affiliate, Energy Tech Africa (“ETA”) to market AOT equipment to **<REDACTED>**. In February through early April 2015, Dr. Tao of Temple University conducted laboratory tests on crude oil samples provided by **<REDACTED>**. These tests demonstrated AOT viscosity reductions of 20%-35%. In his final report dated April 9, 2015 (“Tao **<REDACTED>** Report”, attached as Exhibit 8) Dr. Tao concluded, “The test results clearly show that the viscosity reduction technology, AOT, can significantly reduce the viscosity of the crude oil from **<REDACTED>**.” (Tao **<REDACTED>** report, page 7). Based on test results reported in the Tao **<REDACTED>** Report, QS Energy submitted a case study to **<REDACTED>**, and is currently working with ETA to formalize a purchase agreement proposal.

Key players have expressed interest in our AOT technology, as indicated by their willingness to provide crude oil samples to Temple University at their cost for testing. Each of these confidential tests has yielded positive laboratory results, and each of these players continue to express current interest, subject to final proof of efficacy of this technology. Evidence of these business relationships is provided in the confidential “Final Report (March 2013-April 2015)” prepared by Dr. Tao of Temple University, dated April 15, 2015 (“Tao Final Report”, attached as Exhibit 6). This report summarizes test results on oil samples provided by each company that has expressed strong enough interest in our technology to i) enter into a non-disclosure agreement; and ii) provide samples of their crude oil, at their expense. A brief summary identifying of each of companies and related laboratory results was provided in the Tao Final Report, summarized as follows.

<REDACTED>

Dr. Tao Test Analysis: We conducted tests with crude oil sample from **<REDACTED>** oil company, which was extracted in **<REDACTED>**. The sample is paraffin based crude oil with pour point around 38.5^{0}C. The viscosity is 21.25 cp at 51^{0}C. When an electric field of 12KV/cm was applied, the viscosity is down to 9.77 cp, reduced by 54%. In addition, the pour point is also down to 36.5^{0}C, reduced by 2^{0}C. The viscosity reduction lasts more than 20 hours.

<REDACTED>

Dr. Tao Test Analysis: We tested four fuel samples from **<REDACTED>**. They are Ultra-Low Sulfur Diesel (ULSD) A, ULSD B, Jet Fuel, and BHP Condensate. These samples from **<REDACTED>** are refinery fuels, not crude oil. In comparison with crude oil, all these samples have quite low viscosity. On the other hand, our tests clearly show that the AOT technology can significantly reduce the viscosity of ULSD A and BHP condensate. At 22^{0}C, application of electric field of 1670V/mm reduces the viscosity of ULSD A sample from 4.62cp to 3.53cp, down 23.6%. Similarly, at 20.4^{0}C, application of electric field of 123V/mm brings the viscosity of BHP Condensate from 2.876cp to 2.185cp, down 24%. For ULSD B and jet fuel, the viscosity reduction is moderate. At 22^{0}C, application of electric field of 2500V/mm reduces the viscosity of ULSD B from 3.39cp to 3.22 cp, down 5%. At 20^{0}C, application of electric field of 1830V/mm reduces the viscosity of Jet fuel from 1.9cp to 1.8cp, down 5%.

<REDACTED>
Dr. Tao Test Analysis: We tested two oil samples from **<REDACTED>**, Black wax crude oil and Yellow wax crude oil. The test results clearly show that the AOT technology can significantly reduce the viscosity of both oil samples. The technology is extremely effective for Yellow wax crude oil sample. At 52^0C, the AOT technology with electric field 360V/mm reduces its viscosity from 15.7 poise to 1.01 poise, down 93.5%. Because the Black wax crude oil sample contains metallic particles, we have to use electrodes, which have a gap with the pipe wall. The existence of metallic particles also limits the applied voltage, but the results are still much better than that of most conventional crude oil samples. At 40.3^0C, application of electric field 160V/mm reduces the viscosity of Black wax crude oil from 30.5 poise to 7.6 poise, down 75%. If there were no metallic particles inside Black wax crude oil, the viscosity reduction for Black wax crude oil would be as significant as that for Yellow wax crude oil.

<REDACTED>
Dr. Tao Test Analysis: We did tests with No#2 diesel from **<REDACTED>**, for a temperature range 0^0C to 25^0C. The AOT technology is also able to reduce viscosity of diesel fuel. At 0^0C, application of electric field of 3760V/mm brings the diesel viscosity from 4.5cp to 4.24cp, down 5.8%.

<REDACTED>
Dr. Tao Test Analysis: We conducted additional tests with different refinery fuel samples from **<REDACTED>**. These samples are refinery fuels, not crude oil. In comparison with crude oil, all these samples have quite low viscosity. On the other hand, our tests show that the AOT technology can reduce the viscosity of these diesel fuels moderately, about 4-5%.

<REDACTED>
Dr. Tao Test Analysis: We conducted tests with crude oil sample from **<REDACTED>**. The tests clearly show that the AOT technology can significantly reduce the viscosity of the crude oil from **<REDACTED>**. At 71^0C, application of electric field of 1400V/mm brings the oil viscosity from 120.1cp to 71.2cp, down 40.7%.

<REDACTED>
Dr. Tao Test Analysis: We conducted lab tests with SHG condensate from **<REDACTED>**. While the condensate sample from **<REDACTED>** is different from conventional crude oils, the viscosity reduction technology, AOT, can significantly reduce its viscosity. Many suspended particles inside the condensate oil sample have micrometer size. Therefore, the electrorheological effect is quite strong and a moderate electric field is sufficient to reduce its viscosity effectively. For example, at 20^0C, a moderate electric field of 116.1V/mm can reduce the sample viscosity from 4.65cp to 3.93cp, down 15%.

<REDACTED>
Dr. Tao Test Analysis: We were asked to conduct research about the conductivity of Black wax crude oil sample from **<REDACTED>**, especially explore the relationship between conductivity and temperature. We have found that the conductivity of black wax crude oil is mainly due to the metallic particles inside. Normally, metals have their conductivity decreasing with temperature up. For fluids, the situation is opposite: the conductivity of most fluids goes up with the temperature increasing. This is due to the following fact: the ions inside the fluid are the main charge carriers for most fluids. Then as the temperature goes up, the fluid viscosity goes down and the ions are more mobile, making the conductivity up.

<REDACTED>
Dr. Tao Test Analysis: We conducted lab tests with Sour Crude oil sample from **<REDACTED>**. The test results show that the AOT technology can significantly reduce the viscosity of the Sour crude oil. For example, at 61.3^oC, application of a moderate electric field of 60V/mm reduces the sample viscosity from 2553.16cp to 1544.21 cp, down 39.5%.

<REDACTED>
Dr. Tao Test Analysis: We conducted lab tests with crude oil sample from **<REDACTED>**. The test results show that the AOT technology can significantly reduce the viscosity of the crude oil sample. For example, at 38.1^{o}C, application of electric field of 1011V/mm reduces the oil viscosity from 50.5cp to 39.46cp, down 21.86%. On the other hand, we also found that the electric current is relatively higher because of the high volume fraction of water and remaining of DRA polymers. We also conducted some tests to see how to reduce the electric current.

In addition, Gregg Bigger, QS Energy CEO, is currently in discussions regarding the Company's AOT technologies with representatives of top-tier oil and gas companies, including, **<REDACTED>**, **<REDACTED>**, **<REDACTED>**, **<REDACTED>**, **<REDACTED>**, **<REDACTED>**, **<REDACTED>**, and **<REDACTED>**.

COMMENT 5. At page 11, you suggest that producers "would also benefit from their midstream transporters implementing our AOT 2.0 transmission-line series by its ability to increase the overall flow capacity…." Clarify for the reader your reference to your "AOT 2.0 transmission-line series."

RESPONSE 5
The "AOT 2.0" nomenclature is a holdover from when the first commercial-sized midstream unit was manufactured, and announced in a Company press release on August 9, 2012, referring to the "second generation AOT", and "The commercial design, known as AOT™ 2.0". A copy of this press release can be found online at: http://www.qsenergy.com/news/detail/1593/stwa-begins-commercial-manufacturing-of-aot-2-0

The AOT 2.0 and AOT Midstream nomenclatures were defined in the Company's 2012 Form 10-K filed on March 22, 2013 ("2012-10K") in the following statement:

> "In September, 2012 the Company began production of its first AOT Midstream commercial design ('AOT 2.0', 'AOT Midstream') with its supply chain based in Casper, Wyoming." (2012-10K, page 5)

"Transmission line" is common nomenclature in the oil and gas industry to denote a network of pipelines for the transportation of oil and natural gas.

We currently favor the "AOT Midstream" nomenclature over "AOT 2.0" as it better represents both our technology and our target market.

COMMENT 6. We note your statement at page 14 that "our technology is commercially unproven and the use of our technology by others is limited." Explain the reference to this "limited" usage.

RESPONSE 6
The referenced section of our Form 10-K is identifying risk factors. The use of our technology to date has been limited only to joint development, research, and testing applications, including:

1. Temple University (testing, research and joint development);
2. U.S. Department of Energy Rocky Mountain Oilfield Testing Center (testing, research);
3. PetroChina Pipeline R&D Center (testing);
4. TransCanada (testing, joint development, possible conversion to commercial use);
5. Kinder Morgan Crude and Condensate (testing, joint development, possible conversion to commercial use);
6. Newfield Exploration Company (testing, joint development);

FOIA Confidential Treatment Requested Pursuant to Rule 83

Management's Discussion and Analysis, page 22

Liquidity and Capital Resources, page 24

COMMENT 7. Please quantify the amount of additional funds that you will need to operate your business and, to the extent, indicate the approximate amounts that you will need:

- pursuant to your agreements with Temple University;
- to fund product development and commercialization;
- to manufacture and ship your products; and
- to fund the other items listed under "Summary."

Similarly, please ensure that your discussion of issuances of unregistered securities at page 21 provides for each applicable issuance all information that Item 701 of Regulation S-K requires. In that regard, we note that you have not provided the date of sale of your unregistered securities, the name of the persons or class of persons to whom you issued the securities, or the facts you relied upon to make the "Section 4(2) and/or Regulation S" exemption(s) available. Also, provide enhanced disclosure regarding the issuance of convertible notes that you reference at page 24. We note the discussion in the notes to your unaudited June 30, 2015 financial statements relating to non-interest bearing convertible notes that you issued in spring 2015. We are unable to locate the documents underlying that issuance listed in the exhibit list of any of your filings. See Item 2.03 of Form 8-K.

RESPONSE 7
The amount of additional funds required is dependent upon levels of success and timing of our commercialization efforts.

As noted in the contractual obligations section of page 24 of the referenced 2014 Form 10-K, the Temple University license agreements require the payment of minimum license fees of $187,500 annually. Obligations under the Temple University research agreement end in 2015; total outstanding expense as of December 31, 2014 was $64,648.

Funds required for product development and commercialization are relatively low due to the fact that we have 5 full-scale commercial AOT units in inventory (one currently deployed at Kinder Morgan). These units are not included in assets on our balance sheet under GAAP. In accordance with GAAP, they were expensed as a research and development expense. Details regarding current estimates for product development and commercialization, manufacture and shipping of our products, and other budget expenses including those generally under "other items" are stated in our previously filed Form 10-K, for the period ended December 31, 2014, and subsequent Form 10-Q filings, along with current funding and operations plans, are detailed in our business plan reported in Form 8-K filed on December 1, 2015.

The Company's Form 10-Q for the nine-month period ended September 30, 2015, filed November 9, 2015 ("2015Q3-10Q") provided convertible note details, as follows:

> "In the second quarter of 2015, the Company issued convertible notes in the aggregate of $550,000 for cash consideration of $475,500, net of original issue discount of $50,000 and commission paid of $24,500. The notes do not bear any interest; however, the Company used an implied interest rate of 10%. The notes are unsecured, mature one year after issuance, and are convertible into 1,833,333 shares of common stock at a conversion price of $0.30 per share. The Company determined that the notes contained a beneficial conversion feature of $352,139 since the market price of the Company's common stock was higher than the effective conversion price of the notes when issued.
>
> "Investors in the convertible notes received, for no additional consideration, warrants to purchase a total of 916,667 shares of common stock. Each warrant is exercisable on a cash basis only at an exercise price of $0.30 per share, are exercisable immediately upon issuance, and expires one year from the date of issuance. The relative fair value of the warrants issued with the convertible notes was determined to be $118,806 computed using the Black-Scholes Option Pricing model.
>
> "The fair value of the warrants, the beneficial conversion feature, the original issue discount and commission paid, aggregated $545,445 and is considered a debt discount. In June 2015, the full balance of these notes in the amount of $550,000 was converted to 1 ,833,333 shares of common stock and the full aggregated debt discount amortized as interest expense. During the three and nine month periods ending September 30, 2015, the total note discount amortized as interest expense was $0 and $545,455, respectively. As of September 30, 2015 there was no remaining balance due on these notes." (2015Q3-10Q, page 10-11)

FOIA Confidential Treatment Requested Pursuant to Rule 83

The Company's Form 10-K for the year ended December 31, 2015 will contain similar disclosures for all notes funded during calendar-year 2015.

The documents underlying the issuance of the convertible notes in 2015 will be filed in the Company's Form 10-K for the period ended December 31, 2015, to be filed on or before March 15, 2016. Please advise if this is acceptable.

COMMENT 8. Please file or incorporate by reference all material agreements that Item 601(b)(10) of Regulation S-K requires you to file, including without limitation the following:

- The research agreement with Temple University and any amendments thereto, which you reference in Note 6 to your financial statements at page F-15; and
- All equity compensation plans, including the plan(s) pursuant to which you provide your board committee members with a monthly fee and pursuant to which you have issued options, warrants, and rights to purchase 16,760,000 shares of common stock at $0.26 per share, as you indicate in the second row of your equity compensation plan table (see the related disclosure at pages 44 and 45).

RESPONSE 8
The Company intends to make this filing in its Form 10-K for the period ended December 31, 2015, to be filed on or before March 15, 2016. Please advise if this is acceptable.

The Company confirms the following:

A. The Company is responsible for the adequacy and accuracy of the disclosures in the filing.

B. Staff comments or changes to disclosure in response to staff comments do not foreclose the Commission from taking any action with respect to the filing.

C. The Company may not assert staff comments as a defense in any proceeding initiated by the Commission or any person under the federal securities laws of the United States.

Please contact me if you have any questions or further comments in this matter.

Very truly yours,
Gartenberg Gelfand Hayton LLP

By: /s/ Edward S. Gelfand
Edward S. Gelfand, as counsel to the Company

The foregoing statements and contents of this letter are hereby true and accurate and confirmed and adopted by the Company.

QS Energy, Inc.

BY: /s/ Gregg Bigger
Gregg Bigger, CEO

Exhibit 1

ROCKY MOUNTAIN OILFIELD TESTING CENTER

RMOTC

PROJECT TEST RESULTS

STWA, INC.
VISCOSITY REDUCTION TECHNOLOGY

Prepared for:

Industry Publication

Prepared by:

GEORGE HUGHES & JEANETTE BUELT
RMOTC Field Engineers

April 04, 2012

Exhibit 1

ABSTRACT

April 04, 2012

The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the STWA in-line viscosity reduction device at the Naval Petroleum Reserve No. 3 (NPR-3) located 35 miles north of Casper in Natrona County, Wyoming. The in-line viscosity reduction device is designed to reduce the line-loss and increase the flow rate of crude oil traveling through a commercial pipeline, thereby reducing the energy required for crude oil transportation. Reductions in line-loss and gains in pump operation efficiency (i.e., reduced power consumption) were observed on the 4.4 mile 6” schedule 80 metal buried pipeline test loop.

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List of Figures

Exhibit 1

INTRODUCTION:

The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the STWA in-line viscosity reduction device (Applied Oil Technology, AOT) at the Naval Petroleum Reserve No. 3 (NPR-3) located 35 miles north of Casper in Natrona County, Wyoming.

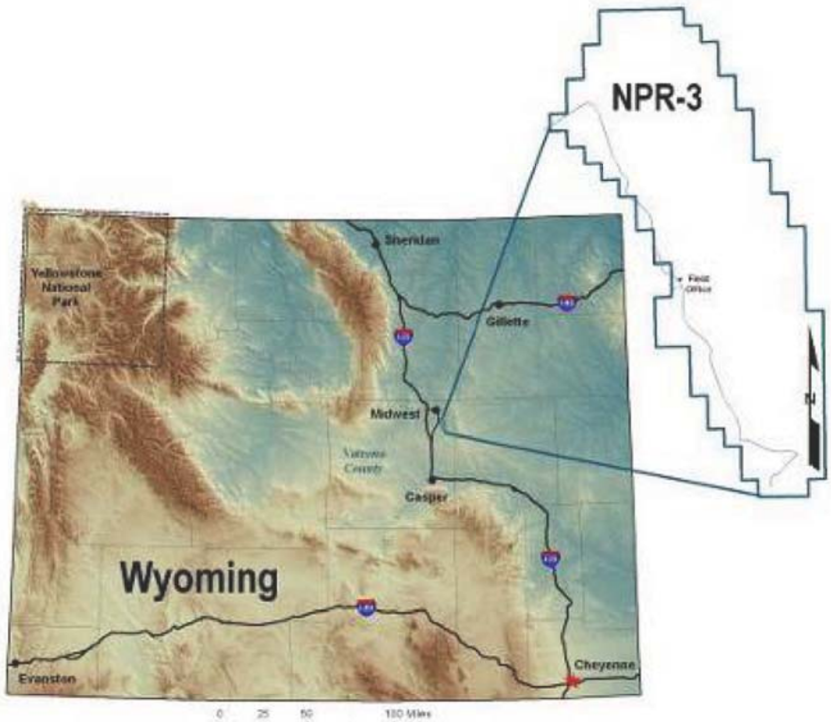


Figure 1. State Map of NPR-3

STWA, Inc. (STWA) of Santa Barbara, California, together with Temple University of Philadelphia's physics department designed and created the AOT device to reduce the energy required to transport crude oil through commercial pipelines.

The device exposes passing crude oil to a precisely controlled electric field to reduce the oil viscosity. This is intended to reduce line-loss (fluid drag) and pressure, without changing the oil temperature or composition. In a commercial pipeline operation, the intended results would translate into reduced pump power required to maintain constant flow rates, and would thereby deliver energy savings for crude oil transportation.

Exhibit 1

TEST RESULTS:

Test results are detailed within Appendix A.

OBSERVATIONS:

In 2011, the AOT device was installed on a flow loop located at the RMOTC field test site in NPR-3. The flow loop – a 4.4 mile, 6 inch, schedule 80 metal buried pipeline – was modified specifically to support this viscosity reduction test. RMOTC validated overall system integrity after AOT installation, and filled the loop with field-produced API 34° oil to facilitate testing. The initial phase of testing in 2011 is detailed within *"STWA Final Report: Viscosity Reduction Test"* dated October 19, 2011.

The AOT device was removed in January 2012 and reworked to include new components, some of which were composed of alternate materials. The reworked device, referred to as the AOT 1.2H prototype, was reinstalled on the test loop in March 2012. RMOTC again validated overall system integrity after the AOT 1.2H installation, and filled the loop with field-produced API 34° oil to facilitate this second phase of testing. The test was conducted on March 29, 2012.

A motor operating at 30 Hz and controlled by a Variable Frequency Drive was used to circulate oil through the loop to establish baseline performance. Baseline performance was measured as follows:

Exhibit 1

- 11.1-12.1 C oil temperature
- 0.8459 g/cm3 oil density
- 81.6 centipoise (cp) viscosity
- 1205.237 Reynolds #
- 0.053 friction
- 82.09 cm/s velocity
- 205 gal/min flow rate
- 1,379,000 dyne/cm2
- 24.8 psi/mile pressure drop

After establishing baseline performance, the AOT 1.2H device was turned on and operated for 3.8 hours. AOT performance was measured as follows:

- 11.1-12.1 C oil temperature (unchanged)
- 0.8459 g/cm3 oil density (unchanged)
- 48.95 cp viscosity (reduced 40%)
- 2009.138 Reynolds # (increased 67%)
- 0.032 friction (reduced 38%)
- 82.09 cm/s velocity
- 205 gal/min flow rate (unchanged)
- 827,400 dyne/cm2 pressure (reduced 40%)
- 14.87 psi/mile pressure drop (reduced 40%)

When the AOT was disengaged, viscosity and pressure were observed to revert slowly back to baseline.

Exhibit 1

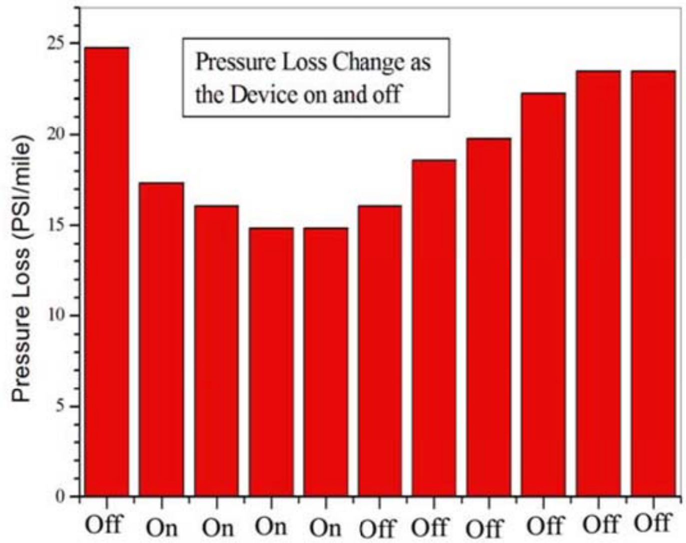


Fig.1 When the AOT device is turned on, the pressure loss is reduced by 40%, from 24.8 psi/mile down to 14.87 psi/mile. After the device turned off, the crude oil in the section was replaced by untreated crude oil and the pressure loss returns to the original value.

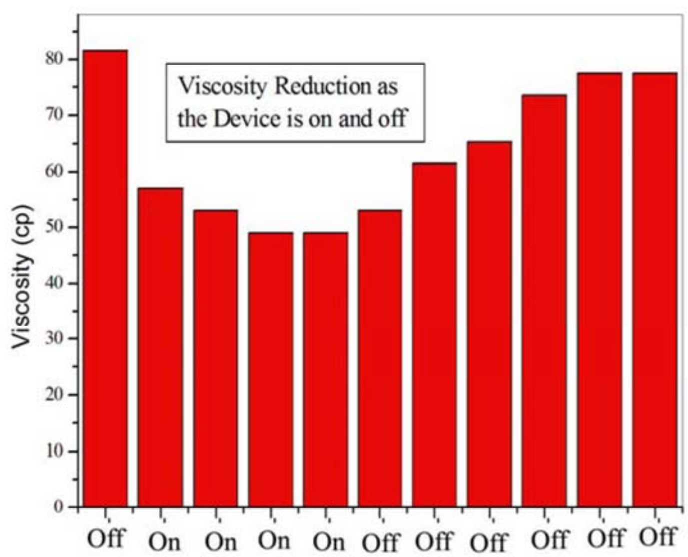


Fig.2. The original viscosity was 81.6 cp. After the AOT device was turned on, it was reduced by 40%, down to 48.95cp. After the AOT device was turned off, the crude oil in the section was gradually replaced by untreated crude oil and the viscosity returned to the original value.

Exhibit 1

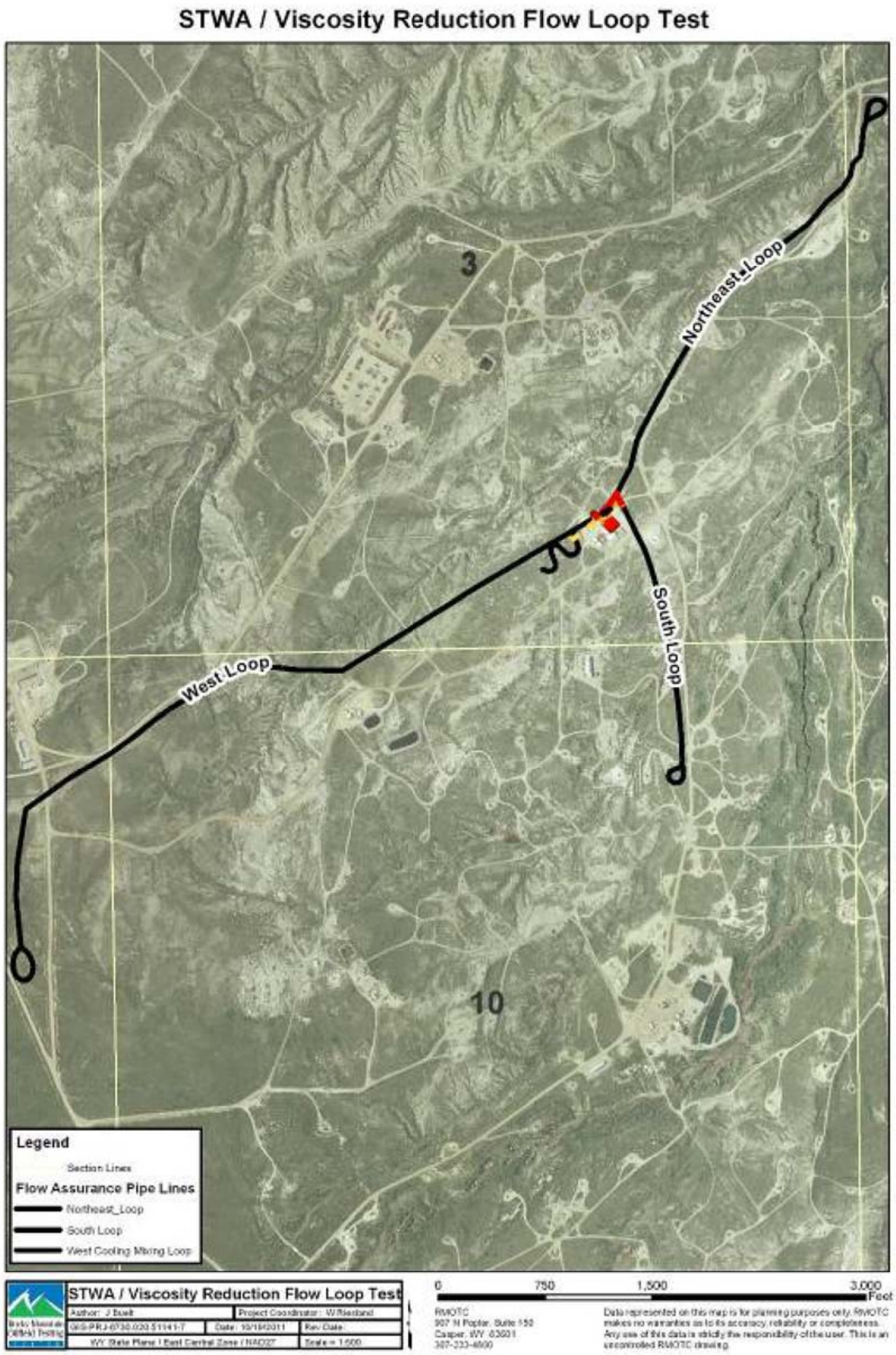


Figure 2. NPR-3 Flowloop Map

Exhibit 1

CONCLUSION:

Test results indicate that the viscosity reduction device operated successfully and that the AOT 1.2H prototype delivers improved performance over the original AOT prototype tested in October 2011. Pipeline line-loss and pump motor power consumption were reduced for a given flow rate during the observed test. The device may hold potential for energy savings and increased pipeline flow rates for the oil production and transportation industry.

Exhibit 1

This research was co-funded by STWA, Inc. and the Pipeline Research Council International (PRCI). Work was directed by Clarke Turner, Brian Haight, Wes Lintz, Wes Riesland, George Hughes, and Jeanette Buelt.

Exhibit 1

APPENDIX A

Raw Data

Pressure Values STWA AOT Test 03292012 RMOTC

	Pressure (PSI)							
Time	#1	#2	#3	#4	#5	#6	Flow rate	Velocity
9:46	5	218	170	150	89	5	205	82.0910458185
10:04	5	196	153	139	104	5		
10:40	5	186	140	127	100	4		
10:47	5	187	139	126	99	4		
11:00	5	194	138	124	99	3		
11:25	5	192	134	122	98	3		
11:45	5	192	134	122	98	3		
11:52	4	191	131	118	97	4		
12:16	5	195	132	117	94	4		
12:31	5	198	133	117	93	4		
12:50	5	203	135	117	91	4		
12:59	5	206	136	118	91	4		
1:19	5	212	139	120	92	3		
1:39	5	215	141	122	94	3		
1:48	5	217	142	123	94	3		
2:07	5	215	141	123	95	3		

Note: 10:00 turned on the AOT device

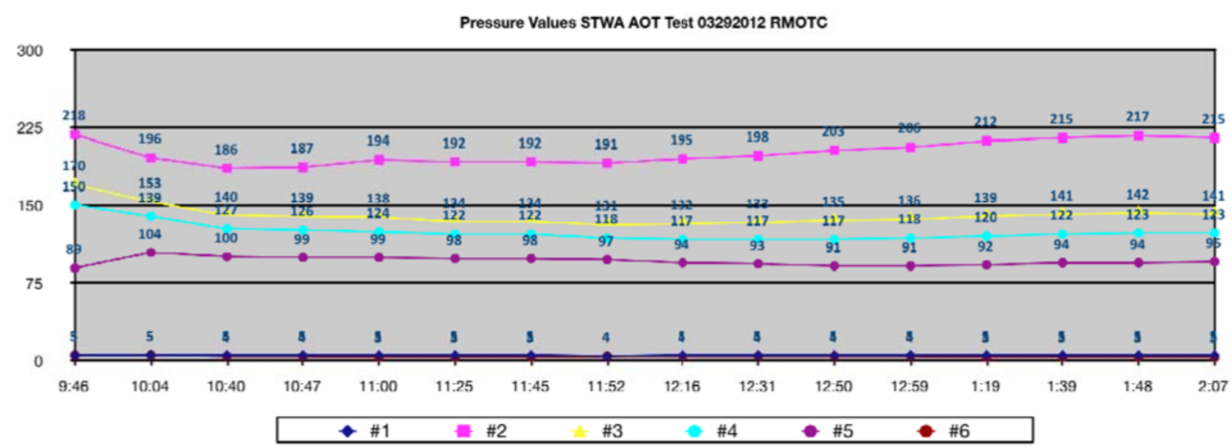


Exhibit 1

R. TAO Calculation STWA AOT Test 03292102 RMOTC

	Diameter (in)	Density (g/cm^3)	Flowrate (gallon/min)	Velocity (cm/s)	Length (m)	Viscosity (poise)	Ren-#	Friction Loss	P1 (PSI)	P2 (PSI)	Pressure Loss (dyne/cm^2)	Calculated Loss	Pres Loss
9:46am	5.575886784565	0.8459	205	82.09104543828	1291	0.816	1205.2366	0.05310160619	170	150	1379000	1379643.370717	24.78698683191
	5.575886784565	0.8459	205	82.09104543828	1291	0.571	1722.3697	0.03715810923	153	139	965300	965412.2116168	17.35089078234
	5.575886784565	0.8459	205	82.09104543828	1291	0.5304	1854.2102	0.03451604402	142	129	896350	896768.190966	16.11154144074
10:04	5.575886784565	0.8459	205	82.09104543828	1291	0.5304	1854.2102	0.03451604402	140	127	896350	896768.190966	16.11154144074
10:47	5.575886784565	0.8459	205	82.09104543828	1291	0.5304	1854.2102	0.03451604402	139	126	896350	896768.190966	16.11154144074
11:00	5.575886784565	0.8459	205	82.09104543828	1291	0.571	1722.3697	0.03715810923	138	124	965300	965412.2116168	17.35089078234
11:25	5.575886784565	0.8459	205	82.09104543828	1291	0.4895	2009.1381	0.03185445617	134	122	827400	827616.9484876	14.87219209915
11:46	5.575886784565	0.8459	205	82.09104543828	1291	0.4895	2009.1381	0.03185445617	134	122	827400	827616.9484876	14.87219209915
11:52	5.575886784565	0.8459	205	82.09104543828	1291	0.5304	1854.2102	0.03451604402	131	118	896350	896768.190966	16.11154144074
12:16	5.575886784565	0.8459	205	82.09104543828	1291	0.615	1599.1432	0.04002143114	132	117	1034250	1039804.746312	18.59024012393
12:31	5.575886784565	0.8459	205	82.09104543828	1291	0.654	1503.7815	0.04255937555	133	117	1103200	1105743.583883	19.82958946553
12:50	5.575886784565	0.8459	205	82.09104543828	1291	0.7356	1336.9672	0.04786953617	135	117	1241100	1243707.920955	22.30828814872
12:59	5.575886784565	0.8459	205	82.09104543828	1291	0.7356	1336.9672	0.04786953617	136	118	1241100	1243707.920955	22.30828814872
1:19	5.575886784565	0.8459	205	82.09104543828	1291	0.775	1268.9975	0.05043351078	139	120	1310050	1310323.054296	23.54763749032
1:39	5.575886784565	0.8459	205	82.09104543828	1291	0.775	1268.9975	0.05043351078	141	122	1310050	1310323.054296	23.54763749032
1:48	5.575886784565	0.8459	205	82.09104543828	1291	0.775	1268.9975	0.05043351078	142	123	1310050	1310323.054296	23.54763749032

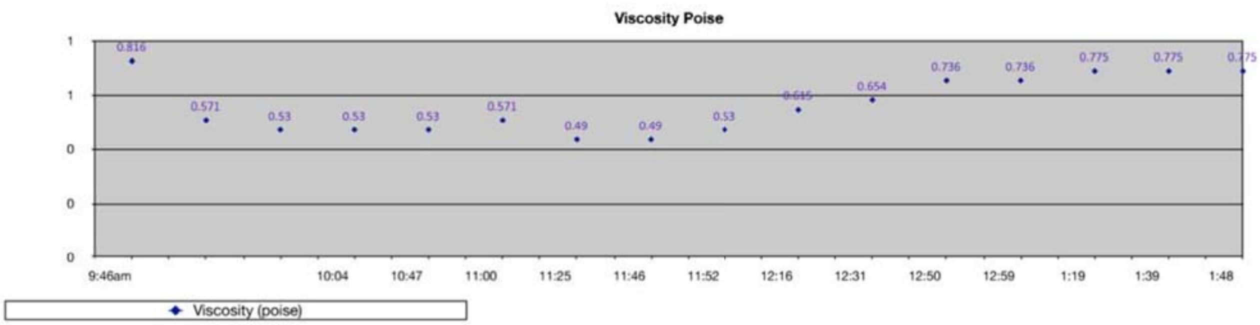
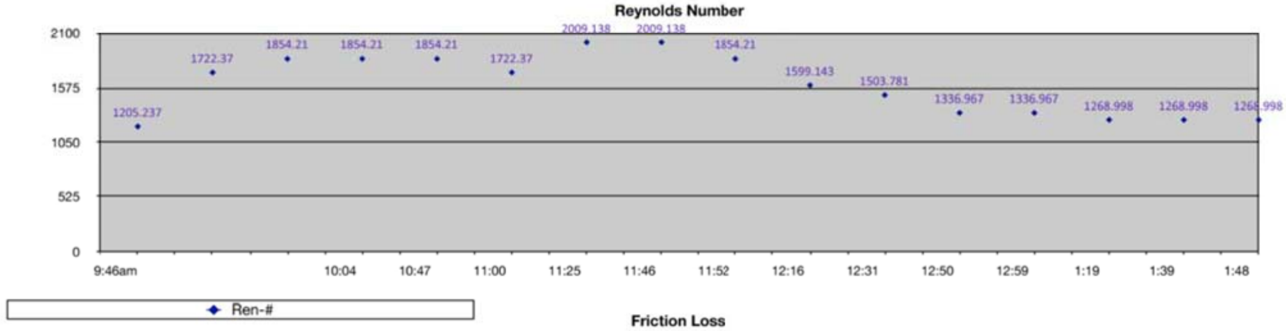


Exhibit 1


Reynolds Number
2100
1575
1050
525
0
1205.237
1722.37
1854.21
1854.21
1854.21
1722.37
2009.138
2009.138
1854.21
1599.143
1503.781
1336.967
1336.967
1268.998
1268.998
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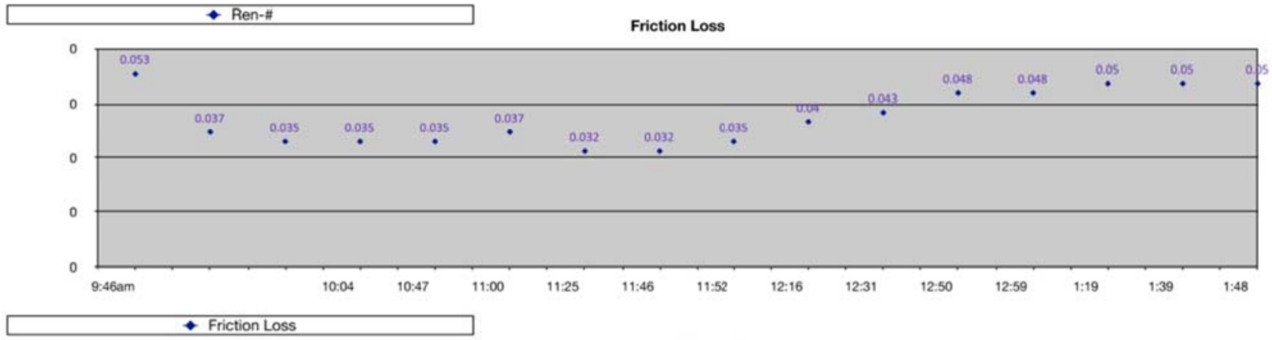
Ren-#


Friction Loss
0
0
0
0
0
0.053
0.037
0.035
0.035
0.035
0.037
0.032
0.032
0.035
0.04
0.043
0.048
0.048
0.05
0.05
0.05
9:46am 10:04 10:47 11:00 11:25 11:46 11:52 12:16 12:31 12:50 12:59 1:19 1:39 1:48
Friction Loss

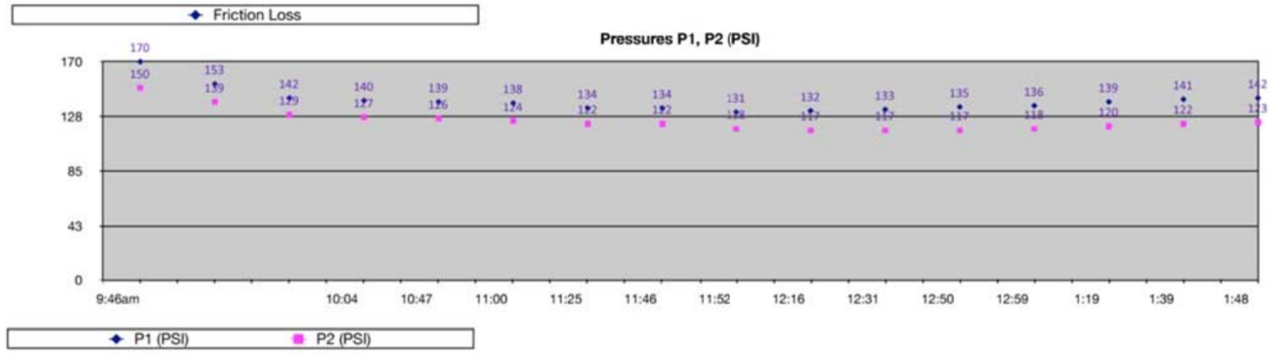
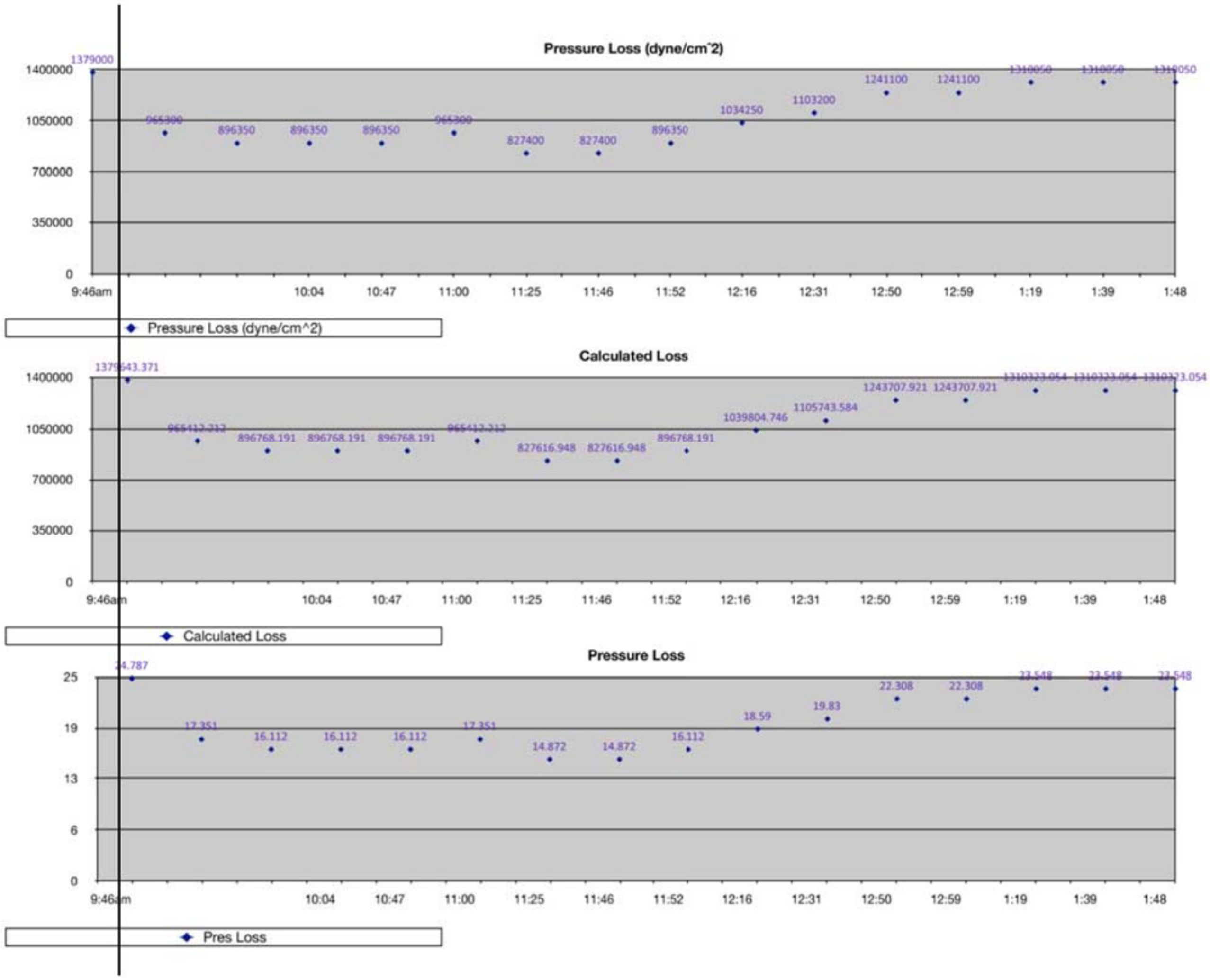

Pressures P1, P2 (PSI)
170
128
85
43
0
170 150
153 139
142 129
140 127
139 126
138 124
134 122
134 122
131 118
132 117
133 117
135 117
136 118
139 120
141 122
142 123
9:46am 10:04 10:47 11:00 11:25 11:46 11:52 12:16 12:31 12:50 12:59 1:19 1:39 1:48
P1 (PSI)
P2 (PSI)

Exhibit 1



Pressure Loss (dyne/cm^2)
1400000
1050000
700000
350000
0
9:46am
10:04
10:47
11:00
11:25
11:46
11:52
12:16
12:31
12:50
12:59
1:19
1:39
1:48
Pressure Loss (dyne/cm^2)
Calculated Loss
Calculated Loss
Pressure Loss
25
19
13
6
0
Pres Loss

Exhibit 2

ATS RheoSystems
A division of CANNON

231 Crosswicks Road
Bordentown, New Jersey 08505 USA
t: 609.298.2522 | f: 609.298.2795
atsrheosystems.com

Monday, October 6, 2014

Mike McMullen
STWA Inc.
Applied Oil Technologies
735 State Street, Suite 500
Santa Barbara, CA 93101

Dear Mike,

This report encompasses the viscosity data and the data analysis of the viscosity measurements of crude oils that were conducted on-site at the Wichita, KS facility of the Keystone pipeline where the AOT device is installed, on the 16th and 17th of September, 2014. The tests were conducted to determine the effectiveness of the devices in reducing the flow viscosity of crude oil flowing through the pipeline. Viscosity measurements were conducted on the crude collected before the oil flowed through the AOT device as well as after the oil passed through the device (treated). Viscosity measurements were conducted on three different grades of oils (WCS, SHB and MKH) over a period of two days. The treated WCS oil was tested at different intervals over a 24 hour period in order to assess the effect of the treatment through the time period. The SHB and MKH oils were tested before and immediately after the treatment.

Experimental

Crude oil samples were collected before the oil passed through the AOT device and after the oil passed through the device. Treated WCS crude oil was collected in bottles labelled #1, #2, #3 and #4 in the order they were collected consecutively. Viscosity measurements were conducted on a ViscoLab 3000 viscometer. This viscometer uses an electromagnetically controlled piston that moves in a up and down motion in a cup of oil. This technique was selected in order to minimize the structural disturbance that a rotational viscometer would cause during measurements. Since treatment of the oil is inferred to align the particulates in the crude, disturbance of such alignment due to rotational viscosity measurements would diminish the effects of the treatment. The up and down motion in the ViscoLab 3000 viscometer minimizes such disturbances during measurements. The viscosity measurements were conducted at 28 °C because the oil in the pipeline was flowing at 28 °C (as measured by TransCanada control systems). The electric field applied was approximately 5 kV voltage and 50 mA current.

Exhibit 2

Results

Viscosity data of the WCS crude oil collected using the ViscoLab 3000 viscometer is tabulated below:

Sample	Viscosity @ 28 °C (centipoise, cP)
Untreated	(215.0+212.7+215.6+216.4)/4 = **214.92**
Treated, t = 0	**167.1**
Treated, t = 3 hours	(167.8+167.7+166.5+166.4)/4 = **167.1**
Treated, t = 13 hours	(191.3+191.2+192.3+192.5)/4 = **191.83**
Treated, t = 22 hours	(212.6+212.5+213.3+213.5)/4 = **212.98**

Data indicates that treatment of the crude oil using the AOT device reduces the viscosity of oil, which is demonstrated by the oil viscosity drop after the treatment compared to the viscosity of the oil before the treatment. The viscosity measurements taken right after collection of the oil were discarded. These measurements were conducted on oil taken from bottle # 1 and showed a viscosity of 202.4 cP at 28 °C. However, measurements conducted on the treated crude from bottles #2 and #3 after 3 hours of sample collection showed an average viscosity of 167.1 cP. Therefore, it was inferred that the oil in bottle #1 was collected before the treatment of the oil was complete. Considering the viscosity values of the treated crude obtained over a period of 22 hours from different bottles (# 2 and # 3), the viscosity values of the crude from bottle # 1 can be ignored. In the table above, viscosity value obtained at time, t = 3 hours is used in place of the values measured at time, t = 0.

As can be observed from the data, the viscosity of the crude oil is reduced by the AOT device treatment. A drop in viscosity from 215.75 cP before treatment to about 167 cP after treatment is observed. This is approximately a 23% decrease in viscosity in the case of the treated oil, up to time, t = 3 hours. At time, t = 13 hours the reduction in viscosity is approximately 11% and after 22 hours after the treatment the crude oil viscosity gets back to its original viscosity before treatment. This trend indicates that the effect of the treatment at 5 kV and 50 mA electric field lasts several hours.

The SHB and MKH crude oils were collected before and after the treatment and the viscosities were measured at 28 °C. The viscosity data is tabulated below:

Sample		Viscosity @ 28 °C (centipoise, cP)
SHB	Untreated	(173.6+174.5+173.3+174.1)/4 = **173.88**
	Treated	(157.7+157.8+156.1+157.9)/4 = **157.38**
MKH	Untreated	(166.1+166.3+169.5+166.3)/4 = **167.05**
	Treated	(152.5+155.3+152.3+154.0)/4 = **153.53**

The data indicates an approximately 10% decrease in viscosity in the case of the SHB crude and an approximately 8% decrease in viscosity in the case of the MKH crude oil due to the AOT treatment.

Exhibit 2

The drop in viscosity is apparent in all the crude oils tested in this study. However, the amount of decrease in viscosity varies with the kind of crude oil tested. This is due to the different kinds of particulates present in different grades of crude oil. Some particulates have higher/lower dielectric constants than others and so are polarized differently leading to different degrees of alignment which result in different levels of decrease in viscosity.

Therefore, in order to achieve bigger drops in viscosity across the spectrum of grades and kinds of crude oil that flow through the pipeline, a sufficiently strong electric field needs to be applied. The electric field strength needed to fully treat the crude oil flowing through the pipeline of 36 inch diameter at approximately 2 miles/hr flow rate is far higher than was applied in this round of testing.

In conclusion, this study finds that the AOT technology appears to cause a decrease in viscosity of the crude oils flowing through the pipeline. In order to achieve the maximum decrease in viscosity and take full advantage of the AOT technology, the applied electric field would need to be increased to appropriate levels. As a logical next step towards optimizing the technology, the next round of testing should be conducted using the appropriate levels of electric field.

It is also recommended that as a secondary confirmation, capillary viscosity measurements of the crude oils be conducted using an automated capillary viscometer. An automated capillary viscometer is specifically recommended because the accuracy and reliability of the measurements conducted on a manual glass capillary viscometer are largely influenced by the operator and human error, and measuring inconsistencies can cause large errors in the final results.

Sincerely,

Jeshwanth Rameshwaram, Ph.D.
Principal Rheologist

E-Mail: info@atsrheosystems.com
Visit our Web site @ http://www.atsrheosystems.com

Exhibit 3

ATS RheoSystems
A division of CANNON

2139 High Tech Road
State College, PA 16803, USA
T: 609-298-2522
F: 814-353-8007
atsrheosystems.com

February 5, 2015

Greggory Bigger
President and CEO, STWA
735 State Street, Suite 500
Santa Barbara, CA 93101

Dear Mr. Bigger,

This report provides a summary of results from testing of the STWA AOT device in September, 2014, conducted by ATS RheoSystems, a division of the CANNON Instrument Company. Viscosity measurements of crude oils were acquired on-site at a North American oil pipeline. Oil samples were taken from the pipeline under normal operating conditions before and after exposure to the electric field generated by the AOT. Viscosity measurements were conducted on three grades of oils over a period of two days. Data for the before and after (treated) cases were compared to determine the influence of the AOT electric field on the manifest viscosity.

Procedure

Viscosity measurements were made using the ViscoLab 3000 viscometer provided by STWA. This viscometer was purported to have a lesser tendency to disrupt induced orientation of constituent particulates as compared to other viscometer designs. The viscosity measurements were conducted at a stable temperature consistent with the temperature of the oil flowing through the pipeline. Multiple samples and measurements were taken in order to obtain average measurement values having precision levels that would allow inference to be made regarding noted trends in the attenuated viscosity.

Considerations

Prior to the viscosity testing, it was determined by STWA in conjunction with Temple University that the electric field strength measured within the AOT was significantly less than necessary for optimum induced orientation of components in the oil. A replacement for the installed AOT power supply was expected to correct the situation[1]. Due to time constraints, all parties agreed to go forward with the testing using the installed power supply.

[1] According to STWA, the power supply provided with the AOT device was specified and approved by Temple University based on infrastructure and operating parameters, as well as on laboratory testing done with crude oil samples provided by the pipeline operator. After commissioning of the AOT device, it was determined by STWA in conjunction with Temple University that the electric field measured within the AOT device was approximately 10% of the expected value.

Exhibit 3

ATS RheoSystems
A division of CANNON
2139 High Tech Road
State College, PA 16803, USA
T: 609-298-2522
F: 814-353-8007
atsrheosystems.com

Findings

The treated oil samples consistently showed lower measured viscosity than the untreated oil. This was true for all three grades of oil. Samples for one of the oil grades were measured over duration of 22 hours. These measured viscosity values showed a persisting attenuation of the viscosity for several hours followed by an increase with time until at 22 hours they had approached near to the viscosity of the untreated oils.

Recommendations

It is felt that optimization of the power supply may provide a greater influence on the attenuated viscosity. ATS was informed by STWA that specifications[2] have been provided by Temple University for a new power supply capable of offsetting the electric field shortfall. Installation of a replacement power supply with the revised specification may afford an opportunity to make additional viscosity measurements that could be used to document an improvement in viscosity reduction.

Sincerely,

Jeshwanth Rameshwaran, Ph.D.
Principal Rheologist

[2] Electric field and power supply specifications are dependent upon the types of crude oil to be treated, pipeline operating characteristics (pipeline diameter, flow rate, etc.), and the AOT configuration (size and number of pressure vessels, etc.)

Exhibit 4

管道科技研究中心
PETROCHINA PIPELINE R&D CENTER

Report

AOT Viscosity Reduction Tests in China

Using Certain Chinese Crude Oil Samples

2012 年 6 月 26 日

储 运 工 艺 研 究 所

Division of Oil & Gas Storage and Transportation

Exhibit 4

管道科技研究中心
PETROCHINA PIPELINE R&D CENTER

Report
AOT Viscosity Reduction Tests in China Using Certain Chinese Crude Oil Samples

INTRODUCTION

Most crude oil produced in China is highly paraffin based, with generally high viscosity in low temperature environment, which presents an extreme hardship for pipeline transportation. For China's oil storage and transportation sector, viscosity reduction has, therefore, been a highly focal issue and one of the most pressing problems that demand for a satisfactory solution.

In 2006, based on the concepts of electrotheology (ER), a new technology to reduce the viscosity of crude oils by a strong electric field was proposed by Professor Rongjia Tao of Temple University. This new technology is now called AOT (applied oil technology) in news media. The comparative advantages of the AOT are reflected in three areas: consuming minimum amount of energy, producing fast effect, and generating significant viscosity reduction results.

In 2011 and 2012, AOT technology and device have been repeatedly tested at Rocky Mountain Oilfield Testing Center (RMOTC) of US Department of Energy. The testing results show that AOT has significantly reduced the viscosity of the crude; with stable flow rate, AOT would significantly reduce the pump pressure, whereas it would significantly increase the flow rate if pump pressure remains stable. Clearly, such testing results would have obvious, meaningful and great potential for commercial application for transporting high viscosity crude oil.

At the beginning of 2012, Beijing Henghe XingYe Technology Development Corporation ("TDC") introduced AOT to PetroChina Pipelie R&D Center, （or CPP in short). AOT has since attracted great attention from experts at CPP, who expressed significant interests in using AOT to conduct laboratory tests in China using Chinese crude oil samples. On such base, TDC has engaged in discussions with Save The World

Air Inc. ("STWA"), the company owns exclusive licensing rights on AOT. TDC and STWA have since made great efforts jointly for such objective. In March, 2012, Mr. Cecil Bond Kyte, the CEO of STWA, visited CPP with his team, and has nailed down the related details on such tests to be conducted.

STWA then specifically ordered the test experiments to be made for tests in China. From July 6 to 15, 2012, Professor Rongjia TAO and his team, working closely with experts from CPP, had carried out a series of tests to investigate the viscosity reduction effect of AOT with Daqing crude oil, Changqing crude oil and crude oil from Venezuela. This report summarized the testing equipment, testing conditions, testing contents, testing results, data analysis and so on.

The report highlights the following basis information:

1). The testing equipment was made by Professor Tao at Temple University in the US, and has been assembled for testing with assistance and coordination from experts at CPP.

2). Labview is used as the testing analysis software.

3). Persons participating in the tests:

Professor Rongjia TAO (Temple University in the US)
DU Enpeng, PHD (Temple University in the US)
MIAO Qing, Senior Engineer (CPP)
GAO Xinlou, Senior Engineer(CPP)
CHEN Zhi, PHD (graduate of Temple University, technology director of TDC)

STWA's CFO, Mr. Gregg Bigger, and COO, Mr. Bjorn Simundson, as well as Mr. ZHAO Ruilin, the GM of TDC, attended to the tests, as well as observed and witnessed the testing process.

I. Testing Equipment

Fig.1 Device for testing Changqing crude oil and crude oil from Venezuela.

Fig.2 Device for testing Daqing crude oil

The device in Fig.1 is used to test crude oil sample at room temperature or freezing temperature. The device in Fig.2 is specialized for Daqing crude oil, which stops flow and condensed into jell with a finite yield stress at 32℃ and below. Therefore, to test Daqing crude oil, we have to use an incubator to maintain the temperature of the oil sample and device at desirable temperature above 32℃.

II. Methods of Testing

The crude oil sample is loaded in cylindrical container at the top, which serves as the reservoir. Underneath the reservoir, there is a switch. When the switch is open, crude oil flows down under the gravity, passes through three electrodes into a long capillary tube. A cup on a microbalance collects the crude oil down through the capillary tube. The microbalance is connected to a computer, which, with labview software, automatically records the oil mass in the cup as a function of time. Hence we can determine the flow rate. From the flow rate, we can easily determine the viscosity. In this experimental setup, the pressure gradient due to the gravity remains as a constant. Therefore, the flow rate goes up as the viscosity is reduced.

III. Viscosity Reduction Process

The electrodes are connected to a high voltage power supply. When the power supply is turned on, a strong electric field is produced in the flow direction, forcing the suspended particles inside crude oil to aggregate into streamlined short chains along the flow direction. In this way, the effective viscosity of crude oil is reduced, while no heating or dilution is used here.

IV. Test Results

(1). Daqing Crude Oil

We conducted experiments with Daqing crude oil at 35.1℃, 40℃, and 47.4℃.

Figure 3 is the recorded crude oil mass as a function of time at 35.1℃. The slope of the curve is the flow rate. It is clear that as a strong electric field is applied, the flow rate is increased dramatically.

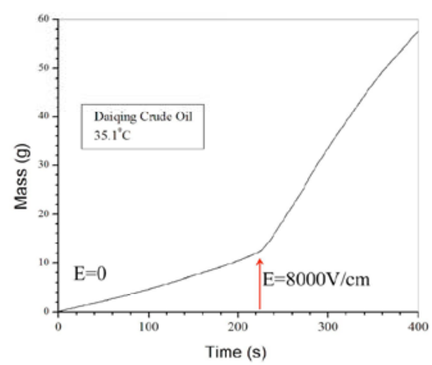


Fig.3 As a strong electric field is applied, the Daqing crude oil flows much faster.

Without electric field applied (at 35.1℃), the flow rate of Daqing crude oil is 0.04182 g/s, corresponding to viscosity 764.5 cp. When an electric field of 7200V/cm is applied, the flow rate is increased to 0.28252 g/s and the viscosity is down to 113.16 cp. In an electric field of 8000V/cm, the flow rate is increased to 0.318095 g/s and the viscosity is down to 100.5cp. The flow rate and viscosity are plotted in Figures 4 and 5 respectively. We note that it is a factor of 7.61 for the flow rate to be increased from 0.04182 g/s to 0.3181 g/s. This implies that under the same pump pressure, the new technology can increase the flow rate by 761%. The viscosity is also reduced by 86.9%. (Therefore, if we want to keep the same flow rate, then with the new technology the required pump pressure is only 13.1% of the original pressure).

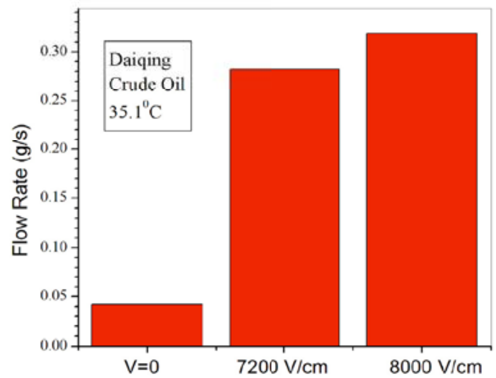


Fig. 4 At 35.1℃ , the Daqing crude oil flow rate is increased more than 6 times when a strong electric field is applied.

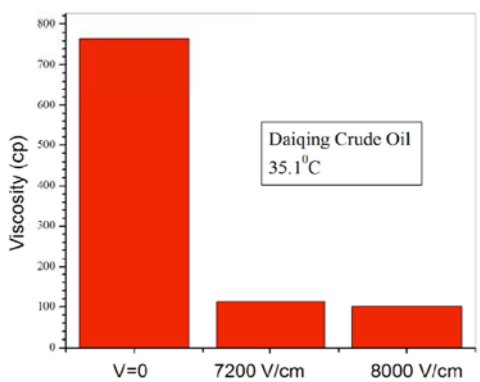


Fig.5. At 35.1℃, the viscosity of Daqing crude oil is reduced significantly when a strong electric field is applied.

Similarly at 40℃, a strong electric field can significantly increases the flow rate of Daqing crude oil and reduces its viscosity. The details are in Figures 6-8. Without electric field applied, the flow rate of Daqing crude oil at 40℃ is 0.006089 g/s, corresponding to viscosity 464.4 cp. When an electric field of 8000V/cm is applied, the flow rate is increased to 0.045179 g/s and the viscosity is down to 49.12 cp. In an electric field of 9600V/cm, the flow rate is increased to 0.048241 g/s and the viscosity is down to 46.0 cp. It is a factor of 7.92 for the flow rate to be increased from 0.006089 g/s to 0.048241 g/s. This implies that under the same pump pressure, the new technology can increase the flow rate by 792%. (If we want to keep the same flow rate, then with the new technology the required pump pressure is only 12.6% of the original pressure.)

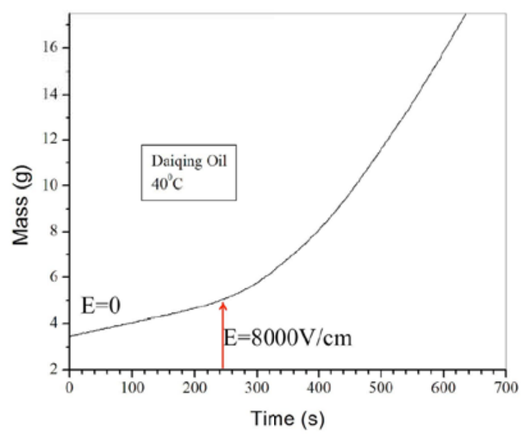


Fig. 6 As a strong electric field is applied, the Daqing crude oil flows much faster.

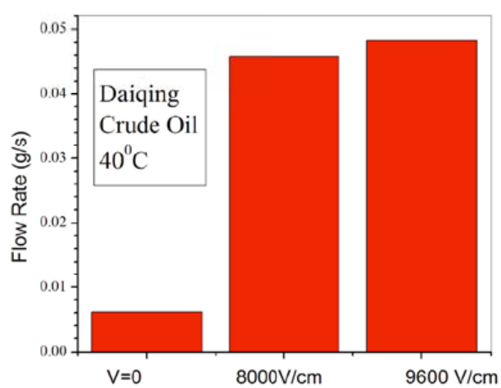


Fig.7 At 40℃ , the Daqing crude oil flow rate is increased more than 6 times when a strong electric field is applied.

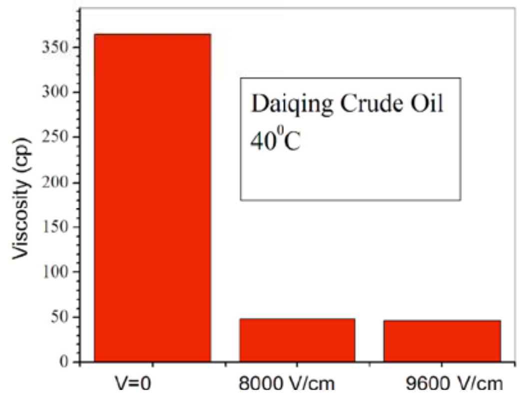


Fig.8. At 40℃, the viscosity of Daqing crude oil is reduced significantly when a strong electric field is applied.

At 47.4℃, a strong electric field can still increase the flow rate and reduce the viscosity significantly. As shown in Fig. 9 to 11 below,

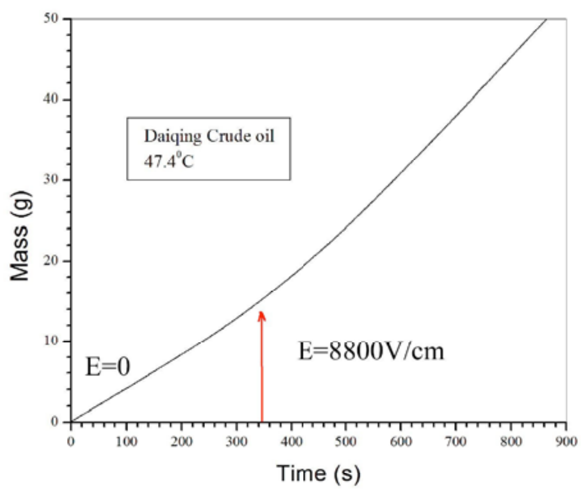


Fig.9 As a strong electric field is applied, the Daqing crude oil flows faster.

Exhibit 4

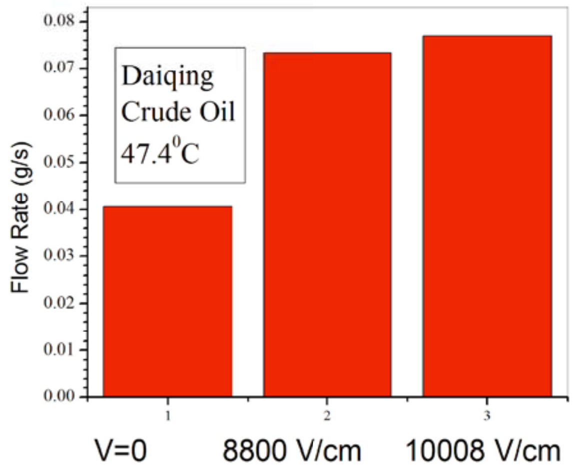


Fig.10 The flow rate is increased as the strong electric field is applied.

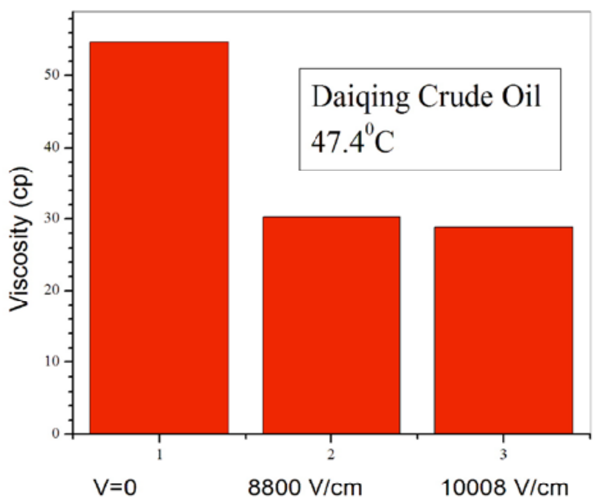


Fig.11 The viscosity is reduced by the electric field.

At 47.4℃ without electric field applied, the flow rate of Daqing crude oil is 0.040613 g/s, corresponding to viscosity 55.61 cp. When an electric field of 8800V/cm is applied, the flow rate is increased to 0.073315 g/s and the viscosity is down to 30.8 cp. In an electric field of 10008V/cm, the flow rate is increased to 0.076894 g/s and the flow rate is increased by 89.3%. The effect is equally remarkable.

CPP scientists also used a rotational viscometer (Physica made in Germany) to measure the viscosity of Daqing crude oil sample. The viscosity at various shear rates for untreated crude oil is in Table 1.

Table 1. Viscosity of untreated Daqing crude oil at 35.1℃

Shear rate (1/s)	10	20	30	40	50	100	150	180
Viscosity (cp)	1500	911	663	527	441	283	219	190

We also collected crude oil in the cup, which is treated by a strong electric field of 8000V/cm. With the same rotational viscometer, we measured its viscosity. The results are in Table 2.

Table 2. Viscosity of Daqing crude oil at 35.1℃ treated with electric field of 8000V/cm

Shear rate (1/s)	10	20	30	40	50	100	180
Viscosity (cp)	524	390	327	287	258	200	186

The same treated oil sample was re-measured again with rotational viscometer 13 hours after the treatment and 26 hours after the treatment. The results are in Tables 3 & 4.

Table 3. Viscosity of Daqing crude oil at 35.1℃, 13 hours after it was treated with electric field of 8000V/cm

Shear rate (1/s)	10	20	30	40	50	80	100	120	160	180
Viscosity (cp)	710	480	385	324	290	220	210	190	135	165

Table 4. Viscosity of Daqing crude oil at 35.1℃, 26 hours after it was treated with electric field of 8000V/cm

Shear rate (1/s)	10	20	30	40	50	80	100	120	150
Viscosity (cp)	693	487	389	332	292	258	242	229	216

As discussed above, the treated crude oil has the suspended particles aggregated into short chains along the flow direction. Therefore, the viscosity is anisotropic. Along the flow direction, the viscosity is the minimum. Along the other directions, the viscosity is higher than that along the flow direction. Therefore, our capillary tube is excellent to determine the viscosity along the flow direction.

Rotational viscometer is not the best to measure such viscosity. As the spindle starts to rotate, the short chains are initially not parallel to the rotational direction. Under the shear force, the short chains are driven to tilt and align along the rotational direction. Once this process is completed, the viscometer will find a low viscosity reading. Comparing Table 1 and Table 2, we see clearly that the treated crude oil has its viscosity reduced.

On the other hand, because some short chains are broken during this driving process, the viscosity measured by the rotational viscometer will be higher than that determined with our capillary tube. Our experiment confirms this analysis. For untreated crude oil, the flow rate of 0.04182 g/s corresponds to shear rate 25.7 (1/s). The viscosity 764.5 cp at such a shear rate is consistent with the data in Table1. For the treated crude oil, the flow rate 0.318095 g/s corresponds to a shear rate 195.47 (1/s). Its viscosity 100.5 cp measured with the capillary tube is much lower than that measured by the rotational viscometer, which is about 180 cp (see table 2), although 180cp is still lower than that of the untreated crude oil.

Comparing Table 3 and Table 4 with Table 1, we are convinced that the viscosity reduction effect lasts more than 24 hours although it is gradually weakened.

During the test, we also note that this viscosity reduction technology consumes very little energy for Daqing crude oil. To treat one barrel Daqingcrude oil, we only need about 0.1 kW-hour electricity.

(2) Changqing Crude Oil

Similar to Daqing crude oil, Changqing crude oil is also a paraffin-base crude oil. Our technology can reduce its viscosity significantly. We conduct the experiment at 26.5℃. As shown in Fig. 12 - 14, a strong electric field can make the crude oil flow much faster. When there is no electric field is applied, the flow rate is 0.21998 g/s, corresponding to a viscosity 178.26cp. In the electric field of 4000 V/cm, the flow rate is increased to 0.4237 g/s and the viscosity is reduced to 92.55 cp. An electric field of 7200V/cm increases the flow rate to 0.6 g/s and reduces the viscosity to 65.35cp. When the electric field is 9600 V/cm, the flow rate is increased to 1.0 g/s and the viscosity is reduced to 38.9 cp. We note that with the electric field of 9600V/cm, the flow rate is increased by 354.6% and the viscosity is reduced by 78.2%.

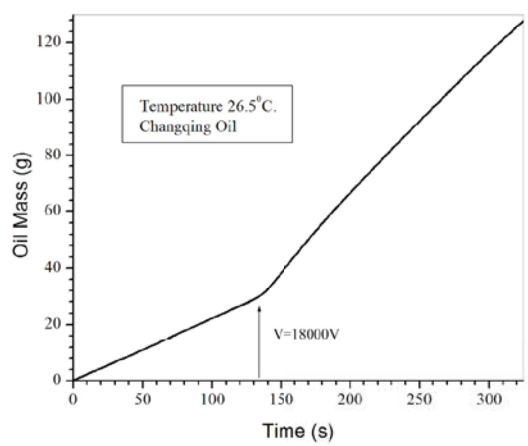


Fig.12 As a strong electric field is applied, the Changqing crude oil flows much faster.

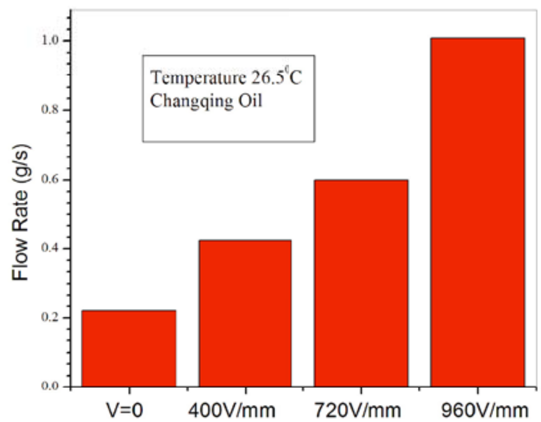


Fig. 13. The flow rate is increased substantially as the strong electric field is applied.

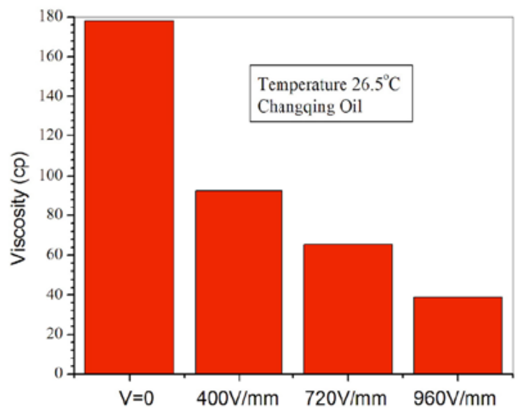


Fig.14 As a strong electric field is applied, the viscosity of Changqing crude oil is reduced significantly.

We also tested Changqing crude oil with anti-freezing additive, the data of which is shown in Fig. 15 and 16.

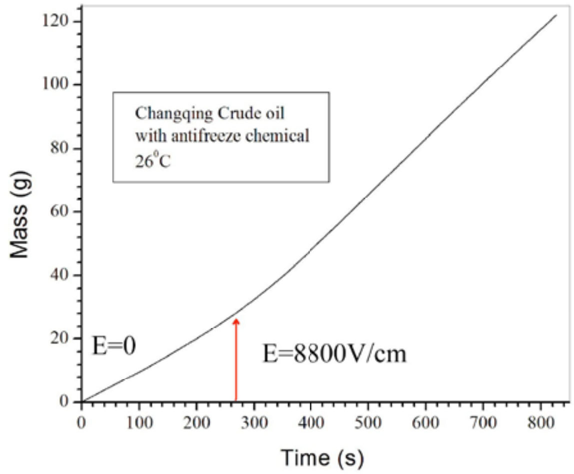


Fig. 15 As a strong electric field is applied, the Daqingcrude oil flows faster.

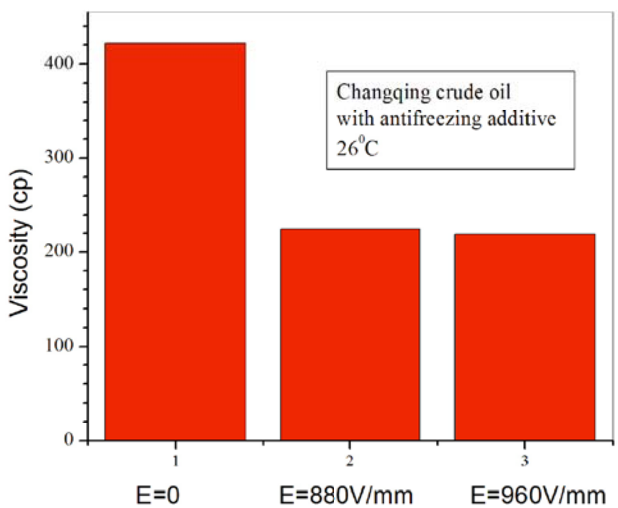


Fig.16 The viscosity is reduced by the electric field.

When there is no electric field, the flow rate is 0.09312 g/s, corresponding to a viscosity of 421.11 cp. A strong electric field of 960V/mm increases the flow rate to 0.17876g/s, increased by 92%. The viscosity is reduced to 219.36 cp. While this viscosity reduction is not as dramatic as the result for Changqing crude oil sample without the additive, the viscosity reduction is still significant.

During the test, we also note that this viscosity reduction technology consumes very little energy for Changqing crude oil. To treat one barrel Changqing crude oil, we only need about 0.1 kW-hour electricity.

(3) Venezuela Crude Oil

Different from Daqing and Changqing crude oils, Venezuela crude oil is asphalt based. At Temple University in USA, extensive research has done with asphalt-base crude oil. This viscosity reduction technology can effectively reduce the viscosity of asphalt-base crude oil.

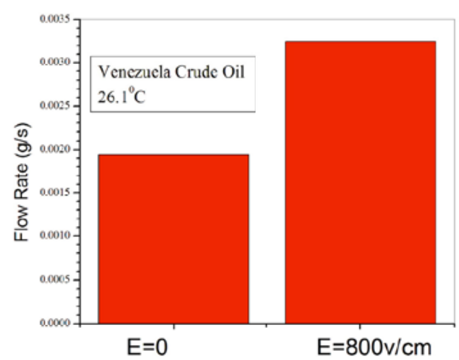


Fig.17 At 26.1°C , with a moderate electric field, the flow rate is increased from 0.00194 g/s to 0.00324 g/s, an increase of 67%.

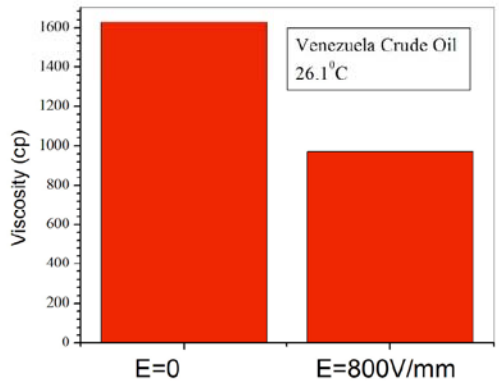


Fig.18 At 26.1°C , with a moderate electric field reduces the viscosity of Venezuela crude oil from 1628.2cp to 971.7 cp, a reduction of 40.32%.

We conducted the experiment at 26.1°C. Without electric field applied, the flow rate of Venezuela crude oil is 0.00194 g/s, corresponding to viscosity 1628.2 cp. When a moderate electric field of 800V/cm is applied, the flow rate is increased to 0.00324 g/s and the viscosity is down to 971.7 cp. The flow rate is increased by 67% and the viscosity is reduced by 40.32%. This is quite significant especially for such a moderate electric field.

During the test, we also note that Venezuela crude oil contains more water than Daqing crude oil and Changqing crude oil. Therefore, the treatment consumes more power than Daqing crude oil and Changqing crude oil. To treat one barrel Venezuela crude oil, we need about 0.3 kW-hour electricity.

Conclusions

The above series of tests show that it is very effective to use AOT to reduce the viscosity of crude oil. We can see that AOT has significantly reduced the viscosity of Daqing crude oil, Changqing crude oil, and Venezuela crude oil, and greatly improved its flow rate.

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The test results on Daqing and Changqing crude oil show that AOT has significant effect on reducing viscosity for paraffin based crude oil. For Daqing crude oil, the AOT can reduce its viscosity by 87% at 35℃, and 40℃, and can improve its flow rate by 7 to 8 times. For Changqing crude oil, the AOT can reduce its viscosity by more than 78% at 26℃, and can improve its flow rate by 3 to 4 times.

As to Venezuela crude oil, the tests conducted here show that AOT reduced its viscosity by 42.3%, and improved its flow rate by 67%. Taking into consideration of tests previously conducted by Professor Tao at Temple University, AOT can double the flow rate of Venezuela crude oil, and reduce its viscosity by nearly 50% (See Appendix 3 for relevant data).

The tests also show that the viscosity reduction effect lasts more than 24 hours.

We can clearly see that AOT's viscosity reduction effect is not only remarkable, bust also very fast (producing results in a few seconds), and at the same time it consumes minimum amount of energy.

The experts from both China and US side will work closely to propose solutions that are tailored to China's peculiar crude oil transportation situation.

Division of Oil & Gas Storage and Transportation

Petrochina Pipeline R&D Centre

Dated: June 26th, 2012

Exhibit 5

Robert Strange
4093 Old Cahaba Pkwy
Helena, AL 35080
(205) 215-2009
rjsstrange@gmail.com

7 January 2016

John Valenti
Special Projects
QS Energy, Inc.
735 State Street, Suite 500
Santa Barbara, CA 93101

Re: Joule Heating Experiments

Dear John,

I am writing in regards to the testing performed at Southern Research during the 4th quarter of 2015. As you are aware I was part of a staffing reduction at Southern Research and no longer have any access to any of the data or reports generated during my time with Southern Research. As a result I will only write regarding my recollection of the events during the testing period.

During your visit we tested a number of configurations for two of QS Energy proprietary techniques, (1) Viscosity Reduction Technology and (2) Joule Heating Technology. For the Viscosity reduction testing I was able to forward you a report before I left Southern Research, however I was unable to generate and transmit a report for the joule heating experiments. We began testing with a small prototype provide by QS Energy. We tested a light crude oil sample in two modes of operation (1) Flow through and (2) static testing with temperature measurements being taken in the outlet tubing using a Type K thermocouple. For the flow through experiment using the small prototype we were able to observe a temperature increase of approximately 3°F. For the static testing we were able to observe a temperature increase of approximately 10°F after a minute of applied power to a static crude oil sample. We also tested a module from your full-scale unit, which was inconclusive due to constraints within the laboratory setting including heat loss and small pump sizes.

Yours Truly,

Robert J Strange

Robert Strange
Mechanical Engineer

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College of
Science and Technology
TEMPLE UNIVERSITY®

Department of Physics
SERC (035-08)
1925 N. 12th Street
Philadelphia, PA 19122-1801

phone 215-204-7651
fax 215-204-5652
email rtao@temple.edu
web phys.cst.temple.edu

Final Report

(March 2013-April 2015)

Submitted by
Rongjia Tao, Ph.D.
Professor of Physics
Team Members: Dr. H. Tang, Dr. R. Ren,
Dr. X. Xu, and E. Du
Department of Physics
Temple University
Philadelphia, PA 19122, USA

April 15, 2015
(Confidential)

I. Introduction

During the past two years, we carried out various activities, including research, service, and development for the Applied Oil Technology (AOT). All these further develop the technology and help its commercialization led by STWA.

AOT was invented in 2006, based on the concepts of electrorheology [1-2]. Comparing to the heating method, the AOT technology consumes much less energy and is very fast and, therefore, much more efficient. In 2011 and 2012, Rocky Mountain Oilfield Testing Center (RMOTC) of US Department of Energy published three reports, showing that this technology is feasible on pipeline and able to reduce viscosity, pressure loss, and increase flow rate substantially on pipelines [3-5]. Afterwards, the technology develops very fast.

Crude oil is a suspension. Gasoline and diesel, as the base liquid, have very low viscosity. The oil's high viscosity is due to randomly suspended asphalt, paraffin, and other particles in the base liquid. The AOT technology can be illustrated in Fig.1.

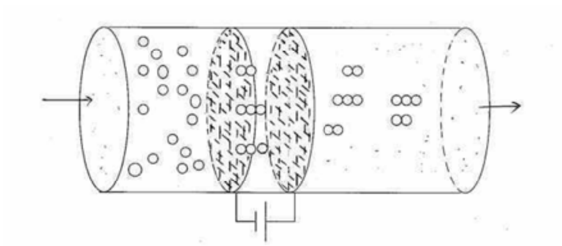

Fig.1 Illustration of our new technology, AOT.

A strong electric field is applied along the flow direction in a small section of the pipeline. Since the suspended particles and the base liquid have different dielectric constants, the particles are polarized. The dipolar interaction forces them to aggregate into short chains along the field direction. Once the particles form such aggregates, the symmetry is broken and the viscosity becomes anisotropic: (1) along the flow direction, the viscosity is significantly reduced as such aggregates are streamlined in this direction; (2) in the directions perpendicular to the flow, the viscosity is increased substantially as such aggregates have a very high intrinsic viscosity to move in these directions. Hence the oil flow along the pipeline is significantly enhanced because the treated oil has much lower viscosity in this direction and the turbulence can be suppressed as any random motion in the directions perpendicular to the axis becomes very difficult. This technology is much better than heating, which can reduce viscosity but cannot suppress turbulence. In addition, this technology is a green technology, fast, and energy-efficient.

Our work has received much global attention. Recently, American Physical Society had a press release about this work [6]. Many news media also have reports about it [7-8]. Even German National Radio broadcasted the news [9]. All these illustrate the importance of the AOT Technology and our work.

II. Lab tests for various oil samples.

In the past two years, we received 17 different samples. Most of them are crude oil samples from all over the world. Some of them are refinery fuels. We conducted tests with all these samples and have found that the AOT technology is general and able to reduce viscosity of all these samples effectively. The follow is the outline of these tests.

1. **[redacted].** We conducted tests with crude oil sample from [redacted], which was extracted in [redacted]. The sample is paraffin based crude oil with pour point around 38.5^{0}C. The viscosity is 21.25 cp at 51^{0}C. When an electric field of 12KV/cm was applied, the viscosity is down to 9.77 cp, reduced by 54%. In addition, the pour point is also down to 36.5^{0}C, reduced by 2^{0}C. The viscosity reduction lasts more than 20 hours. The details are in our report submitted on March 18, 2013.

2. **Fuel Samples [redacted].** In 2013, we tested four fuel samples from [redacted]. They are Ultra-Low Sulfur Diesel (ULSD) A, ULSD B, Jet Fuel, and BHP Condensate. As stated in the report submitted on March 27, 2013, these samples from [redacted] are refinery fuels, not crude oil. In comparison with crude oil, all these samples have quite low viscosity. On the other hand, our tests clearly show that the AOT technology can significantly reduce the viscosity of ULSD A and BHP condensate. At 22^{0}C, application of electric field of 1670V/mm reduces the viscosity of ULSD A sample from 4.62cp to 3.53cp, down 23.6%. Similarly, at 20.4^{0}C , application of electric field of 123V/mm brings the viscosity of BHP Condensate from 2.876cp to 2.185cp, down 24%. For ULSD B and jet fuel, the viscosity reduction is moderate. At 22^{0}C, application of electric

field of 2500V/mm reduces the viscosity of ULSD B from 3.39cp to 3.22 cp, down 5%. At 20^0C, application of electric field of 1830V/mm reduces the viscosity of Jet fuel from 1.9cp to 1.8cp, down 5%.

3. Black wax crude oil and Yellow wax crude oil from [redacted]. In 2013, we tested two oil samples from [redacted], Black wax crude oil and Yellow wax crude oil. As stated in our report submitted on May 8, 2013, the test results clearly show that the AOT technology can significantly reduce the viscosity of both oil samples. The technology is extremely effective for Yellow wax crude oil sample. At 52^0C, the AOT technology with electric field 360V/mm reduces its viscosity from 15.7 poise to 1.01 poise, down 93.5%. Because the Black wax crude oil sample contains metallic particles, we have to use electrodes, which have a gap with the pipe wall. The existence of metallic particles also limits the applied voltage, but the results are still much better than that of most conventional crude oil samples. At 40.3^0C, application of electric field 160V/mm reduces the viscosity of Black wax crude oil from 30.5 poise to 7.6 poise, down 75%. If there were no metallic particles inside Black wax crude oil, the viscosity reduction for Black wax crude oil would be as significant as that for Yellow wax crude oil.

4. **No#2 Diesel from [redacted].** In 2013, we did tests with No#2 diesel from [redacted], for a temperature range 0^0C to 25^0C. The report was submitted on Oc.t 8, 2013. The AOT technology is also able to reduce viscosity of diesel fuel. At 0^0C, application of electric field of 3760V/mm brings the diesel viscosity from 4.5cp to 4.24cp, down 5.8%.

5, Ultra Low Sulfur Diesel (ULSD) –BR, ULSD-CO1, ULSD-CO2, and ULSD CO3 from [redacted]. In 2013, we conducted additional tests with different refinery fuel samples from [redacted]. As stated in the report on Oct. 22, 2013, these samples are refinery fuels, not crude oil. In comparison with crude oil, all these samples have quite low viscosity. On the other hand, our tests show that the AOT technology can reduce the viscosity of these diesel fuels moderately, about 4-5%. .

6. Black Crude oil. In 2014, we conducted tests with Black Crude oil sample. As stated in the report submitted on Jan. 20, 2014, the tests clearly show that the AOT technology can significantly reduce the viscosity of black crude oils, in spite of the fact that the oil sample contains metallic particles. At 40^{0}C, application of electric field of 1250V/mm brings the sample viscosity from 35.9cp to 22.2cp, down 38.2%.

7. [redacted] Crude oil. In May and June 2014, we conducted tests with crude oil sample from [redacted]. As stated in the report submitted on June 26, 2014, the tests clearly show that the AOT technology can significantly reduce the viscosity of the crude oil from [redacted]. At 71^{0}C, application of electric field of 1400V/mm brings the oil viscosity from 120.1cp to 71.2cp, down 40.7%.

8. SHG Condensate from [redacted]. In October and November 2014, we conducted lab tests with SHG condensate from [redacted]. As described in our Report on Nov. 21, 2014, while the condensate sample from [redacted] is different from conventional crude oils, the viscosity reduction technology, AOT, can significantly reduce its viscosity. Many suspended particles inside the condensate oil sample have micrometer size. Therefore, the electrorheological effect is quite strong and a moderate electric field is sufficient to reduce its viscosity effectively. For example, at 20^{0}C, a moderate electric field of 116.1V/mm can reduce the sample viscosity from 4.65cp to 3.93cp, down 15%.

9. Conductivity of Black Wax crude oil sample at high temperature. In November and December 2014, we were asked to conduct research about the conductivity of Black wax crude oil sample from [redacted], especially explore the relationship between conductivity and temperature. Our report was submitted on December 29, 2014. We have found that the conductivity of black wax crude oil is mainly due to the metallic particles inside. Normally, metals have their conductivity decreasing with temperature up. For fluids, the situation is opposite: the conductivity of most fluids goes up with the temperature increasing. This is due to the following fact: the ions inside the fluid are the main charge carriers for most fluids. Then as the temperature goes up, the fluid viscosity goes down and the ions are more mobile, making the conductivity up.

For Black wax crude oil, the situation is a combination of the above two facts. When the temperature is below 48^{o}C, the Black wax oil viscosity is very high. Therefore, with the temperature increasing, the viscosity goes down quickly and as a result, we see the conductivity goes up. However, with further increase of temperature, the metallic particle's conductivity goes down; therefore, after the temperature goes above 69ºC, we see the conductivity begins to go down and stabilized in spite of the fact that the viscosity is further decreasing with the temperature.

10. Sour Crude oil. In December 2014 and January 2015, we conducted lab tests with Sour Crude oil sample from [redacted]. The test results clearly show that the AOT technology can significantly reduce the viscosity of the Sour crude oil. For example, at 61.3ºC, application of a moderate electric field of 60V/mm reduces the sample viscosity from 2553.16cp to 1544.21 cp, down 39.5%. The details are in the report submitted on Jan. 12, 2015.

11. Crude Oil from [redacted]. In February, March and April, 2015, we conducted lab tests with crude oil sample from [redacted]. The test results clearly show that the AOT technology can significantly reduce the viscosity of the crude oil sample. For example, at 38.1ºC, application of electric field of 1011V/mm reduces the oil viscosity from 50.5cp to 39.46cp, down 21.86%. On the other hand, we also found that the electric current is relatively higher because of the high volume fraction of water and remaining of DRA polymers. We also conducted some tests to see how to reduce the electric current. The details are in the report submitted on April 15, 2015.

III. Field Tests

After a long preparation, on July 22, 2014, we came to Wichita, KS to participate in the field tests. Afterwards, on September 16, 2014, we came to Wichita again to conduct another field tests. The field tests clearly show that the AOT technology reduces the oil viscosity along the flow direction and suppresses turbulence. Hence it substantially reduces the pump power required for the oil flow. Especially, the results of turbulence suppression are remarkable. In our lab tests, we are unable to perform experiments to study turbulence suppression because we do not have a long pipeline. Therefore, all experimental results related to turbulence suppression were obtained in the field tests at RMOTC and Daqing oil field. As described in my reports on July 31, 2014 and November 6, 2014, the tests at Keystone pipeline provide additional valuable information and convincing evidence that the turbulence was suppressed after the AOT device was turned on. While we have not received any data from TransCanada for the tests on September 16 and 17, our own data presented in the report on Nov. 6, 2014 fully confirmed that the tests on Sept. 16 and 17 repeated the results obtained on July 22.

During the tests on Keystone pipeline, we also gained much experience.

(a) We should install powerful power supplies with the AOT device. Because the flow rate and oil properties can vary, powerful power supplies can deal with all kinds of situations. The details were discussed in the reports submitted on Nov. 5, 2014 and March 26, 2015.

(b) The tests at RMOTC (Rocky Mountain Oil Test Center) are different from the tests on the production pipelines, such as Keystone pipeline and Daqing oil pipeline. At the test pipeline of RMOTC, there are a number of sensors spread on the pipeline at a short interval. Therefore, once the AOT device is turned on, as the treated crude oil flows down along the pipeline, we will soon see the pressure gradient is reduced near the entrance of treated oil. Therefore, this leads to some misconception that once the AOT device is turned on, we should see the effect immediately. In fact, this is not true. Especially, as there are no such sensors installed on the production pipeline, we should not expect some instant effect after the AOT device is turned on. In fact, in absence of such sensors, what we can monitor on the production pipeline are pump power, pressures, and flow rate. When the flow rate is maintained as a constant, the pump power reduction and reduction of pressure gradient are the results when the untreated oil is replaced by the treated crude oil. There is no instant effect. With time, because the treated oil occupies more distance inside the pipeline, we see that the pump power is reducing with time. This is confirmed by the tests on Keystone pipeline on July 22, 2014. The pump power was continuously reducing as the treated crude oil replaces the untreated oil during the test. The effect is a combination of reduction of viscosity along the flow direction and suppressing turbulence. When the pipeline is filled with all treated crude oil, the pump power is reduced to the minimum.

IV. Research

1) Suppressing turbulence.

As mentioned before, we cannot conduct lab experiments related to suppressing turbulence because there is no pipeline in the lab to create a turbulence flow with Reynolds number >2300. Therefore, we conducted much theoretical research, including analysis and calculation for the physical mechanism related to turbulence suppression.

First from the small angle neutron scattering at the NIST Center for Neutron Research, we verified the aggregation inside crude oil under a strong electric field [10-12]. As shown in Fig.2, with no electric field, the scattering is isotropic and sparse, indicating the particles are randomly distributed in the oil. Under an electric field of 250 V/mm (middle), the scattering reveals short chains of particles aggregated along the field direction. When E=400V/mm, the neutron scattering signal clearly indicated that the short chain has a prolate spheroid shape. We note that the measured electric field here is the applied electric field. The local electric field E_{loc} acting on the particles is usually much stronger than the applied electric field.

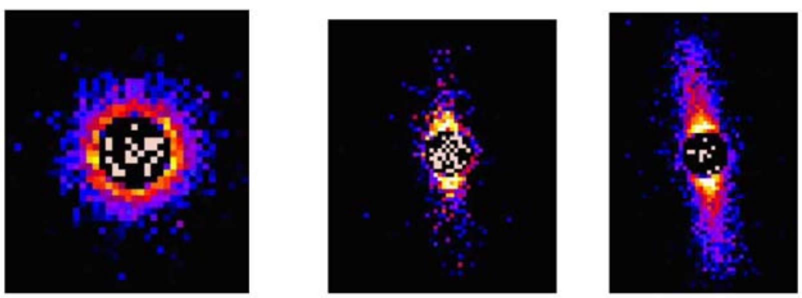

Fig.2 Small angle neutron scattering has confirmed the aggregation. With no electric field, the scattering is isotropic and sparse, indicating the particles are randomly distributed in the oil (left). Under an electric field of 250 V/mm (middle), the scattering reveals short chains of particles aggregated along the field direction. When E=400V/mm, the short chain has a prolate spheroid shape (right).

Before the electric field is applied, the suspension's viscosity is isotropic. Based on the neutron scattering information, we can approximate the short chain by a prolate spheroid with its rotational z-axis along the flow direction,

$$(x^2 + y^2)/b^2 + z^2/a^2 = 1 \qquad (1)$$

For such spheroid, the intrinsic viscosity along the z - axis ν_z is much smaller than that of the intrinsic viscosity along the other direction, $\nu_\perp$. If *(a-b)/a=0.9,* for example, we have $\nu_z = 2.01$, while $\nu_\perp = 4.48$.

Fig.3. The prolate spheroid shape of the aggregated short chain.

To calculate the viscosity of crude oil η, we will use the following formula,

$$\eta / \eta_0 = (1 - \phi / \phi_m)^{-\nu\phi_m} \qquad (2)$$

where ν is the intrinsic viscosity of the particle, η_0 is the viscosity of base liquid, ϕ is the particle volume fraction, and ϕ_m is the maximum volume fraction of random packing.

Before we use Eq.(2) to calculate the viscosity of treated oil, we also note that ϕ_{m} strongly depends on the particle shape. For spheres, $\phi_{sphere} = 0.64$. For spheroids $\phi_{spheroid} \geq 0.72$, higher than that for spheres.

If the crude oil suspension has $\phi = 0.5$, the original relative viscosity from the following equation, we have $\eta / \eta_0 = 11.38$. For sphere particles, the intrinsic viscosity ν=2.5.

After the electric field is applied, with $\nu_z = 2.01$ and $\nu_\perp = 4.48$, the viscosity along the field direction is reduced to $\eta_z / \eta_0 = 5.56$, down 51.1%, while the viscosity perpendicular to the field is increased to $\eta_\perp / \eta_0 = 45.80$, up 302%. The electric-field treated crude oil is now similar to a flow of nematic liquid crystal with its molecule alignment in the flow direction.

Since the viscosity in the directions other than the flow direction is increased substantially, the turbulence is suppressed as the vortices in turbulence must have the fluid moving in the direction transversal to the pipeline axis. For this purpose, the aggregated short chains play similar function as polymer additives in DRA. However, this AOT technology has no additives and thus is friendly to the refineries in the crude oil case. Moreover, the technology also significantly reduces the viscosity along the flow direction and enhances the flow output, while DRA cannot reduce the oil's viscosity.

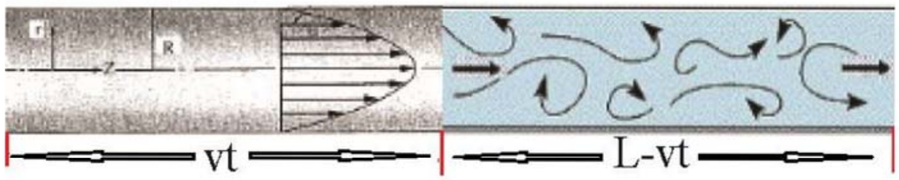

Fig. 4 The laminar flow of the treated oil pushes the turbulent flow downstream.

Because the AOT technology reduces the viscosity along the flow direction and suppresses turbulence, it is very effective in enhancing the flow output and reducing the pump power for the pipeline.

As outlined in Fig.4, once the AOT device is turned on, the treated oil flows down into the downstream pipeline. The treated oil is in laminar flow. If the original flow is turbulent, we will see the pump power reduced significantly with time. Let us use the data of our recent test on the Keystone Phase pipeline to illustrate this point. Keystone pipeline has diameter 36 inch with inner diameter 35 inch (88.9cm). During tests, the flow rate was around Q=2280 m^3/h, which effectively gave the average flow velocity $v = Q/(\pi D^2/4) = 1.02$ m/s. The oil density was $\rho = 0.887$ g/cm^3. Hence the Reynolds number $N_R = \rho v D/\eta_0 = 3757.9 > 2300$, where $\eta_0 = 214.1$ cp. The flow inside the pipeline is turbulent. For such turbulence, the friction factor is calculated by the Blasius relation $f_T = 0.3164/(N_R)^{1/4} = 0.040411$. Hence the pressure difference on the pipeline is given by

$$\Delta P = \tfrac{1}{2}\rho v^2 f_T L/D, \qquad (3)$$

After other minor pressure loss is ignored, the required pump power can estimated by

$$Pwi = Q\Delta P = \pi\rho v^3 D L f_T/8 \qquad (4)$$

After the AOT device was turned on, the treated oil had a lower viscosity along the flow direction and, in addition, the flow changed from turbulent to laminar. Therefore, as shown in Fig.4, the laminar flow pushes the turbulent flow downstream. When the AOT device is on for time t, the laminar flow section has length *vt* while the turbulent flow has length *L-vt*.

Further, the treated oil has viscosity $\eta_e = 142.5$ cp along the flow direction. The Reynolds number is $N_{RL} = \rho v D / \eta_e = 5646.1$. The friction factor for the laminar flow is $f_L = 64 / N_{RL} = 0.011335261$. The pump power for the period, $0 \le t \le L/v$, is given by

$$Pw(t) = \pi\rho v^3 D[vtf_L + (L - vt) f_T]/8 = Pwi[1-(1-f_L/f_T)vt/L]. \quad (5)$$

Substituting the values for f_L and f_T, we have the pump power for $0 \le t \le L/v$

$$Pw(t) = Pwi(1 - 0.7195vt/L), \quad (6)$$

which is represented by a curve in Fig. 5

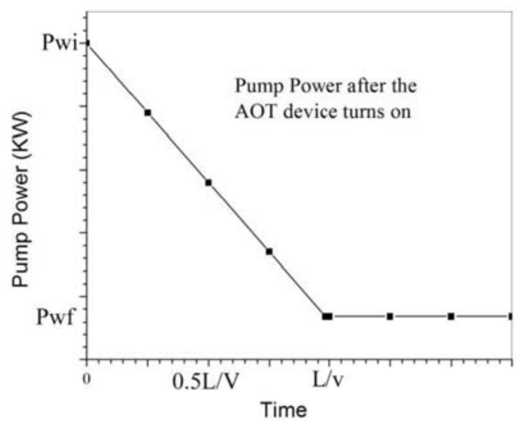

Fig.5 The curve for the pump power after the AOT device is turned on.

After $t \ge L/v$, the section of pipeline was filled with all treated oil and the calculated pump power was $Pwf = \pi\rho v^3 DLf_L / 8 = Pwi(f_L / f_T) = 0.28Pwi$. This signified that if the AOT device was operated long enough to fill the section of pipeline with all treated oil, the pump power will be reduced by 72%.

The theoretical analysis and calculations are extremely useful in analyzing the field test results.

2) Design of electrodes to reduce electric current

During the lab tests, we have found that most crude oils have very small electric current under a strong electric field. However, there are some oil samples, which have high electric current under a high electric field because they contain some metallic particles or have high water contents. Reducing electric current is thus important for the development of AOT technology. Otherwise the high voltage power supplies for the AOT devices will need high power, which may create some difficulties for the commercialization of technology.

To resolve this issue, we carried out much research.

a) [redacted]

[redacted]

[redacted]

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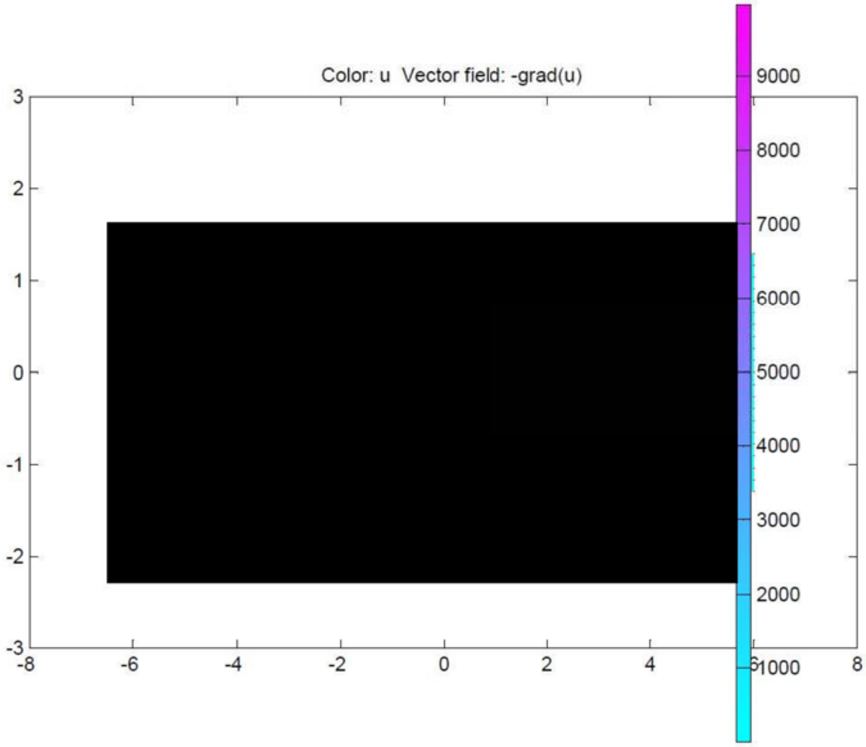

Figure 6. Electric field distribution of [redacted]

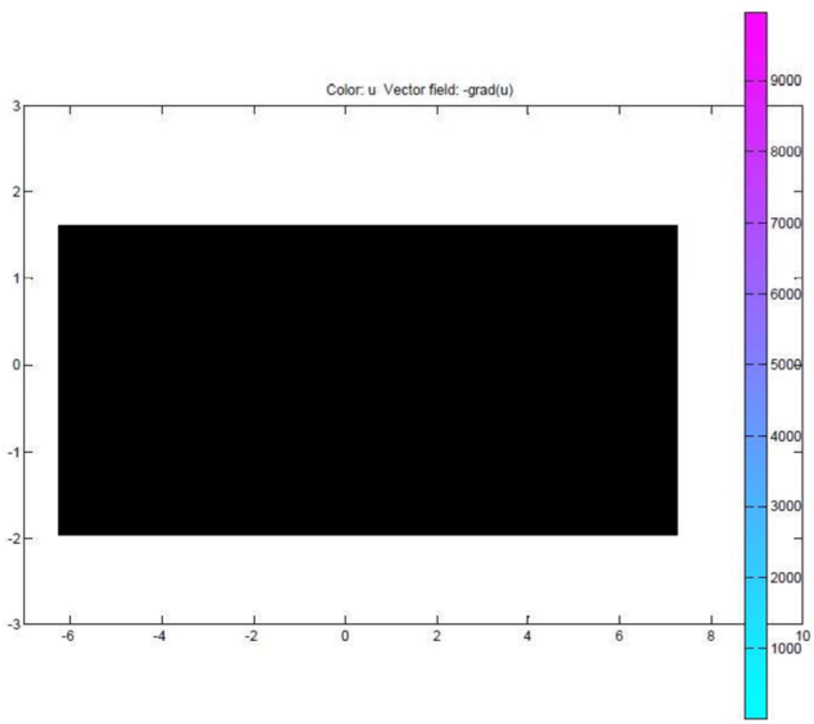

Figure 7.   Electric field distribution of [redacted]

Figure 8. Electric field strength distribution of [redacted]

[redacted]

[redacted]

b). New Design of Electrodes.

[redacted]

[redacted]

[redacted]

Fig.9. Our new design of electrodes.

[redacted]

We will carry out more research in this direction and believe that this will be useful and important for the technology development. .

V. Discussions and Conclusions

While further studies and tests, especially about suppressing turbulence, are needed, our present test results confirm that the AOT technology aggregates suspended particles inside crude oil to form short chains along the flow direction, making the oil's viscosity anisotropic: along the flow direction it is significantly reduced and in the directions perpendicular to the flow, the viscosity is substantially increased. Hence the turbulence in pipelines is suppressed, the flow along the pipeline is greatly enhanced, and the pump power and the pressure gradient for the oil flow are significantly reduced.

We truly appreciate STWA taking the leading role in commercializing the technology and sponsor this project. It is worthwhile to note that this work has received much public

attention, including American Physical Society [6], news media [7-8], even the German National Radio [9]. All these just illustrate the importance of the technology and great impact it is going to produce in the energy area.

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College of
Science and Technology
TEMPLE UNIVERSITY®

Department of Physics
SERC (035-08)
1925 N. 12th Street
Philadelphia, PA 19122-1801

phone 215-204-7651
fax 215-204-5652
email rtao@temple.edu
web phys.cst.temple.edu

Report

Viscosity Reduction Tests
With
[redacted] Crude Oil Sample

Submitted by

Principal Investigator: Rongjia Tao, Ph.D.
Professor of Physics
Temple University
Philadelphia, PA 19122, USA

December 8, 2015

Exhibit 7 - REDACTED

I. INTRODUCTION

In December 2015, at the Physics Department, Temple University, we conducted a series of tests to investigate the viscosity reduction effect of QS Energy's AOT technology on a "[redacted]" crude oil sample.

In 2006, Professor Rongjia Tao of Temple University invented and patented a new technology based on the concepts of electrorheology through which exposure to a strong electric field reduces crude oil viscosity. This technology, refined and commercialized under a cooperative research agreement with QS Energy, is exclusively licensed to QS Energy and marketed under QS Energy's trademarked name, AOT™ (Applied Oil Technology). The AOT is proven to be a highly efficient, rapid means of reducing crude oil viscosity, with the added benefit of adding no heat to the system, which is significantly more efficient than direct heating methods. In 2011 and 2012, Rocky Mountain Oilfield Testing Center (RMOTC) of US Department of Energy published three reports on extensive testing performed at its facilities, which concluded that this technology substantially reduced viscosity and pressure loss, and increased pipeline flow rates. Since that time, QS Energy has demonstrated the AOT is capable of operating on commercial pipelines at full-scale flowrates and throughput.

Crude oil is a suspension. Gasoline and diesel, as the base liquid, have very low viscosity. The oil's high viscosity is due to randomly suspended asphalt, paraffin, and other particles in the base liquid. The AOT technology can be illustrated in Fig.1.

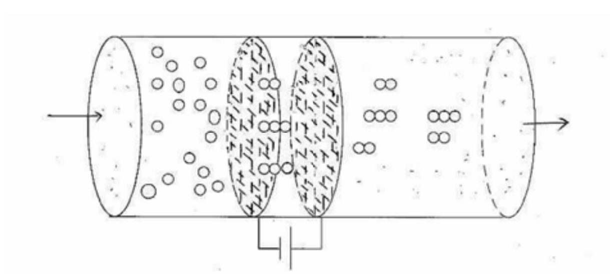
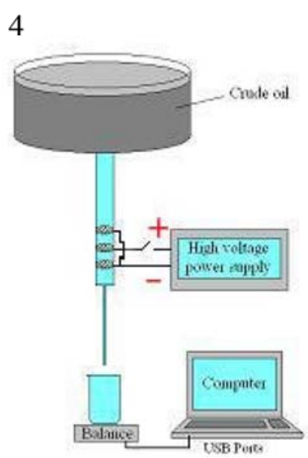


Fig.:1 Illustration of our new technology.

A strong electric field is applied along the flow direction in a small section of the pipeline. As the suspended particles and the base liquid have different dielectric constants, the particles are polarized. The dipolar interaction forces them to aggregate into short chains along the field direction. Once the particles form such aggregates, the symmetry is broken and the viscosity becomes anisotropic: (1) along the flow direction, the viscosity is significantly reduced as such aggregates are streamlined in this direction; (2) in the directions perpendicular to the flow, the viscosity is increased substantially as such aggregates have a very high intrinsic viscosity to move in these directions. Hence the oil flow along the pipeline is significantly enhanced because the treated oil has much lower viscosity in this direction and the turbulence can be suppressed as any random motion in the directions perpendicular to the axis becomes very difficult. The method is fast and energy-efficient.

II. Methods of Testing

Our lab device is outlined in Figure 2a, which is placed in an environment chamber (Fig.2b). The chamber provides the desirable and stable temperature for our test. The crude oil sample is loaded in cylindrical container at the top (Fig.2a), which serves as the reservoir. Underneath the reservoir, there are three meshes, serving as electrodes. The crude oil flows down under gravity and passes through three electrodes into a long capillary tube. A cup on a microbalance collects the crude oil down through the capillary tube. The microbalance is connected to a computer, which automatically records the oil mass in the cup as a function of time with Labview software. Hence we can determine the flow rate easily. The electrodes are connected to a high voltage power supply. When the power supply is turned on, a strong electric field is produced in the flow direction, forcing the suspended particles inside crude oil to aggregate into streamlined short chains along the flow direction (see Fig.1). In this way, the effective viscosity of crude oil along the flow direction is reduced, while no heating or dilution is used here.



(a)

(b)

Fig.2: Device to test the crude oil samples.

Because the Reynolds number is low, the crude oil flow inside the capillary tube is laminar. The capillary tube services as a viscometer. From the flow rate, we can easily determine the viscosity. In this experimental setup, the pressure gradient due to gravity remains as a constant. Therefore, the flow rate goes up as the viscosity is reduced. Usually, we measure the flow rate without electric field applied first and obtain the viscosity of untreated oil. Afterwards, we turn on the electric field, measure the new flow rate, and hence obtain the viscosity of electric-field treated crude oil. By adjusting the electric field strength, we can reach the optimal state to reduce the crude oil viscosity.

III. Test Results

We conducted the tests at room temperature (73F) first. Then we preheated the oil to preselected temperature and kept the oil at that temperature to conduct the AOT tests. Afterwards, we move to another pre-selected temperature for another test. Altogether, we conducted 6 tests, which were at 73F, 82F, 90F, 100F, 110F, and 120F respectively.

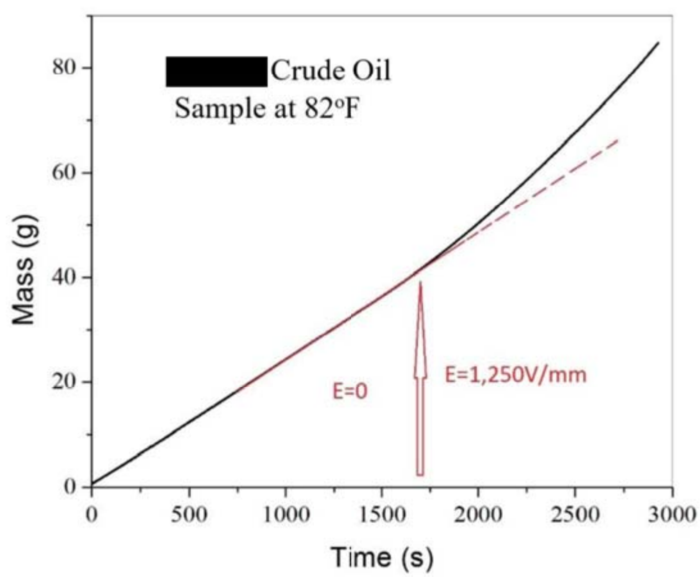


Fig.4: At 82F, once an electric field of 1250V/mm is applied, the flow rate of [redacted] crude oil is increased.

It has been found that the AOT technology can significantly reduce the viscosity of [redacted] crude oil and increase the flow rate. Figure 4 shows the typical test results. The crude oil was first heated to the predetermined temperature inside the Environment Chamber (Fig.2b). Initially, there was no electric field applied and the oil flowed through the capillary tube. The slope of the curve was the flow rate. Afterwards, the electric field was applied; the oil flow rate increased significantly, indicating that the viscosity was reduced effectively. From the flow rates, we calculated the viscosities.

The test results are summarized in the following table and graphic:

Test #	Temperature (Fahrenheit)	Pre-Treatment Viscosity	Post Treatment Viscosity
1	73° (room temp)	1,251.3 cSt	898.3 cSt
2	82°	1,012.2 cSt	642.2 cSt
3	90°	789.4 cSt	423.1 cSt
4	100°	402.8 cSt	288.4 cSt
5	110°	236.5 cSt	181.2 cSt
6	120°	207.3 cSt	142.8 cSt

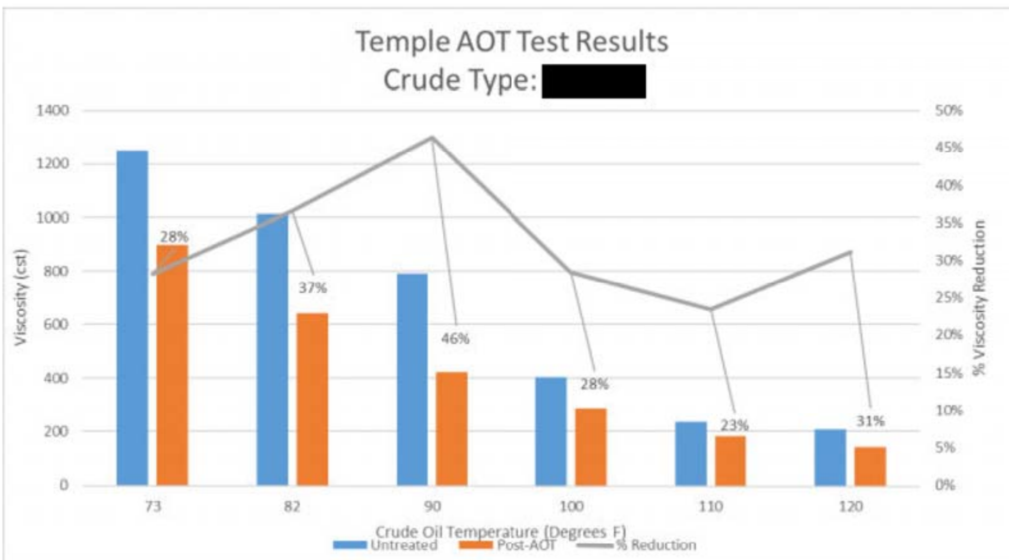


Fig. 5: AOT Test Results

The applied electric field for all these tests was around 1,250V/mm to 1,300V/mm. The test results clearly show that the viscosity reduction technology, AOT, can significantly reduce the viscosity of [redacted] crude oil.

Naturally, there is an additional question: How long can such reduced viscosity last after one treatment? Our test with [redacted] crude oil is consistent with many other oil samples: after the electric field treatment, the reduced viscosity lasts for about 24 hours in laboratory.

Exhibit 8 - REDACTED

College of Science and Technology
TEMPLE UNIVERSITY®

Department of Physics
SERC (035-08)
1925 N. 12th Street
Philadelphia, PA 19122-1801

phone 215-204-7651
fax 215-204-5652
email rtao@temple.edu
web phys.cst.temple.edu

Report

Viscosity Reduction Tests With Crude Oil Sample From

[redacted]

Submitted by

Principal Investigator: Rongjia Tao, Ph.D.
Professor of Physics
Team Members: Dr. H. Tang & Dr. R. Ren
Temple University
Philadelphia, PA 19122, USA

April 9, 2015

Exhibit 8 - REDACTED

I. INTRODUCTION

In February, March, and April 2015, at the Physics Department, Temple University, we conducted a series of tests to investigate the viscosity reduction effect of our new technology with crude oil sample from [redacted].

In 2006, based on the concepts of electrorheology, a new technology to reduce the viscosity of crude oils by a strong electric field was proposed by Professor Rongjia Tao of Temple University. This technology is now called AOT (applied oil technology) in news media. Comparing to the heating method, the AOT technology consumes much less energy and is very fast and, therefore, much more efficient. Afterwards, the AOT technology has developed very fast. In 2011 and 2012, Rocky Mountain Oilfield Testing Center (RMOTC) of US Department of Energy published three reports, showing that this technology is feasible on pipeline and able to reduce viscosity, pressure loss, and increase flow rate substantially on pipelines.

Crude oil is a suspension. Gasoline and diesel, as the base liquid, have very low viscosity. The oil's high viscosity is due to randomly suspended asphalt, paraffin, and other particles in the base liquid. The AOT technology can be illustrated in Fig.1.

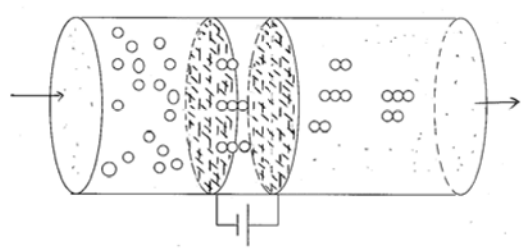
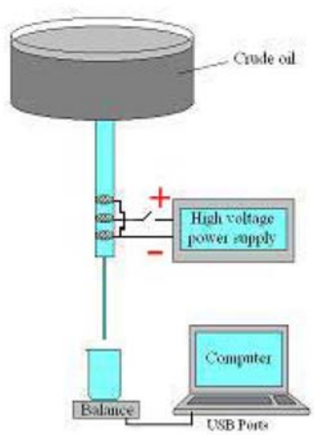


Fig.1 Illustration of our new technology.

A strong electric field is applied along the flow direction in a small section of the pipeline. As the suspended particles and the base liquid have different dielectric constants, the particles are polarized. The dipolar interaction forces them to aggregate into short chains along the field direction. Once the particles form such aggregates, the symmetry is broken and the viscosity becomes anisotropic: (1) along the flow direction, the viscosity is significantly reduced as such aggregates are streamlined in this direction; (2) in the directions perpendicular to the flow, the viscosity is increased substantially as such aggregates have a very high intrinsic viscosity to move in these directions. Hence the oil flow along the pipeline is significantly enhanced because the treated oil has much lower viscosity in this direction and the turbulence can be suppressed as any random motion in the directions perpendicular to the axis becomes very difficult. With turbulence suppressed, the oil flow is further enhanced. Therefore, this technology is much better than heating, which can reduce viscosity but cannot suppress turbulence. In addition, this technology is fast and energy-efficient.

II. Methods of Testing

Our lab device is outlined in Figure 2a, which is placed in an environment chamber (Fig.2b). The chamber provides the desirable and stable temperature for our test. The crude oil sample is loaded in cylindrical container at the top (Fig.2a), which serves as the reservoir. Underneath the reservoir, there are three messes, serving as electrodes. The crude oil flows down under the gravity and passes through three electrodes into a long capillary tube. A cup on a microbalance collects the crude oil down through the capillary tube. The microbalance is connected to a computer, which automatically records the oil mass in the cup as a function of time with Labview software. Hence we can determine the flow rate easily. The electrodes are connected to a high voltage power supply. When the power supply is turned on, a strong electric field is produced in the flow direction, forcing the suspended particles inside crude oil to aggregate into streamlined short chains along the flow direction (see Fig.1). In this way, the effective viscosity of crude oil along the flow direction is reduced, while no heating or dilution is used here.



(a)

(b)

Fig.2 Device to test the crude oil samples.

Because the Reynolds number is low, the crude oil flow inside the capillary tube is laminar. The capillary tube services as a viscometer. From the flow rate, we can easily determine the viscosity. In this experimental setup, the pressure gradient due to the gravity remains as a constant. The flow rate goes up as the viscosity is reduced. Usually, we measure the flow rate without electric field applied first and obtain the viscosity of untreated oil. Afterwards, we turn on the electric field, measure the new flow rate, and hence obtain the viscosity of electric-field treated crude oil. By adjusting the electric field strength, we can reach the optimal state to reduce the crude oil viscosity.

III. Test Results

(a). Viscosity and Flow Rate.

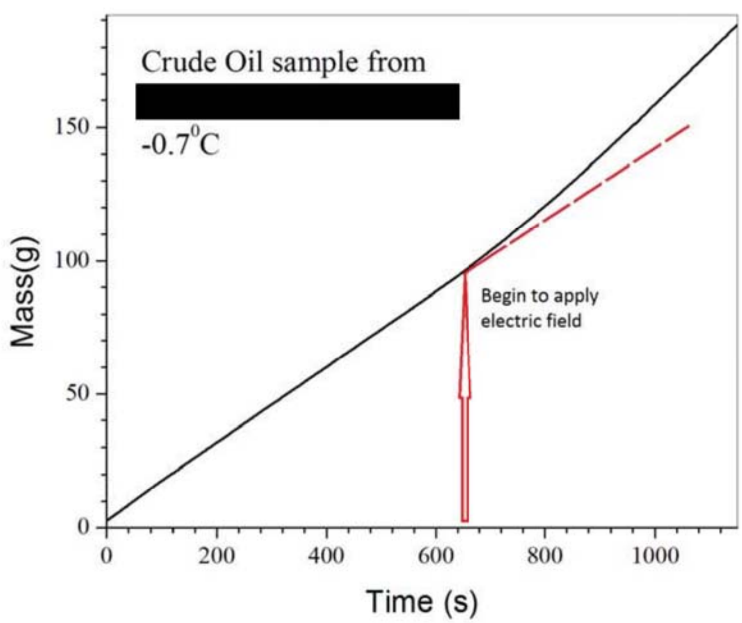


Fig.3 At -0.7^{0}C, after an electric field of 1400V/mm is applied, the flow rate of crude oil is increased 55% and the viscosity is reduced by 35.6%.

Our tests covered a temperature range from about 0^0C to 51.5^0C. The AOT technology can significantly reduce the viscosity of crude oil and increase its flow rate.

At -0.7^0C , the crude oil has viscosity 179.5cp. Therefore, the flow rate was 0.1425 g/s along a capillary tube of radius 0.127cm. After an electric field 1400V/mm was applied, the flow rate was increased to 0.2211 g/s, up 55%. The viscosity was down to

115.67cp, reduced by 35.6% (Fig.3).

As the temperature goes up, the viscosity reduction effect remains significant. For example, at 38.2^{0}C, when an electric field of 1000V/mm was applied, the viscosity was down from 50.56cp to 39.46cp, reduced by 21.86%. The flow rate was increased by 27.97%.

The test results for the temperature range 0-50^{0}C, are summarized in Table 1. Especially, we paid much attention to the temperature range for oil inside the pipeline, 35^{0}C-50^{0}C. The viscosity reduction is more than 20% for this whole temperature range. We repeated the tests several times and the results were consistent.

Table 1. The summary of test results

Oil Temperature (^{0}C)	Electric Feld Applied (V/mm)	Current (μA)	Viscosity (cp)	Reduction
-0.7	0	0	179.5	
-0.7	1400	12	115.7	35.6%
38.2	0	0	50.5	
38.2	1011	180	39.46	21.86%
43.5	0	0	40.07	
43.5	928.8	202	32.036	20.55%
51.5	0	0	36.13	
51.5^{0}C	900	207	27.55	23.8%

(b). Current

As shown in Table 1, the electric current is relatively higher for the crude oil sample under the electric field. For similar crude oil samples, under similar electric field, the electric current is around 10-20μA.

The higher electric current is due to the following two factors: (1) the broken polymers of DRA (drag reduction agent); (2) high water volume fraction of the crude oil sample.

As shown in Fig. 4, under microscope, we see many broken polymers in micrometer size inside the crude oil sample. They are the remaining of added DRA polymers, which are broken by pumps etc. These micrometer-scale polymers increase the electric current under the electric field. Especially, most DRA has aluminum powders mixed in, which help to prevent the DRA polymer from clustering together. Therefore, a small amount of DRA will increase the electric current significantly.

Fig.4 Many micrometer-scale broken DRA polymers inside the crude oil sample.

In addition, the volume fraction of water inside the crude oil sample may also be high, leading to a high electric current after the electric field is applied. To verify this point, we used the electrodes, which have no conductive contact with the pipe wall (Fig.5), to conduct additional tests.

Water and oil are immiscible. When a strong electric field is applied, many water droplets are joined together and flowing along the pipe wall. With such electrodes, we can reduce the electric current if the current is produced by water. In fact, we did find that the electric current was reduced by 30-40% with such electrodes while the viscosity reduction remains the same. This implies that the water contents are the second factor for the high electric current and we can reduce the electric current if the electrodes have no conductive connection with the pipe wall.

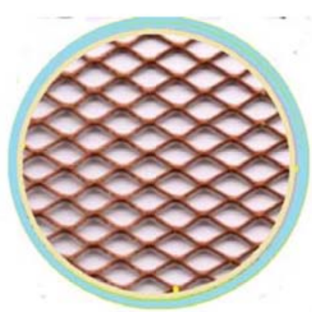


Fig.5 The metallic mesh electrode has a small gap with the pipe wall.

IV. Discussions and Conclusions

The test results clearly show that the viscosity reduction technology, AOT, can significantly reduces the viscosity of the crude oil from [redacted]. It should also mention that the electric field treated oil in fact has anisotropic viscosity: Along the flow direction, the viscosity is significantly reduced, improving the flow; in the directions perpendicular to the flow, the viscosity is increased substantially, helping to suppress turbulence inside the pipeline effectively. Therefore, once the AOT technology is adapted, there is no need to add DRA into the oil. Without DRA additive, the electric current will be reduced.

To reduce the electric current further, the AOT device should adapt the electrodes as shown in Fig. 5, which have a small gap with pipe wall. On the other hand, in order to have successful operation, we suggest using the following power supply for the AOT device, which can output 50kV and 1500mA. With such a power supply, the AOT device can be operated smoothly, reducing the crude oil viscosity and suppressing turbulence.