New Technologies for Safe and Cost Effective Oil Conditioning in North Dakota
Revision Addendum – 4/29/2016
Principal Investigator: Darren Schmidt, Statoil

Please find enclosed this addendum to our original application submitted March 1, 2016. Upon technical review, a number of clarifications were recommended to further define the proposed scope of work, timeline, and budget. The following is the requested information.

Summary

Our research team and asset team is fully engaged to find field solutions for improving the ability to produce crude oil meeting new RVP requirements. The biggest challenges include operation of existing heater-treaters, and what to do when there are large amounts of off-spec crude oil in the system. Technologies that can be implemented at the wellhead are most likely to combat the problems associated with production, and have the highest likelihood for being economic. We have selected sonic technology based on supplier conversations, and believe it is worth the partnership with the NDOGRP because of the potential upside if successful. The project team considers the potential for chemical treatment to be a reasonable solution for treating volumes of high RVP crude that may be present within our system. As a basis, present operations do chemically treat crude in the pipeline system. The need however is for a flexible and economic chemical service to work across the industry in which we intend to guide the development. The proposed work is specifically focused on the tasks within that appear to have the highest reward; however our team is remaining open to other potential solutions as we move forward.

Many of the approaches we have encountered to comply with recent RVP requirements involve centralized stabilization, or significant equipment added to the wellhead. Although robust, such efforts add significant cost and complexity. The intent for this work is to develop simple solutions that improve performance specifically geared towards reliability, and addressing issues surrounding field operations that can be implemented across the basin. For instance, if a technology can bolt-on to an existing treater, both operational reliability and a cost advantage can be achieved simultaneously.

Scope of Work

Task 1 – The project team will model the evolution of light ends from the well head to tank storage. The purpose is to gain a greater understanding of the expected vapor pressures throughout the oil conditioning process at the wellhead and identify the mechanism behind the RVP challenge. Based on results, we may be able to identify some unique opportunities for technology to remove additional light ends based on the expected concentrations of light ends. Additionally, there are currently issues involving ambient temperatures and storage. The team would like to better understand the nature of light ends that may condense and cause an increase in vapor pressure. Understanding the quantification surrounding these mechanisms may elucidate simple solutions.

Most of our well-pad locations use a two-phase separator, and heater treater arrangement. The two-phase separator is operated at pipeline pressure to push gas to sales (~100 psi). Few of our locations include VRUs. The project team will model the conditions at the operating pressures and temperatures of the well head separation equipment. The laboratory equipment in task 2 is to be operated near ambient pressure; however we are also operating our treaters at relatively low pressures. The NDIC limits the operating pressure of treaters to no greater than 50 psi.

Task 2 – An experimental apparatus is proposed to better understand the application of sonic technology in separating gas from crude oil. Equipment is readily available off-the-shelf for flow through experiments, and a number of qualified labs have the capability to sample and conduct gas analysis and light ends analysis. We will hire the most qualified laboratory. We expect to develop a test matrix that will provide operational data at various temperatures, acoustic settings and residence times. The project team will subcontract to a laboratory to fully instrument, conduct sampling, and analyze results. This activity is expected to cost on the order of $100,000. Our team will be instrumental in designing the experiments, and ultimately measuring the RVP performance. We plan to use Grabner instruments following ASTM method D6377 to measure RVP. The experimental apparatus will be instrumented for temperature and pressure and to provide a complete mass balance.

Task 3 – We have identified a number of services that can gel hydrocarbons which will reduce RVP. Hydraulic fracturing is the most common service in which gelling of crude can be accomplished with a phosphate-ester gel. However this task involves customizing the chemical for the purpose of reducing the vapor pressure, and determining if the service can be economically applied in the field. No single chemical company has the capability of solving the problem from an operational viewpoint, and the project team is needed to provide the guidance to ultimately develop a service that our industry can use economically. We expect to measure the RVP of crude samples before and after chemical treatment to determine performance, and minimize the amount of chemical. Based on servicing and chemical costs; we will also design and determine a means to treat volumes of high RVP crude in the field from individual tanks, to in-line treatment. Ultimately we will determine the downstream saleable impacts and chemical limitations.

Notes about subcontracted work

We did not solicit subcontracts prior to this proposal. The authors are familiar with the expected magnitude of the laboratory work and typical costs. Our team will select the best candidate to perform the work. Most labs do not have flow-through sonication equipment on hand. We are expecting to purchase the equipment through the subcontract, and expect the laboratory to instrument and operate. The equipment is off-the-shelf. We are breaking new ground by looking at a sonic technology. There is little understanding for how this technology will perform relative to separation of gas from crude oil, and our problem in North Dakota is unique to the recent order. There are a reasonable number of resources providing fundamentals in sonochemistry, we are currently involved in literature review in this area to enhance our understanding.

Budget

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)
Direct Salaries	$129,032.26	$64,516.13
Indirect Costs	$70,967.74	$35,483.87
Subcontract		$100,000
Total Project Costs	$200,000	$200,000

The proposed budget includes salaries paid by the NDIC's share. These expenses will be limited to Statoil's staff labor costs to complete the modeling work in task 1, the laboratory work in task 2, and the chemical investigations in task 3. Under no circumstances will any salary expenses be incurred other than the proposed work scope. Laboratory equipment is expected to be purchased under subcontract in task 2. The costs are expected to be less than $10,000.

Timetable

	2016			2017			
	June	August	November	January	March	May	
Task 1 - Modeling	■	■					
Deliverable		Report provding mass balance of light ends around wellhead equipment					
Task 2 - Sonic Separation & Dev.					& ambient temperature influences.		
Establish subcontract	■	■					
Complete lab experiments		■	■				
Report & plan forward w/ field test				■	■		
Note: if unsuccessful; decision gate is to explore other technologies such as VRU based options, and other mechanical solutions.							
				Decision gate for Task 2			
Task 3 - Chemical RVP Treatment							
laboratory work	■	■					
Field test		■	■				
Reporting				■			
Decision gate: At the conclusion of the laboratory work, costs will be assessed to determine if an economic application is possible.							
			Decision gate for Task 3				
Final project report						■	

The three project tasks are expected to occur simultaneously, and are mutually exclusive with regards to a stage-gate process.

Task 1 is intended to improve our understanding of RVP in wellhead processes and storage. Although this information may be useful to task 2 and task 3, it does not significantly influence the early lab work planned for these tasks. More importantly, task 1 may help identify other approaches to RVP reduction.

Task 2 involves initial laboratory testing of ultrasonics to enhance our understanding of the efficacy for RVP reduction of crude oil. The stages involved in the completion of task 2 include establishing the subcontracted work at a qualified laboratory, purchasing equipment, and completing the lab testing. The technology gate is the laboratory results which will influence the decision regarding future field tests.

Task 3 involves laboratory testing of chemicals to reduce the RVP of crude oil. The laboratory works is required to confirm chemical volumes and potential costs. Investigation of downstream effects will also be considered. The stages for this task include technical feasibility followed by economic evaluation. Technical feasibility is the first technology gate, followed by economic feasibility. A third gate is field testing and verification.

Statoil

March 1, 2016

Ms. Karlene Fine
North Dakota Industrial Commission
ATTN: Oil and Gas Research Program
State Capitol – Fourteenth Floor
600 East Boulevard Avenue, Dept. 405
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Statoil Proposal Entitled "New Technologies for Safe and Cost Effective Oil Conditioning in North Dakota" in Response to the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program March 1st, 2016 Grand Round.

Statoil is pleased to propose research that is designed to encourage, and promote the use of new technologies and ideas that will have a positive economic and environmental impact on oil and gas exploration, development, and production in North Dakota. The proposed work includes gaining scientific understanding and developing new technologies that can improve operations relative to NDIC order 25417, which specifies conditioning standards to improve the marketability and safe transportation of the crude oil in North Dakota.

This transmittal letter represents a binding commitment by Statoil to complete the project described in this proposal. Point of contact is Darren Schmidt (701) 739-5680, dschm@statoil.com.

Sincerely,

Bruce Alastair Tocher
Manager Shale Oil and Gas Research
TPD R&T ST SOG
Statoil

Fredrick Beck, SVP DPUSA
Statoil

March 1, 2016

Ms. Karlene Fine
North Dakota Industrial Commission
ATTN: Oil and Gas Research Program
State Capitol – Fourteenth Floor
600 East Boulevard Avenue, Dept. 405
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Affidavit of Tax Liability

> Statoil Proposal Entitled "New Technologies for Safe and Cost Effective Oil Conditioning in North Dakota" in Response to the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program March 1st, 2016 Grand Round.

Statoil is current on sales tax payments to the North Dakota Tax Commission, and is not a recipient of previous funding from the Commission.

Sincerely,

Kiran Rizvi

Kiran Rizvi
Leader Indirect Tax
AM FC ITX
Statoil Gulf Services LLC

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title:

New Technologies for Safe and Cost Effective Oil Conditioning in North Dakota.

Applicant: Statoil

Principal Investigator: Darren Schmidt

Date of Application: March 1, 2016

Amount of Request: $200,000

Total Amount of Proposed Project: $400,000

Duration of Project: 1 year

Point of Contact (POC): Darren Schmidt

POC Telephone: (701) 739-5680

POC E-Mail Address: dschm@statoil.com

POC Address: 14649 Brigham Dr.

Williston, ND 58201

TABLE OF CONTENTS

ABSTRACT

Objective: On April 1st 2015 order 25417 by the North Dakota Industrial Commission (NDIC) went into effect that requires all producers to install and utilize oil conditioning equipment to significantly reduce the vapor pressure of Bakken crude oil. Although a high percentage of compliance has been achieved by the industry, these efforts have brought on additional costs, and operation during cold and inclement conditions continue to be a challenge. Compliance with the order for the first time this winter has provided the field experience to pinpoint a number of operational issues. This proposal is to explore cost effective robust technology solutions that can be implemented as early as next winter to improve safe operations, manage operational costs, and continue compliance with the crude oil conditioning order.

Proposed is a phase 1 feasibility study to be followed by field testing and implementation. Specifically the scope of work includes:

1) Modeling of surface treatment systems and storage to clearly identify unique operational circumstances that contribute and control Reid Vapor Pressure (RVP) during processing and handling.

2) Sonic separation at the wellhead that does not rely on temperature for oil conditioning. The technology can be an alternative or an enhancement to existing heater treater operations (1).

3) Batch chemical treatment to reduce RVP and meet midstream standards. This approach is intended to provide a solution to volumes of oil that would otherwise require a more expensive transportation and processing option.

Expected Results: The expected result of the project is improved reliability and safety associated with oil conditioning operations, and specifically focused on the marketability, cost competiveness, and ultimate revenues achieved from the production of Bakken crude oil in North Dakota. The project includes a first phase feasibility. The results from the scope of work include:

1) Technical and scientific results of a modeling study which help to identify opportunities for technology implementation.
2) A path forward for field and commercial demonstration of sonic separation.
3) Laboratory and field results for chemical treatment options.

Duration:

1 year

Total Project Cost:

Phase 1 - $400,000; Phase 2 - budget & scope of work not proposed at this time.

Participants:

Statoil; Phase 2 Participants to be announced at end of phase 1

PROJECT DESCRIPTION

Objectives:

The goal of this project is to provide technical solutions that address challenges relative to meeting RVP requirements for Bakken crude oil. Specific objectives are as follows:

- Provide a technical and scientific understanding of vapor pressure behavior in oil conditioning operations through modeling treating and storage equipment.
- Improve the reliability and decrease the cost of crude oil conditioning at the wellhead by investigating the feasibility for sonic separation.
- Decrease the costs associated for conditioning high RVP crude oil by investigating chemical treatment options.

This winter has been the first cold weather experience for operators since the approval of order number 25417 which specifies conditioning standards to improve the marketability and safe transportation of the crude oil in North Dakota. Order 25417, in brief, specifically requires the following:

1) All wells must produce through a gas-liquid separator and/or emulsion heater-treater.
2) A gas-liquid separator and/or emulsion heater-treater must operate at no more than 50 psi on the last stage of separation and at a temperature of no less than 110°F.
3) If operating the above at greater than 50 psi, a vapor recovery system is required upstream of the oil storage tanks.
4) If equipment other than specified above is used, a RVP of 13.7 psi must be demonstrated.

Generally, compliance with order 25417 has been maintained by the industry however a number of challenges have been encountered relative to the order.

1) Heater treaters can blow out during windy conditions requiring increased attention to maintain operating temperature.
2) In some cases, oil conditioning equipment is operated at temperatures of over 150°F to meet pipeline requirements for RVP, resulting in lost liquid volume.
3) Various midstream operators have defaulted to an RVP of 13.7 psi, even though the intent of order 25417 is relevant to rail transport, and not necessarily pipeline. As specified in the Department of Mineral Resources frequently asked questions document (2); an RVP of 14.7 psi or less is recognized by national standards as stable, and that the commission is allowing for a 1 psi measurement error by choosing the 13.7 psi standard.
4) It has been demonstrated in the field (3) that RVP can increase in tanks where oil is allowed to cool. Small volumes of light ends in tank head space can increase the RVP of the oil when allowed to condense in storage during cold winter weather.

The challenges listed above are drivers for the proposed work. There is an opportunity to improve field operations for oil conditioning at the wellhead, and find cost effective solutions to lower the vapor pressure for volumes of oil in storage that may test above 13.7 psi.

Methodology:

Task 1 – Modeling

Vapor pressure is sensitive to small changes in gas composition of volatile light hydrocarbons (C1-C4) and inert inorganic gases (4). Figure 1 provides the bubble point (BP) pressure or true vapor pressure (TVP) for crude oil sampled from the U.S. Strategic Petroleum Reserve. As the light end composition changes, which occurs during oil conditioning and storage the resulting vapor pressure is affected.

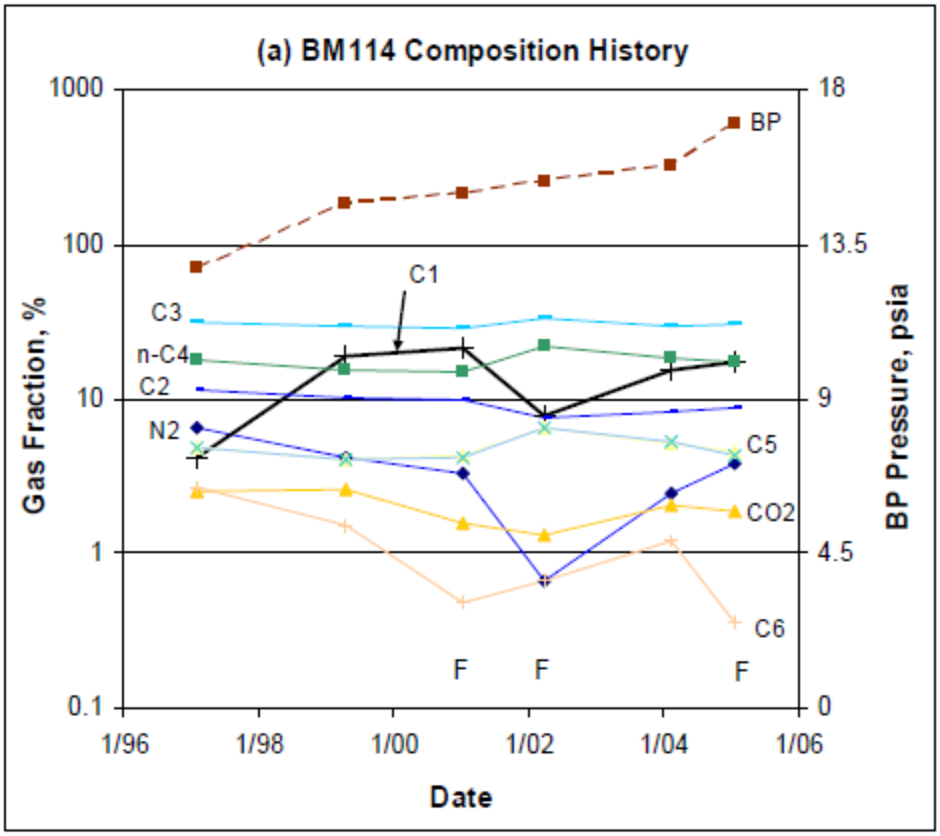

Figure 1 – Vapor Pressure (bubble point pressure BP) as a function of gas components in crude oil (4).

In order to quantify opportunities to manage vapor pressure it is important to model surface operations specific to crude oil composition. Aspen HYSYS is a process modeling software that can quickly conduct complex calculations involved in surface oil conditioning, transport, and storage. This tool is commonly used by petroleum engineers to model reservoir oil properties for fluid characterization and PVT analysis. The project team will use this tool to model oil conditioning operations, storage scenarios, and other techniques such as vapor recovery to better understand the opportunities to control RVP with existing equipment and techniques. Specifically the regain of RVP in storage tanks during cold weather, is of particular interest and may point to mitigation options.

Task 2 – Sonic Separation Testing and Development

The project team has been in discussion with companies that have been in the business of wellhead oil conditioning equipment for over 50 years, and have field tested or experimented with sonic separation of reservoir fluids. Although some field testing has been completed, it is important to quantify separation performance with third party laboratory work. Sonic, acoustic, or ultrasonic gas separation is otherwise known by the phenomena of acoustic cavitation. Acoustic cavitation occurs from the propagation of ultrasonic waves into a liquid which form and grow gas bubbles in the liquid. The acoustic sound wave decreases the local pressure sufficiently below the vapor pressure in which the cohesive forces are overcome and gas bubbles are formed (5). The technique is commonly used to degas liquids (figure 2) however has not been commonly applied to oil conditioning at any significant commercial scale. The project team intends to contract with a qualified laboratory, purchase a simple bench-top apparatus, and examine the performance to verify field data from potential project partners.

Figure 2 – Ultra Sonic Video Capture Created by Hielscher Ultrasound Technology (6).

The laboratory system will include sonication of a fluid to form bubbles followed by mechanical separation. Bakken crude oil will be collected from the wellhead and characterized for light ends. Sampling (liquid & gas) and measurement will occur to provide a mass balance, and experiments will be conducted to understand separation performance relative to light end component separation efficiency, and separation performance relative to temperature. During this task the project team will continue discussions with commercial suppliers in preparation for a phase 2 field test.

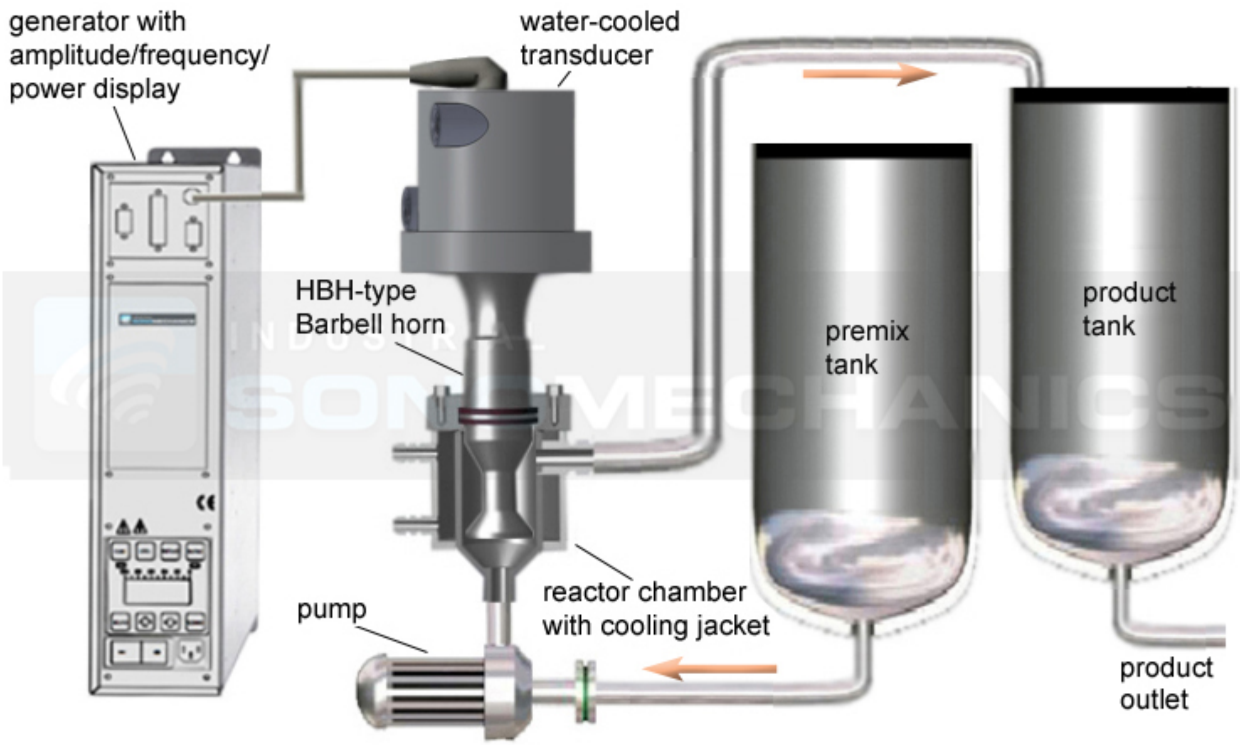

Figure 3 – Example Bench Scale Ultrasonic Liquid Processor from Industrial Sonomechanics (7).

Task 3 – Chemical RVP Treatment

The project team has been in discussion with major oil field chemical suppliers regarding treatment of crude oil to lower or maintain RVP. During this task the project team intends to further these discussions and report on the progress of laboratory testing, and field testing. In order to meet RVP requirements for gasoline, refiners generally remove the butane components that contribute to higher RVP. Similarly, to lower crude oil RVP, heated conditioning is used to remove butane and lighter components. Generally the conditioning occurs at the wellhead, however higher RVP crude oil may arrive at facilities downstream. When this occurs blending with low RVP crude oil, or additional conditioning is needed. Once conditioned, the crude oil volume is decreased resulting in additional costs, and reallocation of production volumes.   Chemical treatment is a means to maintain the crude oil volume while lowering the vapor pressure. A number of chemicals can be suitable to control RVP. Gelling of hydrocarbon fuels has been proposed (8), and previously applied to aviation fuels. Gels may contain amino acids or polymer gelling agents. Previous products have been designed to be flowable and pass through filters and injectors. What remains to be determined is if chemical can be added economically and meet pipeline and refining requirements. This task will identify a potential suite of chemicals and evaluate the economics and downstream requirements.

Anticipated Results:

Task 1 – Report highlighting modeling results for surface oil conditioning, regained RVP from storage, and opportunities to control RVP relative to light end component composition.

Task 2 – Laboratory report of results from sonic separation of Bakken wellhead fluids, and identification of a commercial partner to field demonstrate new technology. The intent is to develop a technology that is not influenced by cold weather or windy conditions.

Task 3 – Identify chemical options that meet downstream requirements and can be economically applied to volumes of oil that require lowering RVP.

Facilities:

Task 1 - modeling will be completed within Statoil facilities.

Task 2 - laboratory testing will be subcontracted. The project team intends to subcontract to a qualified commercial or well-renowned University with experience contracting in the oil and gas industry on short-term delivery projects. Selection will be subject to negotiation.

Task 3 - laboratory testing will be accomplished by a selected chemical service company within their facilities. Any field tests would occur at Statoil facilities in North Dakota.

Resources:

Statoil currently operates a shale oil and gas (SOG) research team focused on the development of onshore assets in the United States. The SOG team is a diversified group of about 20 people covering a wide range of experience including drilling, completions, production, facilities, reservoir, geology, engineering, and chemistry. Our team is currently engaged in field application projects in the Bakken asset to ensure safe operations, improve recovery, limit costs, and increase efficiencies. The team is experienced in technology development, co-sponsored projects, and agreements with major service companies and universities. The proposed work is congruent with our current research portfolio and research objectives.

Techniques to Be Used, Their Availability and Capability:

Statoil currently has the software and capability to conduct the modeling effort proposed in task 1.

Laboratory equipment is currently commercially available to conduct the work proposed in task 2. The project team will subcontract with a well-qualified laboratory that has an established track record for completing similar projects.

The work proposed in task 3 is expected to be commercially competitive and completed by a major chemical service company.

Environmental and Economic Impacts while Project is Underway:

Any field testing that may occur during the project will be subject to standard operating procedures and approvals by the Bakken asset. The asset operates in compliance with the North Dakota Industrial Commission. No environmental impact is expected from this feasibility study. Environmental impacts will be assessed prior and during a phase 2 demonstration.

If task 3 proves successful, positive economic impact may be realized either during or as a direct result.

Ultimate Technological and Economic Impacts:

This project proposal was formulated as a direct result of challenges encountered this winter to maintain compliance with NDIC order 25417. The challenges encompass maintaining heater treaters, ensuring production of low RVP crude oil, and preventing rejection of crude oil relative to midstream shipping requirements. All of which are subject to attendant costs.

A successful project will lower or eliminate the associated costs, and develop new technology for manufacture and positive economic impacts within the industry.

Although it is not a simple matter to pinpoint the additional costs associated with the industry's operation to comply with order 25417 a few benchmarks are worthy of note:

- Delivery of "out of spec" crude oil to storage terminals can add \$2.00 - \$5.00 per barrel due to added conditioning or unplanned transportation.
- \$0.20 - \$1.00 per bbl can be lost by volume reduction of oil based on vaporization of light ends (9).
- In a document provided by the North Dakota Department of Mineral Resources (2), a cost of \$0.10 per bbl was estimated regarding conditioning of crude oil, and provides some basis for costs that may incur especially if operators must reprocess crude oil, or condition at higher temperatures.
- Many operators have incurred the expense of field testing in order to pinpoint wells which produce crude oil at an RVP that pipeline companies refuse to ship. These costs can be in the range of \$1500 per day.

Why the Project is Needed:

The oil conditioning order 25417 was written as a matter of safety. Rail accidents across the country drew attention to how Bakken oil is produced and processed at the well site. The order represents a congruence of a significant volume of testimony for how to make processing and transport as safe as possible. The order is based on science from the testimony received. National standards recognize oil with a Vapor Pressure of 14.7 psi or less to be stable, and the goal in North Dakota is to produce crude oil that does not exceed a measured vapor pressure of 13.7 psi, which allows for a one psi error in the sampling procedures and measurement equipment.

This project is needed to ease compliance with the oil conditioning order, reduce costs, and develop new technology that can be more effective, efficient, and reliable. The impacts of the order have been industry wide; however affect producers in various ways. The impacts are dependent on locality, infrastructure, resources, and shipping routes. Addressing the challenges as close to the wellhead as possible will yield the greatest economic impact for the correlative rights of all owners. Secondarily this project helps to develop new technologies that can drive positive economic impacts beyond the processing and handling of crude oil.

References:

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6. https://www.youtube.com/watch?v=EeWS_mlVQXY; accessed February 2016.
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9. Auers, J.R.; Couture, R.M.; Sutton, D.L.; "The North Dakota Petroleum Council Study on Bakken Crude Properties"; Bakken Crude Characterization Task Force; 4/4/2014

STANDARDS OF SUCCESS

Deliverables:

- The task 1 deliverable will include a report highlighting the results of modeling. The standard of success is an adequately described mass balance for processing and storage of Bakken crude in surface operations. The expected outcome includes volumes and conditions in which lights ends are present and reduce RVP. Operators may use this information to implement various technologies based on the results.
- A successful outcome for task 2 would include a commercial partner that can further the concept of sonic separation. The team hopes to identify through laboratory testing how effective the technology is at removing the high vapor pressure components from Bakken crude independent of temperature. Ultimately the team seeks to enable crude oil conditioning

without the interference of adverse weather conditions which currently hamper the ability to produce low RVP crude oil.

- Success for task 3 would be the identification of various chemicals that can reduce RVP of crude oil. The intent is for a commercial chemical supplier to field test and offer a solution to operators. The challenge will be to find a chemical that is economic, and does not detrimentally interfere with the value of downstream processing of crude oil.

The proposed work touches on all mission goals and purposes of the Oil and Gas Research Council:

- Promote efficient, economic, and environmentally sound exploration, development, and use of North Dakota's oil and gas resources.
- Preserve and create jobs involved in the exploration, production and utilization of North Dakota's oil and gas resources.
- Ensure economic stability, growth, and opportunity in the oil and gas industry.
- Encourage, and promote the use of new technologies and ideas that will have a positive economic and environmental impact on oil and gas exploration, development, and production in North Dakota.
- Promote Public Awareness of the benefits and opportunities provided by the North Dakota oil and gas industry.

The outcomes are intended to assist operators in North Dakota with compliance of order 25417 to significantly reduce the vapor pressure of Bakken crude oil. Success of the project will help operators to achieve the goal in a more robust and cost effective manner that will maintain the competiveness of oil produced in North Dakota and preserve jobs. Additionally, technology development is expected which can bring new investment, create jobs, ensure safe operations, and create new opportunities.

BACKGROUND/QUALIFICIATIONS

The proposed work will be conducted by the Shale Oil and Gas (SOG) research group at Statoil which has been working closely with the Bakken asset over the past 3 years on a number of field implementation projects. The team members from Statoil that will have the most significant involvement in the project include Darren Schmidt, Desikan Sundararajan, and Andrea Carolina Machado Miguens. A brief bio is included for each person:

Andrea Carolina Machado Miguens current work with Statoil as a senior researcher focuses on investigating and developing new technologies to facilitate clean oil and gas production from shale plays.

Andrea holds a master degree in Chemical Engineering from the Norwegian University of Science and Technology, NTNU (Trondheim, Norway) and a bachelor degree from the Simón Bolívar University, USB (Caracas, Venezuela). Andrea joined Statoil in 2009 in the Research and Development Centre in Trondheim. For 7 years she has been working with research, development and implementation of technologies in the area of gas processing and onshore facilities. In 2015 she relocated to Houston, USA.

Dr. Sundararajan is a senior researcher with Statoil focused on investigating and developing new technologies to facilitate clean oil and gas production from shale plays with specific emphasis air emissions and proppant development. Methane and VOC emissions are the focal point of his current work at Statoil. He is involved in developing various strategic policy and technology based alternatives to reduce Statoil's carbon footprint.

Prior to joining Statoil, Dr. Sundararajan worked on diverse process-related R&D projects which include catalyst development for jet fuel reforming, desulfuriers for fuel reformate polishing, sulfur tolerant anode materials for solid oxide fuel cells, non-precious metals oxidation catalyst for CO and VOC control. In this previous role as a Research Technical Leader at Owens Illinois, Desikan was responsible for leading a technical team working on selective glass batching using core and shell granule design and development for improved melting kinetics.

He has authored numerous peer-reviewed publications and is a leading inventor of multiple patented and commercialized emissions sensing and mitigation technologies. Dr. Sundararajan obtained his PhD in Chemical Engineering from University of Toledo in 2009, MS in Environmental Engineering from The University of Arizona in 2004 and a BE in Chemical Engineering from the University of Pune.

Darren Schmidt is a principal engineer for drilling and well operations within the shale oil and gas team at Statoil. He is located in Williston, ND and serves to facilitate research projects within our operations. Over the past 3 years Mr. Schmidt was responsible for completion operations in Williams County, North Dakota. Prior to joining Statoil he worked as a technical advisor for Weatherford's first fracturing service operations in the Bakken. Mr. Schmidt was responsible for procuring research, developing technology, and conducting scientific study for 15 years at the Energy & Environmental Research Center located at the University of North Dakota on a wide range of energy technologies mostly focused on distributed power generation, and oil and gas. His experience also includes testing a biomass gasification power plant for Research Triangle Institute in North Carolina. Mr. Schmidt is a registered professional engineer in North Dakota in both the disciplines of Petroleum and Mechanical engineering. He graduated from West Virginia University (BSME), holds one patent, and has published over 100 publications.

MANAGEMENT

The principal investigator for this project is Darren Schmidt, he will work in coordination with team leader Dr. Sundararajan to ensure project timelines and deliverables are met. Andrea Machado will be primarily responsible for the modeling task. A subcontract is planned to conduct the laboratory work described in task 2. The project team has a wealth of experience in conducting subcontracted laboratory work and will be fully responsible for the timely execution and completion by the subcontractor. Further oversight of Statoil funds are accomplished through our technology project development management system which includes oversight from senior management within our Research and Technology group in Norway managed within Technology Projects and Drilling.

TIMETABLE

This project will be completed in one year according to the following schedule.

- Task 1 – 3 months; interim report.
- Task 2 – 6 months; interim report
- Task 3 – 6 months interim report.
- Final report – 1 year from start.

BUDGET

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)
Direct Salaries	$129,032.26	$64,516.13
Indirect Costs	$70,967.74	$35,483.87
Subcontract		$100,000
Total Project Costs	$200,000	$200,000

Laboratory equipment is expected to be purchased under subcontract in task 2. The costs are expected to be less than $10,000.

CONFIDENTIAL INFORMATION

There is no confidential information provided in this proposal.

PATENTS/RIGHTS TO TECHNICAL DATA

Patent rights may be preserved relative to sonic separation.

STATUS OF ONGOING PROJECTS

Statoil does not have any current projects with the North Dakota Oil and Gas Research Program.