HEAVY OIL JOURNAL ARTICLE

Benefits of the Enercat Downhole Tool Technology in the Viscous Waxy and Heavy Crude Oils of California; Optimizing Production and Mitigating Recurring Oilfield Maintenance by Reducing Heavy Oil Viscosity and Preventing Asphaltene and Paraffin Deposition. *Douglas S. Hamilton and Brian Herman, Enercat Technology Group, Canada*

This paper is proposed for presentation at the 2023 International Petroleum Technology Conference, Bangkok, Thailand, 28 February-2 March, 2023.

Abstract

The Enercat tool is a proven technology, with more than 5,000 successful downhole installations across 23 countries. Numerous field case studies demonstrate that the tool reduces viscosity of heavy oils, lowers wax appearance & pour point temperatures of paraffinic oils, and decreases interfacial tension in heavy oil reservoirs. Empirical evidence from laboratory testing confirms these observed field results.

The Enercat downhole tool is encased in a jacket of quartz crystals and semi-precious metals constructed to emit negatively charged particles, or passive energy, that are specifically designed to neutralize the positively charged particles generated by the electrokinetic effect of crude oil entering a wellbore in the presence of pressure and temperature flux during production. In hydrocarbons, positively charged particles are known to increase the intermolecular forces (forces between molecules) responsible for increased viscosity in heavy oils and elevated wax appearance and pour point temperatures in paraffinic crudes. Interfacial tension is also elevated by positively charged particles.

California's crude oils are predominantly heavy and viscous but the lighter crudes, which are paraffinic, are also viscous. Crude oil production in California is challenged by suboptimal production rates and recurring oilfield maintenance issues of asphaltene and paraffin deposition in production equipment so common to high viscosity crudes and high wax appearance & pour point temperature crudes. Potential applications for the Enercat downhole tool technology to California's heavy and viscous crudes are far reaching and include enhancing production flow rates in heavy crudes by reducing crude oil viscosity,remediating paraffin deposition on production tubulars, rods and pumps by lowering wax appearance and pour point temperatures of paraffinic crudes, and increasing recovery factors and recovery efficiencies in cyclic steam operations by liberating immobile oil otherwise trapped in the reservoir by interfacial tension.

In summary, benefits of the Enercat downhole tool technology to the California oil industry includes:

- ✓ **Mitigating costly recurring oilfield maintenance** associated with organic (heavy and paraffinic) deposition
- ✓ **Increasing daily oil production rates** by reducing crude oil viscosity and removing organic deposition in perforations, near well bore area and production tubulars
- ✓ **Reducing drawdown pressure** by reducing crude oil viscosity and mitigating "sanding" issues and wellbore stability
- ✓ **Improving electric-powered sucker-rod pump (SRP) efficiencies** by reducing crude oil viscosity that in turn reduces mechanical losses, well bore friction pressure drops and increases electricity generation efficiency; Artificial lift in California is in most cases electric, and 80% of oil well pumps are SRPs (Brandt, 2011)
- ✓ **Resolving Oil-in-Water and Water-in-Oil Emulsions** by reducing interfacial tensions at the oil-water interface
- ✓ **Reducing combination organic-inorganic scale deposition** in oil-water separators in cyclic steam operations
- ✓ **Substantially reducing the amount of, or eliminate the need for, light oil diluent or viscosity reducing agents required** to lift heavy crude from the reservoir and/or convey the heavy crude through the transport network (truck, railcar, or pipeline)
- ✓ **Potentially enabling pipeline transport of heavy crude** otherwise constrained to more expensive truck or railcar transport because of high viscosity

Introduction

California is a prolific oil-producing province that has produced tens of billions of barrels of oil since commercial production was established in the 1890’s. There are four major hydrocarbon producing regions in California: San Joaquin Valley, Los Angeles Basin, Ventura Basin and Santa Maria Basin (figure 1). A characteristic of California’s oilfields is that most of them produce heavy crude oils and, moreover, that the crudes produced are unusually viscous for their API gravity (figure 2), particularly when compared to crudes produced elsewhere in the world (figure 3). Even the lighter, paraffinic California crudes are unusually viscous. As a result of the highly viscous and heavy nature of the crudes, California’s oil production has always relied on technological advantages for its commerciality. The advent of the Enercat downhole tool, which can reduce crude oil viscosity, lower pour point & wax appearance temperatures, and prevent asphaltene and paraffin deposition, promises further technological advantages and commercial gains by optimizing California crude oil production and mitigating recurring oilfield maintenance.

The Enercat is a downhole production tool encased in a jacket composed of quartz crystals and semi-precious metals (figure 4) that vibrates at the far end of the infrared spectrum and imparts passive energy (negatively charged particles) at the reservoir/well bore interface. The negatively charged particles are thought to counterbalance and overcome the excess of positively charged particles generated by the electrokinetic effect that occurs when fluid flows in conjunction with pressure and temperature flux, such as typically occurs when oil enters a wellbore during production.

An excess of positively charged particles can increase intermolecular forces (forces between molecules) that, in the context of oil production, strengthen two critical types of intermolecular bonds: London Dispersion Bonds and Hydrogen Bonds. Strengthening London Dispersion Bonds during oil production can 1) increase viscosity in heavy oils substantially reducing production flow rates and potentially depositing asphaltene on production equipment, and 2) elevate wax appearance and pour point temperatures in paraffinic crudes resulting in paraffin crystallization and deposition. Strengthening Hydrogen Bonds during production increases interfacial tension that traps immobile heavy oil on reservoir grains as well as creates oil-in-water and water-in-oil emulsions. The action of the Enercat tool neutralizes the detrimental electrokinetic effects that occur within the wellbore and near wellbore area at the onset of oil production, reducing the intermolecular forces and relaxing the associated bonds (London Dispersion and Hydrogen Bonds) that cause much of the diminished heavy and waxy crude oil production and costly recurring remedial oilfield maintenance.

Case Histories and Laboratory Data from Application of the Enercat Tool to Production Optimization and Oilfield Maintenance Mitigation

The Enercat tool has been successfully deployed across 23 countries with more than 5,000 installations. A selection of case studies from these installations along with empirical laboratory data that underpins the observed production responses are presented to demonstrate the efficacy of the Enercat tool and its potential for broad application across California’s oil industry.

Heavy Crude Oil Applications

In heavy oil, the passive energy emitted by the Enercat tool prevents asphaltene flocculation by stabilizing molecular dispersion and increases oil production rates by keeping the heavy constituents dissolved within the monophasic crude oil mixture (Hamilton and Herman, 2011) that in turn greatly reduces crude oil viscosity at the wellhead. In effect, the Enercat technology maintains the viscosity characteristics of the oil as it exists in the reservoir condition, where the oil can migrate through microscopic porosity.

A case study with Oxy in Argentina demonstrates that the Enercat downhole tool can deliver oil to the wellhead at reservoir conditions. Oxy measured wellhead oil viscosity at their *Epsilon S.R.L Labratorio Industrial* before and after installation of the Enercat downhole tool in the PC 2081 well. Prior to installation, oil viscosity at the wellhead measured 7730 cP at 30^0C (figure 5). The oil was then tested at the wellhead on November 27th, 2010, after installation of the Enercat downhole tool and oil viscosity measured 1807 cP at 30^0C (figure 6). The oil was again tested at the wellhead on December 1st, 2010, and oil viscosity measured 1903 cP at 30^0C (figure 7).

A case study with Anderson Exploration in Canada resulted in a heavy oil production rate increase on the order of 27% from 51.5 barrels of oil per day to 65.4 barrels of oil per day after installation of the Enercat tool (figure 8). High friction losses in the production tubing were impeding production rates and the PCP in turn was running at high torque pressure which caused premature failure. Once installed, the Enercat tool kept the oil viscosity at reservoir conditions, lessening the friction and allowing greater inflow into the well through the perforations and tubing as well as promoting a higher fluid column (hydrostatic pressure was increased by 46%). Pressure on the pump was greatly reduced and RPM on the pump were reduced by 95% (figure 8). The well also experienced a substantial drop in sand production from 3.1 m^3/day to 0.3 m^3/day.

<u>*Reducing Interfacial Tension*</u>

The Enercat tool has proven effective at resolving oil-in-water and water-in-oil emulsions in bench-top experiments and reducing interfacial tension at the oil-water interface in laboratory measurements.

Laboratory analysis measuring interfacial tension at the oil-water interface was undertaken utilizing a force tensiometer with the Du Nouy ring probe. Surface tension of the oil and produced water were measured independently both before and after treatment with the Enercat tool. There is little difference in surface tension of the pre-tool water (11.9 dyn/cm) and post-tool water (12.1 dyn/cm; Table 1). However, when oil is added and exposed to the Enercat tool there is a reduction in interfacial tension on the order of 31% (11.9 to 8.2 dyn/cm and 12.1 to 8.3 dyn/cm; Table 1).

The Enercat tool breaks emulsions effectively by reducing the interfacial tensions at the oil-water interface. Reducing interfacial tension could also have far reaching implications in recovery efficiency and production rates in cyclic steam operations by increasing the wettability in oil-wet heavy oil reservoirs and liberating trapped immobile oil to the pore spaces for production at the well.

Paraffinic Crude Oil Applications

Wax deposition in production tubulars, rods and pumping equipment is the principal culprit for lost or diminished oil production and costly, periodically recurring remedial maintenance in paraffinic crude oils. The 3 phases of wax solidification that results in this wax deposition are precipitation, crystallization & gelling, all of which are temperature dependent. Empirical evidence from laboratory experiments indicates that the Enercat tool suppresses all 3 phases of wax solidification by lowering the Wax Appearance and Pour Point Temperatures and impeding the crystallization process.

An example of our quantitative laboratory analysis demonstrating Wax Appearance Temperature (WAT) reduction after treatment with the Enercat tool is superimposed on the plot of WAT and PP of 331 crude oils tankered around the world (IP, 2004) and illustrated in figure 9. Prior to treatment with the Enercat tool, our proprietary crude oil had a WAT of 55^{0}C (131^{0}F) but after, the WAT dropped to 25^{0}C (77^{0}F), a reduction of 30^{0}C (54^{0}F).

Thin section photography under normal light at x50 magnification (figure 10) captures the onset of precipitation and commencement of crystallization of a paraffinic crude at room temperature prior to treatment with the Enercat tool. The same crude was then subjected to treatment by the tool and no precipitation or crystallization occurred at room temperature.

The Enercat tool has been successfully applied in paraffin-rich crude oil provinces all over the world. A case study from the La Vela field, Venezuela is included here as an example. Because of its remote location in the jungles of Venezuela's northern Falcon State, the La Vela field was marginally economic. Production in the field was intermittent because of severe paraffin deposition in production tubulars, and hot oiling was required frequently to achieve oil to surface. Five Enercat tools were installed in April 2012 and the results were remarkable. Daily oil production that jumped around from 8 to 50 bopd (depending on the time since hot oiling treatments were applied) increased to more than 400 bopd after the installation of the tools. The production was choked back for a production target of 200 bopd to avoid potential for water coning. Production stabilised and then followed a normal production decline for a pressure depleting reservoir (figure 11). Production records were monitored by Enercat staff until September 2013, at which time the La Vela well had produced 70,894 barrels of incremental oil since installation of the tools.

A case study with a New Mexico 2nd Bone Springs producer in the Delaware Basin shows the efficacy of the Enercat tool in resolving paraffin deposition problems in paraffinic crudes. The well was experiencing severe paraffin deposition that required hot H_2O and chemical treatments and workovers to strip paraffin from production tubulars and production equipment (figure 12). Enercat engineers pulled the rods and cleaned all equipment then installed 3 Enercat tools and discontinued all paraffin and chemical treatments. After 131 days, the rods were pulled and all equipment inspected. There was no paraffin build-up anywhere in the production equipment (figure 13) and the trial was deemed 100% successful. The producer estimated that it would take years for a paraffin related failure to occur based on the observed paraffin build-up on production equipment after 131 days.

Application of the Enercat Technology to California's Oil Industry

The high viscosity of the California crudes has been an inexorable challenge for the oil industry. Whereas thermal techniques have shown substantial success in releasing the heavy crudes from the reservoir, other technologies are necessary for efficient lifting of the crude to surface, and once at surface for handling, transporting, and storing the viscous crudes. Diluting the heavy crude with equal parts of light crude oil has been a mainstay of the industry to assist, and in some instances permit, artificial lift from the well bore as well as facilitating transport of the heavy crudes by truck, rail, or pipeline. Light crude oil diluents are expensive however and hauling them to the producing fields is double handling and highly inefficient. Viscosity reducing chemical agents, or rather, drag reducing agents such as polymers and surfactants are also widely deployed downhole and throughout the pipeline transport networks, but these too are expensive and have inherent inefficiencies that negatively impact oilfield operations and economics. Viscous crudes also require high drawdown pressures to move the crude into the wellbore and, if the reservoir sands are poorly consolidated, high drawdown pressure can lead to “sanding” issues and well failure; a problem that can be mitigated by viscosity-reducing technologies.

Asphaltene and paraffin deposition in production tubulars, pumping equipment, oil gathering lines and storage facilities is another drawback of producing heavy and waxy crude oils that reduces efficiency and leads to costly recurring maintenance issues, and in cyclic steam operations so prevalent in the California industry, hydrocarbon carry-over in the water and oil separation process can result in water pipeline blockages where the residual hydrocarbons can help bind inorganic scales to pipeline walls.

Because the Enercat tool can reduce crude oil viscosity, lower pour point & wax appearance temperatures, and prevent asphaltene, and paraffin deposition, its potential for commercial applications is broad across California’s oil industry and includes:

1. **Mitigating costly recurring oilfield maintenance** associated with organic (heavy and paraffinic) deposition
2. **Increasing daily oil production rates** by reducing crude oil viscosity and removing organic deposition in perforations, near well bore area and production tubulars
3. **Reducing drawdown pressure** by reducing crude oil viscosity and mitigating “sanding” issues and wellbore stability
4. **Improving electric-powered sucker-rod pump (SRP) efficiencies** by reducing crude oil viscosity that in turn reduces mechanical losses, well bore friction pressure drops and increases electricity generation efficiency; Artificial lift in California is in most cases electric, and 80% of oil well pumps are SRPs (Brandt, 2011)
5. **Resolving Oil-in-Water and Water-in-Oil Emulsions** by reducing interfacial tensions at the oil-water interface
6. **Reducing combination organic-inorganic scale deposition** in oil-water separators in cyclic steam operations
7. **Substantially reducing the amount of, or eliminate the need for, light oil diluent or viscosity reducing agents required** to lift heavy crude from the reservoir and/or convey the heavy crude through the transport network (truck, railcar, or pipeline)
8. **Potentially enabling pipeline transport of heavy crude** otherwise constrained to more expensive truck or railcar transport because of high viscosity

Experimental Application to California’s Cyclic Steam Operations

Cyclic steam stimulation, or huff and puff, is the alternating injection of steam and production of oil with condensed steam from the same well or wells, involving a 3-step process of firstly injecting a measured amount of steam into a reservoir, secondly allowing a *soak period* for the steam to heat the reservoir and reduce the oil viscosity, and thirdly to produce back the now-mobile oil to the same well (Speight, 2016). Typically, however, the heating radius at the conclusion of several cycles of conventional saturated steam huff and puff in heavy oil reservoirs is only on the order of 10–20 m (Anzhu and others, 2013). Moreover, recovery of the initial oil-in-place within the heating radius is low, limited to less than 30% and usually less than 20% (Speight, 2013). Contributing to this low recovery factor is the high proportion of remaining immobile oil trapped on the sandstone reservoir grains by interfacial tension (defined as oil-wet reservoirs; figure 14).

Although experimental at this stage, the Enercat Technology Group hypothesizes that because the Enercat tool can substantially reduce interfacial tension it may benefit cyclic steam well operations in two significant ways: 1) increase recovery efficiency by producing more of the oil in the pore spaces (or the oil saturation S_o), and 2) increasing the drainage radius of the well bore, thus accessing more initial oil-in-place.

The Enercat tool has been demonstrated to reduce interfacial tensions in the laboratory and has the potential to increase the wettability of oil-wet reservoirs (by reducing interfacial tensions), transforming them to water-wet reservoirs and releasing trapped immobile oil to the pore spaces where the oil can migrate to the wellbore (figure 15). The Enercat tool thus has the potential to enhance recovery efficiencies of typical cyclic steam operations by unlocking the oil bound by interfacial tensions and producing more of the oil saturation S_o in the reservoir.

There is conjecture regarding the subaerial extent to which the ultra-high frequency effect of the Enercat tool can pervade the reservoir (figure 16), but even a modest spatial increase will have an enormous impact on cumulative production of cyclic steam wells. The volume increase in original oil-in-place accessible to the well bore by increasing the drainage radius from 10 m to 20 m and then 30 m is substantial (figure 17). A 10-meter drainage radius for a hypothetical 50 m thick reservoir sandstone of 32% porosity and 65% oil saturation contains 20,552 barrels of original oil-in-place (OOIP). A 20-meter drainage radius for the same reservoir contains 82,208 barrels of OOIP and a 30-meter radius contains 184,968 barrels of OOIP (figure 17). Coupled with producing a greater percentage of the in-place oil saturation, increasing the drainage radius of cyclic steam wells would be transformative for California's cyclic steam operations.

Conclusions

Empirical laboratory tests and more than 5,000 successful downhole installations across 23 countries demonstrate that in heavy and waxy crudes, the Enercat tool can reduce heavy oil viscosity, lower wax appearance & pour point temperatures, prevent asphaltene and paraffin deposition on production equipment and reduce interfacial tension in the reservoir. Passive energy emitted by the Enercat tool downhole is thought to counteract the positively charged particles generated by the electrokinetic effect that occurs when oil enters the wellbore during production in the presence of pressure and temperature flux.

The implications and applications of this technology to the highly viscous heavy and paraffinic crudes of California's oil industry are far reaching. Widespread deployment of this technology tool in the heavy oilfields could substantially improve oilfield economics by reducing crude oil viscosity that significantly enhances production flow rates and reduces costs associated with artificial lift, transport and handling as well as remediating any asphaltene deposition on production equipment. In cyclic steam operations the impact of reducing interfacial tension in the reservoir could liberate otherwise trapped immobile oil and improve recovery efficiency of in-place oil saturation as well as accessing greater volumes of original oil-in-place by increasing wellbore drainage radii.

In paraffin-rich crudes, lowering wax appearance and pour point temperatures similarly enhances production flow rates but more importantly prevents paraffin deposition on production equipment and mitigates frequently occurring and costly maintenance to remove paraffin build-up.

Figures

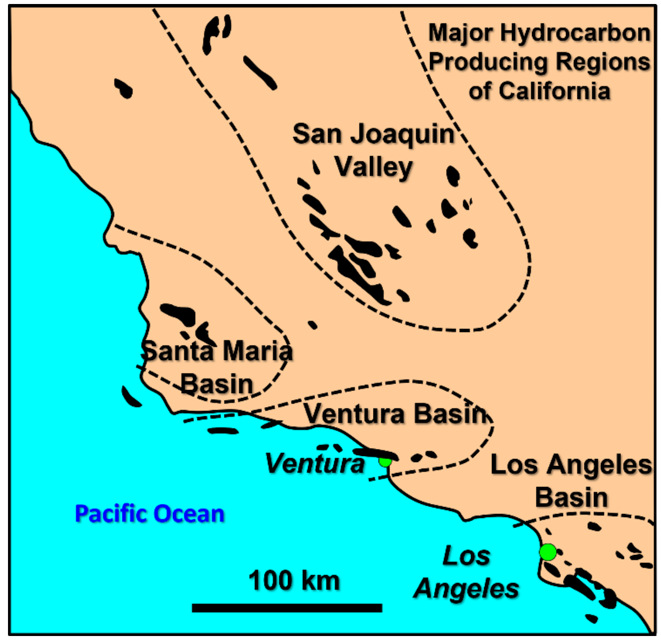


Figure 1. Location of the major hydrocarbon producing regions of California.

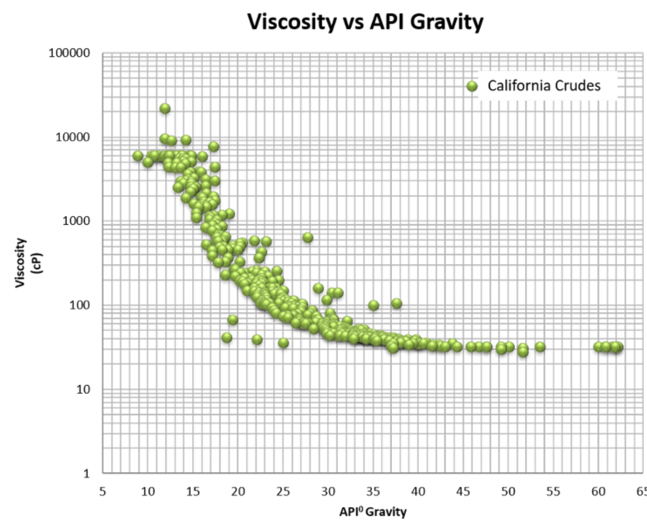


Figure 2. Viscosity versus API gravity for California crudes (data extracted from the COADB, 1996).

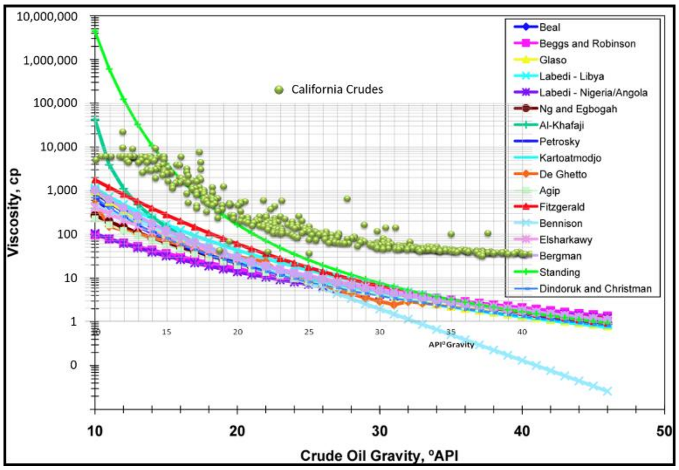


Figure 3. Viscosity versus API gravity for crude oils from numerous studies around the world (from Petrowiki, 2013). California crudes (green dots) are superimposed on world-wide crudes.

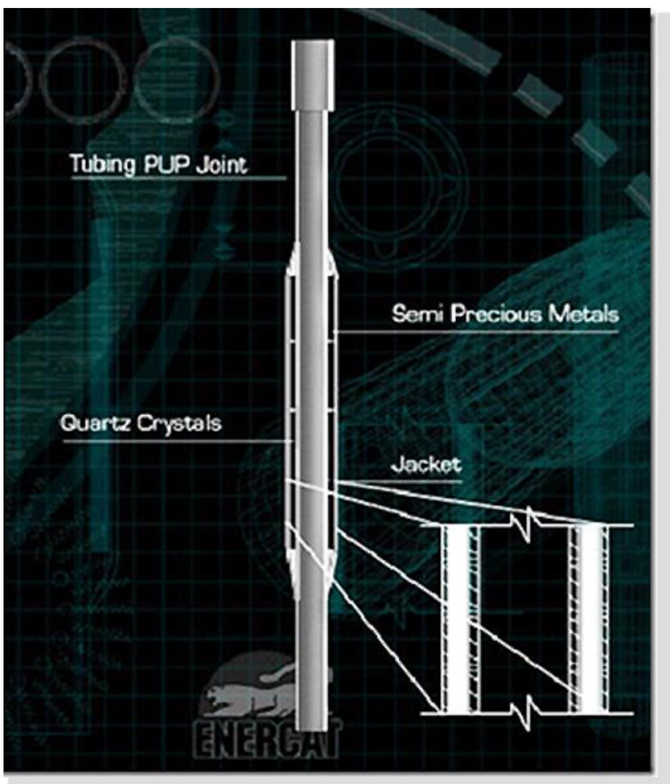


Figure 4. Schematic of the Enercat tool showing the jacket of quartz crystals and semi-precious metals.

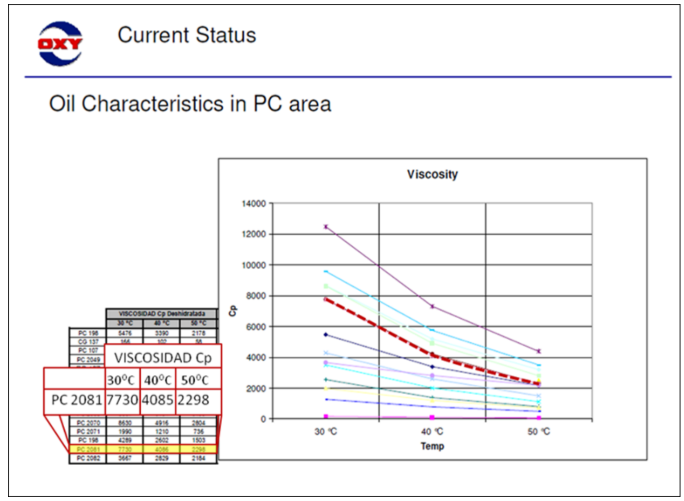
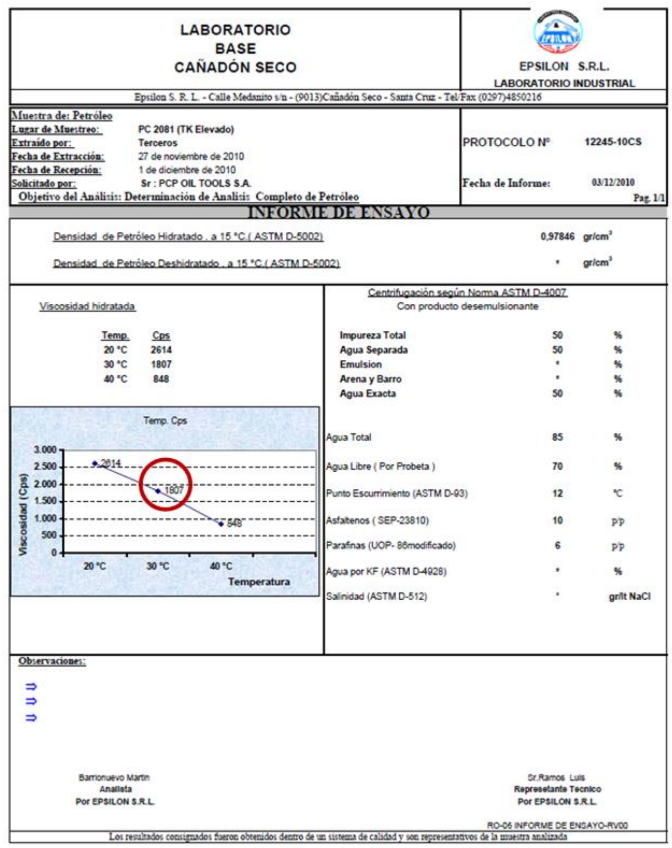


Figure 5. Oil viscosity measurement at the wellhead in PC 2081 prior to installation of the Enercat tool.


LABORATORIO
BASE
CAÑADÓN SECO

EPSILON S.R.L.
LABORATORIO INDUSTRIAL

Epsilon S. R. L. - Calle Medanito s/n - (9013)Cañadón Seco - Santa Cruz - Tel/Fax (0297)4850216

Muestra de: Petróleo
Lugar de Muestreo: PC 2081 (TK Elevado)
Extraído por: Terceros
Fecha de Extracción: 27 de noviembre de 2010
Fecha de Recepción: 1 de diciembre de 2010
Solicitado por: Sr : PCP OIL TOOLS S.A.
Objetivo del Análisis: Determinación de Analisis Completo de Petróleo

PROTOCOLO N° 12245-10CS
Fecha de Informe: 03/12/2010
Pag. 1/1

INFORME DE ENSAYO

Densidad de Petróleo Hidratado , a 15 °C.(ASTM D-5002) 0,97846 gr/cm³
Densidad de Petróleo Deshidratado , a 15 °C.(ASTM D-5002) * gr/cm³

Viscosidad hidratada

Temp.	Cps
20 °C	2614
30 °C	1807
40 °C	848

Temp. Cps
Viscosidad (Cps)
Temperatura

Centrifugación según Norma ASTM D-4007
Con producto desemulsionante

Impureza Total	50	%
Agua Separada	50	%
Emulsion	*	%
Arena y Barro	*	%
Agua Exacta	50	%
Agua Total	85	%
Agua Libre (Por Probeta)	70	%
Punto Escurrimiento (ASTM D-93)	12	°C
Asfaltenos (SEP-23810)	10	p/p
Parafinas (UOP- 86modificado)	6	p/p
Agua por KF (ASTM D-4928)	*	%
Salinidad (ASTM D-512)	*	gr/lt NaCl

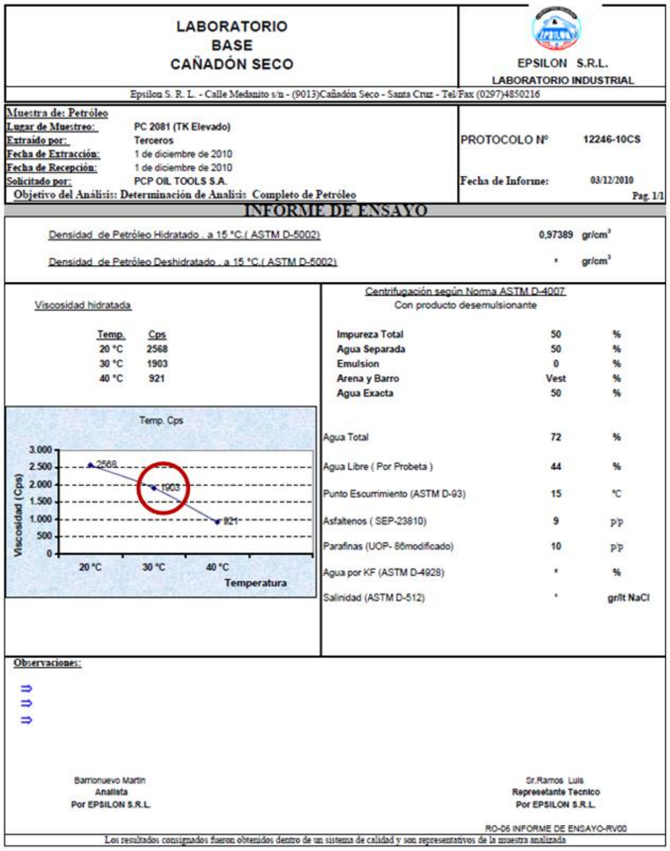
Observaciones:
⇒
⇒
⇒

Barrionuevo Martin
Analista
Por EPSILON S.R.L.

Sr.Ramos Luis
Represetante Tecnico
Por EPSILON S.R.L.

RO-06 INFORME DE ENSAYO-RV00
Los resultados consignados fueron obtenidos dentro de un sistema de calidad y son representativos de la muestra analizada

Figure 6. Laboratory measurement of oil viscosity at the wellhead in PC 2081 on Nov. 27, 2010, after installation of the Enercat tool. Well head viscosity was reduced from 7730 cps to 1807 cps following installation of the downhole tool.



LABORATORIO BASE CAÑADÓN SECO

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Pag. 1/1

INFORME DE ENSAYO

Densidad de Petróleo Hidratado . a 15 °C.(ASTM D-5002)	0,97389	gr/cm³
Densidad de Petróleo Deshidratado . a 15 °C.(ASTM D-5002)	*	gr/cm³

Viscosidad hidratada

Temp.	Cps
20 °C	2568
30 °C	1903
40 °C	921

Centrifugación según Norma ASTM D-4007
Con producto desemulsionante

Impureza Total	50	%
Agua Separada	50	%
Emulsion	0	%
Arena y Barro	Vest	%
Agua Exacta	50	%
Agua Total	72	%
Agua Libre (Por Probeta)	44	%
Punto Escurrimiento (ASTM D-93)	15	°C
Asfaltenos (SEP-23810)	9	p/p
Parafinas (UOP- 86modificado)	10	p/p
Agua por KF (ASTM D-4928)	*	%
Salinidad (ASTM D-512)	*	gr/lt NaCl

Observaciones:

⇒
⇒
⇒

Barrionuevo Martin
Analista
Por EPSILON S.R.L.

Sr.Ramos Luis
Represetante Tecnico
Por EPSILON S.R.L.

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Los resultados consignados fueron obtenidos dentro de un sistema de calidad y son representativos de la muestra analizada

Figure 7. Laboratory measurement of oil viscosity at the wellhead in PC 2081 on Dec. 1st, 2010, after installation of the Enercat tool.

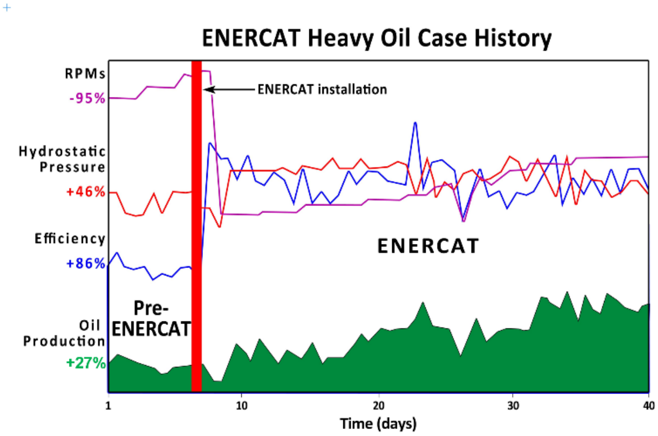


Figure 8. Results of the Enercat tool installation in the Anderson Exploration heavy oil well.

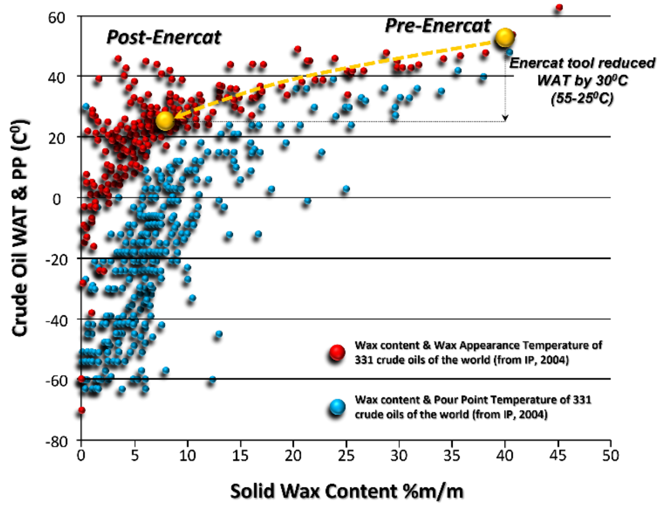


Figure 9. Laboratory tests indicate that the Enercat technology substantially reduces Wax Appearance Temperature.

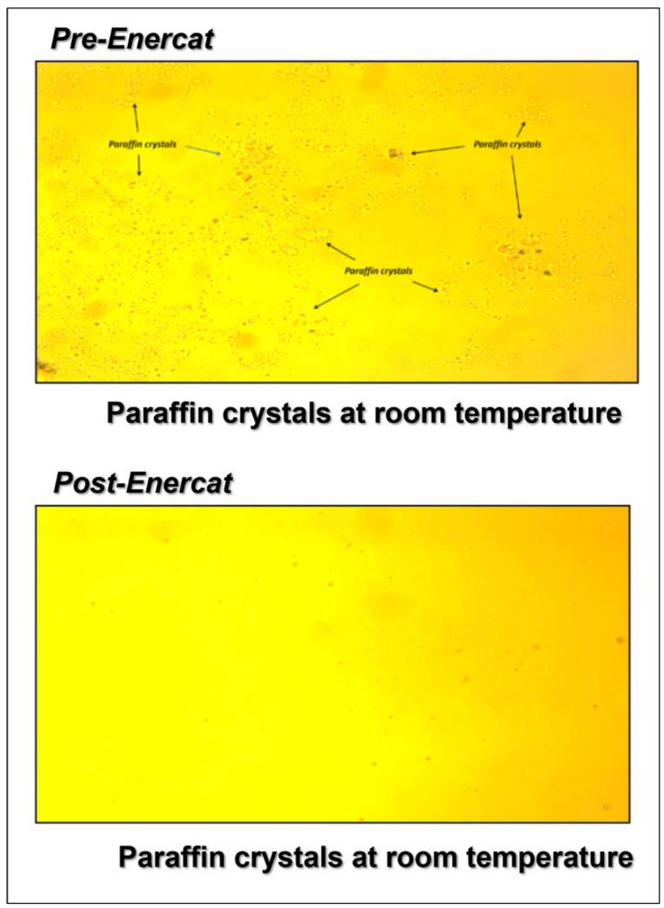


Figure 10. The onset of paraffin precipitation and crystallization of a paraffinic crude at room temperature prior to treatment with the Enercat tool (top image). No precipitation occurs in the same crude at room temperature when treated with the Enercat technology (bottom image). (Thin section of paraffinic crude under normal light x50 magnification).

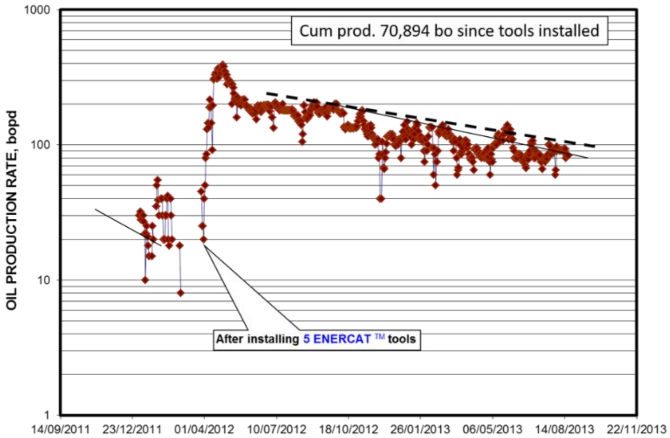


Figure 11. Production profile of the La Vela well before and after the Enercat downhole installation.

Figure 12. Paraffin build-up in flowline and rods in the New Mexico producer's CDH 203H production well.

Figure 13. 131 days after installation of the Enercat tools, all rods and surface flowline equipment were clean and no paraffin build-up.

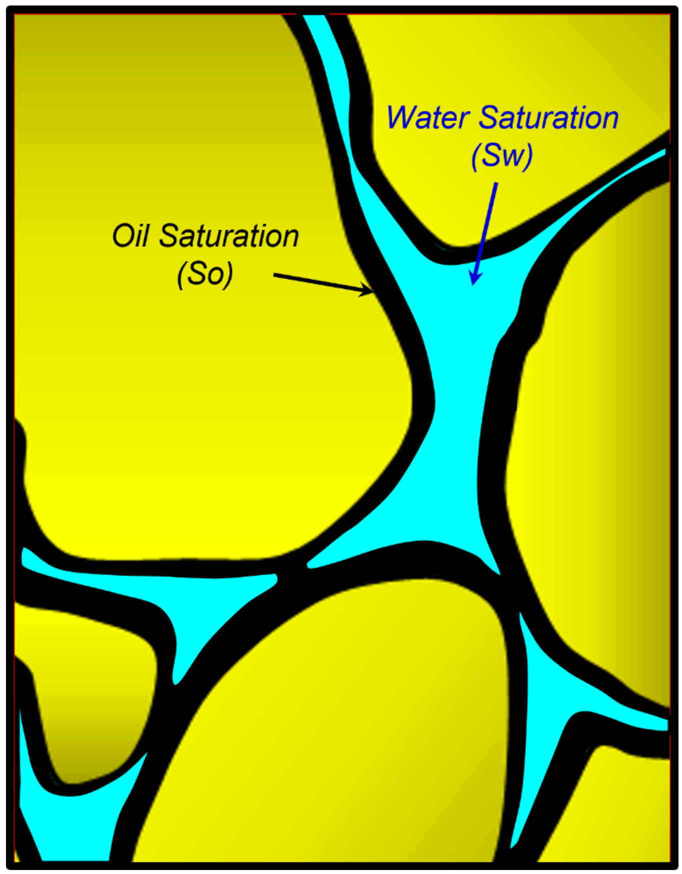


Figure 14. Schematic of an oil-wet reservoir. The reservoir grains are lined with oil which can remain trapped by interfacial tension.

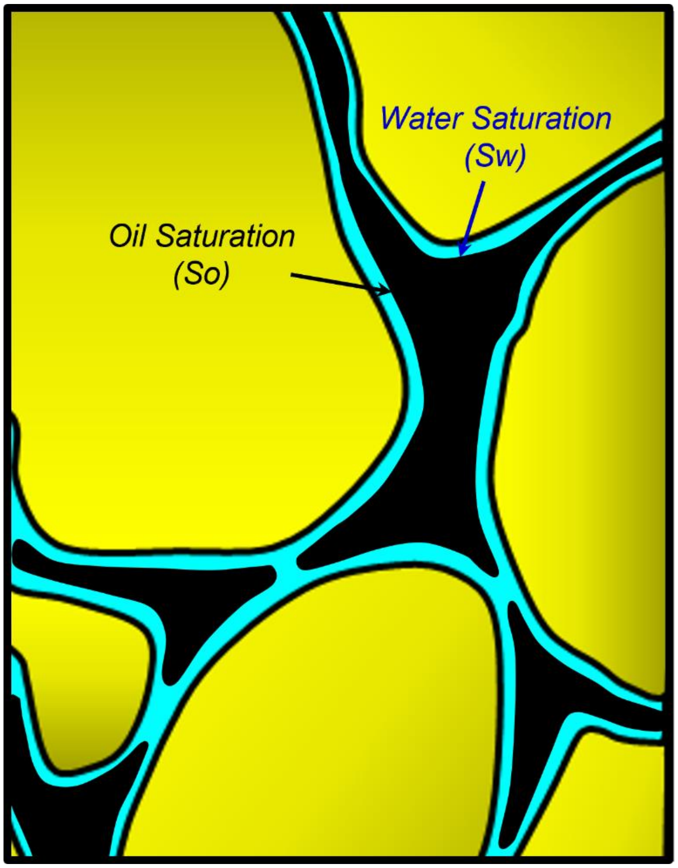
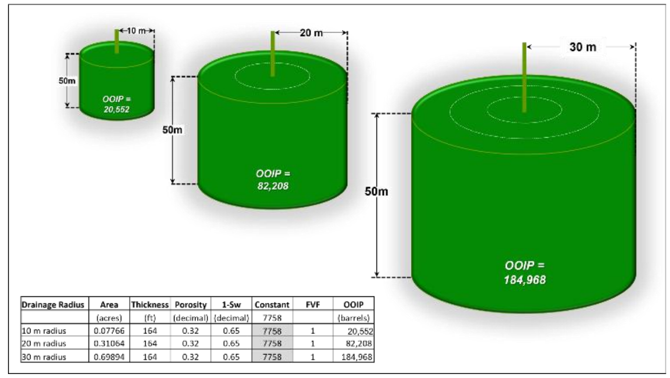


Figure 15. Schematic of a water-wet reservoir. The crude oil resides in the pore spaces and the reservoir grains are lined with connate water.

Figure 16. Schematic wellbore with an installed Enercat downhole tool. The subaerial extent to which the Enercat frequency effect can pervade the reservoir is undetermined, but even a 30 m radius would substantially impact in-place oil recovery.



Drainage Radius	Area	Thickness	Porosity	1-Sw	Constant	FVF	OOIP
	(acres)	(ft)	(decimal)	(decimal)	7758		(barrels)
10 m radius	0.07766	164	0.32	0.65	7758	1	20,552
20 m radius	0.31064	164	0.32	0.65	7758	1	82,208
30 m radius	0.69894	164	0.32	0.65	7758	1	184,968

Figure 17. Illustration of the original oil-in-place for a typical 50 m thick reservoir with a drainage radius of 10 m, 20 m and 30 m.

Tables

Interfacial Tension (dyn/cm)				% Reduction in Interfacial Tension
Pre-Tool Water & Pre-Tool Oil	11.9	Post-Tool Water & Post-Tool Oil	8.2	31
Post-Tool Water & Pre-Tool Oil	12.1	Pre-Tool Water & Post-Tool Oil	8.3	31

Table 1. Reduction in Interfacial Tension before and after treatment with the Enercat tool. Surface tension of the oil and water was measured independently, but the critical factor in reducing interfacial tension was treating the oil with the Enercat technology, the result of which was a 31% reduction in interfacial tension.

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