Universal Paraffin Issues

- As much as 85% of the world's oil is prone to precipitate paraffin deposits
- Studies from the early 90's have shown that paraffin remediation costs accounted for as much as 0.25% of global GPD (*Mokhatab et. al. 2009*).

Paraffin & Asphaltene Remediation

Recipe for Success; Green Earth

Another pump has just gone down.....

As the supply of more favorable light and middle distillates in the oil industry are depleted, the energy industry is forced to look into conversion of heavier fractions of crude to meet increasing energy demand around the world. These heavier fractions however, contain a significant concentration of paraffin waxes, asphaltenes and numerous other macromolecules that require treatment before going to market. These petroleum macromolecules have the ability to cause severe, if not hazardous problems if left untreated.

As we become more and more dependent on heavy and extra heavy crude oils for energy, control of these macromolecules becomes a challenge for engineers. One of the most common problems in production of heavy crude involves the formation of paraffin wax deposition in well bores as well as pipelines. The inner surface becomes fouled with these paraffin deposits, which reduces flow diameter, decreases overall throughput, and results in a higher pressure drop when crude is pumped .

The presence of asphaltene adds another level of difficulty for wax treatment because these structures are almost always found in association with waxes when they are retrieved from wells, storage tanks or pipelines. Paraffin wax deposition could be reduced by increasing the flow velocity of crude since less time in transition means less time for the deposits to form. However, increasing the fluid velocity increases the likelihood of asphaltene deposition. Thus, it can be very difficult and costly to maximize production by only treating one but not the other influencing factors. It is up to the engineers and scientists to seek an economically viable solution that reduces the formation of paraffin wax without increasing the concentration of other macromolecules.

Green Earth Paraffin Solvent Before & After

Green Earth Ingredients

Green Earth solvents and surfactants are non-toxic, plant-based, non-ionic and nanoscale colloidal solutions.

The recipe includes extracts from canola, corn, rice, walnut and almond oils, mustard, potatoes, forestry products and a variety of other plant types. Independently the ingredients are only modestly effective in their role, but; when water is added to the formulation as a catalyst, its ability to perform leaps ahead of hydrocarbon based chemicals to separate the long chain molecules of oils, fats and greases.

Non-toxic! No VOC's, non-flammable, recyclable, readily biodegradable and economical biobased ingredients are all we use.

GREEN EARTH ENERGY SOLUTIONS

Paraffin Wax & Asphaltene

During the recent oil boom there was a race by companies operating within the Oil and Gas space to sign leases, consolidate land holdings, and drill new wells. This philosophy served well during the initial development phase and continued to function as long as the price of oil held steady above $100.00/bbl. In the current pricing climate the emphasis has switched to maximizing existing resources by staving off production declines. Tight formations especially are subject to rapid declines which occur long before the depletion of resources in the formation.

Paraffin Problems, Cause, Effect, Traditional Solutions, Associated Problems:

Oil, Gas, and Condensate wells experience production declines through a variety of factors. Waxes formed of long chain saturated hydrocarbons precipitate under various conditions forming well bore blockages. Similarly, asphaltenes formed of fused aromatic rings can flocculate causing arterial and formation blockages. The mechanisms for the formation of these problems can vary greatly and are not fully understood. Traditional methodologies for fixing these issues generally consisted of flushing the well and the near well bore formation with solvents or acids. Too often these are accompanied by their own inherent problems.

Generally paraffin issues within a wellbore consist of macro crystalline structures. These structures are primarily composed of long chain, linear, saturated hydrocarbons. These structures prefer to remain in a liquid state provided that the temperature of the crude is high, or that the low end, light hydrocarbon portion of the crude remains in the condensed phase rather than transforming into a gas phase, a condition clearly dependent upon pressure. As hydrocarbons move into the wellbore and temperature and pressures drop below that of the formation, nucleation happens. Nucleation can only occur around a nucleation site, some resident particle for the wax to adsorb onto. These nucleation sites consist of but aren't limited to asphaltenes, corrosion, scale, silt, or sand from the formation and in hydraulically fracked wells the proppant itself tends to be an excellent nucleation site for paraffin. Once the nuclei are formed continuous growth is a forgone conclusion.

Conventional treatments for paraffin blockages consist of flushing the well with heated oil to melt the paraffin. Normally this heated oil would be run down the annulus so that the oil reaches the bottom of the wellbore while it carries the most heat, melting the wax and returning it up the tubing. Amongst the most significant issues associated with this approach is the risk of carrying melted paraffin back into the formation creating greater complications rather than solutions.

Unlike traditional chemicals, Green Earth colloidal solutions permanently keeps the paraffin in suspension.

GREEN EARTH ENERGY SOLUTIONS

Paraffin Wax & Asphaltene

Other treatment procedures involve using solvents or heated water with a surfactant package. Traditionally solvents such as xylene are employed to dissolve the wax into solution to be pumped and removed from the well. Xylene and other benzene derived solvents lack desirability on two fronts. One is volatility and flammability, and the other is carcinogenic properties. Transversely, when using a hot water/ surfactant application the surfactant allows for dispersal of the waxes into the water phase through a combination of heat and micelle formation. This methodology is often difficult to successfully employ due to variations in interfacial tensions, macro and micro crystalline wax structures, and formation water qualities which create difficulty in accurately predicting and creating the appropriate surfactant/ co -surfactant package.

Asphaltene Problems, Cause, Effect, Traditional Solutions, Associated Problems:

Asphaltenes, not unlike paraffin create downhole well blockages. The mode of asphaltene blockage formation is flocculation, precipitation, and deposition and this is difficult to model and predict. There can be high percentages of fused aromatic and naphthenic rings in specific crude oils but they exist as dissolved aggregates creating very little issue with deposition. Thus, asphaltene concentration levels in crude oil is not necessarily an accurate predictor of associated problems with blockages. Rather, a combination of specific circumstances including water cut, shear forces, and reservoir pressure help to determine the extent to which precipitation and blockages will occur. Additionally when trying to predict and understand when asphaltene flocculation and deposition appears likely to occur, an imbalance in the crude between basic nitrogen containing components such as primary amines and acidic functional groups such as carboxylic acids can help create accurate working models.

Traditional methodologies for treating wells experiencing blockages due to asphaltene deposition are often similar to the treatments for paraffin, although strong acids such as hydrofluoric, and sulfuric are also often used. These acid technologies have major drawbacks in that there are significant regulatory and worker safety issues, and also serious questions regarding efficacy. Undeniably they can contribute to the removal of blockages, but they can also contribute to formation damage, as well as souring crude, and creating imbalances in the pH downhole leading to more favorable conditions for rapid redeposition of asphaltene to occur.

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GREEN EARTH ENERGY SOLUTIONS

Paraffin Wax & Asphaltene

Revolutionary New Thinking; Green Earth Paraffin/Asphaltene Remedy:

Green Earth Paraffin/Asphaltene remedy is a unique colloidal solution product recently brought into the marketplace by Green Earth. Its current iteration is a 2 part package consisting of a product labeled Part "A" and "B". This product is unique among all offerings currently in the market place. It is readily biodegradable, non-toxic, non-flammable, contains no VOC's and is non-hazardous *("Non-Hazardous Chemical" as defined by the OSHA Hazard Communication Standard 29 CFR 1910.1200).* It has been created on three basic principles. The three components include surfactant, solvent and acidic components. Paraffin/ Asphaltene Remedy is manufactured as a nano-saponified material allowing for micelle formation under a wide variety of conditions. More than 90% of the micelles formed in manufacturing are less than 5 nm. (*equal to 10^{-9} m—a billionth of a meter*) The enhanced interfacial surface area allows significant quantities of materials causing blockages to be dispersed and securely contained within the water matrix. Part A and Part B work best when blended down hole with water (*fresh or produced*). This enables an entropic reaction to occur which allows the monomers in the fluid tremendous mobility and motivity. Founded upon the principles of Brownian Motion* these particles reach far into the formation not just addressing blockages at or near the well bore but also clearing arterial pathways between the well bore and the formation.

Paraffin/Asphaltene Remediation can be applied to producing wells and clogged or partially clogged wells by means of a Surface Pump, a Coiled Tubing Unit, or a Repair drill equipped with insulating plugs and a cleaning tool.

Traditional acid wash formulations can leave wells susceptible to re-deposition of asphaltenes due to imbalances between basic and acidic fractions in the formation fluids. Paraffin/Asphaltene remedy restores this balance and when tested in wells in South America where asphaltene deposition is a very serious problem and in several locations in the US, the resulting production vastly exceeded traditional chemistries and processes. See P 5.

Improvement to flow volumes were further enhanced by extended treatment times with up to 120 days of production before noticeable declines were recorded. This was achieved through rebalancing the acid/base baseline in the crude, reaching into the formation to open blockages that near well bore acid treatments couldn't reach and leaving an inhibitor against paraffin and asphaltene deposition in the well bore and formation.

Improvement to flow volumes were further enhanced by extended treatment times with up to 120 days of production before noticeable declines were recorded.

**Brownian Motion Def: the random movement of microscopic particles suspended in a liquid or gas, caused by collisions with molecules of the surrounding medium.*

GREEN EARTH ENERGY SOLUTIONS

Paraffin Wax & Asphaltene Remedy Case Studies

Green Earth Colloidal Solutions were tested on 5 individual wells in South America where paraffin had been the principle reason for these wells to be shut in. A summary of the results of the test program follow;

1. After repeated conventional petrochemical treatments, well #1 had shown there was no production value in continuing operation and had been shut-in with no production for 16 months prior to the Green Earth stimulation program. Prior to shut-in, its maximum production had been 152 barrels of oil/day. After Green Earth intervention, production rose to 350 bbl.'s/day for a 132% production increase over historical production values and remained open 5 times longer than the best traditional chemical treatments were able to affect.

2. Historical well production figures for well #2 showed that flow had ranged from 92 barrels/day to a maximum of 134 bbl.'s/day but that this well had not been in production since December 1, 2012 when pumping gasoil and wire line work were last and unsuccessfully attempted to re-stimulate the well. After Green Earth treatment the well was successfully brought back to produce 40 barrels oil/day.

3. Well #3 had been in continuous production since 1956 with its last production date of March 2012. Prior to complete shut-down due to paraffin issues this well had produced 50 barrels/day. After Green Earth Paraffin/Asphaltene Remedy had been applied and allowed to soak for 12 hours, production once again registered 50 barrels/day.

Unlike traditional chemicals, Green Earth colloidal solutions keep the paraffin and ashphaltene in suspension.

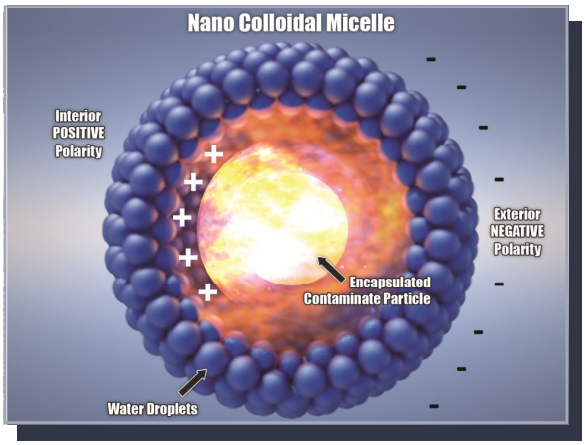
4. Well #4 was completed in 1986 and in 2011 produced 54 bbl.'s/day but by Jan 5, 2012 showed no communication between well and head (*no production*) and was shut-in. Green Earth chemcials were forced downhole and allowed to soak for 4 days. Production resumed after soak and exceeded 150 barrels oil/day for a net production increase of 180%.

5. The last test performed on well #5 in 2010 showed 18 bbl.'s/day production but well was shut-in two months later due to paraffin/wax build-up issues. Green Earth chemicals were injected downhole and allowed to soak for 24 hours. When production was reinstated, well #5 resumed its production of 19 bbl.'s/day and 2 months later without further stimulation was continuing production @ 18 bbl.'s/day.

GREEN EARTH ENERGY SOLUTIONS

Technology Explanation

Micelle are composed of a hydrophobic tail and a hydrophilic head. The hydrophobic tail repels (*dislikes*) water while the hydrophilic head has an affinity (*likes*) with water. The hydrophobic tail attaches itself to the long chain molecules of oils, fats and grease, and the hydrophilic head decreases surface tension in water (*makes the water more slippery*) which in turn allows for easy separation of the oil from the substrate it is attached to.



Green Earth micelle are electrically charged cells that when mixed with water form a colloid. A colloid is a solution (*colloidal solution*) that has particle sizes ranging between 1 and 5 nanometers in diameter yet is still able to remain evenly distributed throughout the solution and will not settle to the bottom. Note that a human hair is ± 80,000—100,000 nanometers.

Benefits That Are Hard To Ignore

- Readily separates long chain molecules making hydrocarbon recovery for resale easy and profitable.
- Solvents easily break down paraffins and asphaltenes in place and allow product to be recovered and sold as a part of the hydrocarbon revenue stream.
- Green Earth products will not contaminate the hydrocarbon stream in any way thereby improving total recovery volumes for resale or disposal.
- Reduced need for extreme heat to perform thereby reducing energy consumption.
- Costly work safe precautions are a thing of the past as no special care is needed when working with these biobased solutions. **Note**; standard safety precautions must be taken when working with any items where particulate matter or hydrocarbon products or by-product odours can cause damage
- Reduced liability and insurance premiums through use of this biobased, readily biodegradable and recyclable product.
- Products can be used with standard operating procedures and cleaning equipment.
- Various Green Earth products can be mixed without concerns of product quality or performance deterioration. See Green Earth for full list of recommendations.
- Performs well at ambient temperature. Improved performance may result with increases to temperatures.
- There are no VOC's (*Volatile Organic Chemicals*)
- Products are non-toxic & non-carcinogenic
- Products are non-flammable
- Products are non-corrosive
- Unopened containers can remain effective as much as 5 years from purchase providing that storage and handling conditions remain at standard ambient room temperature (20 C – 70F).
- Green Earth products DO NOT include; petroleum distillates, glycol ethers, terpenes, chlorines, ammoniates, aldehydes, silicones, Phenolics, Synthetics, Builders & Reagents, Caustics or Metasilicates

Costly work safe precautions are a thing of the past as no special care is needed when working with this biobased solution

GREEN EARTH ENERGY SOLUTIONS

Green Earth Back Story

The Green Earth team brings with it decades of industry experience as suppliers and fabricators to the oil, forestry, agricultural, institutional and manufacturing industries. This has created a knowledge base which helps us understand corporate concerns.

Green Earth products are;

Biobased & readily biodegradable,

Non-toxic & recyclable

Create optimum results.

Green Earth Products

- Perform as well or better than the many caustic chemicals, acids, surfactants, emulsifiers and cleaning agents now in use, but; without the harmful side effects of chemical based products.
- Contain no VOC`s, are non-flammable, non-reactive with other chemistries, recyclable, anti-oxidant by nature and readily biodegradable
- Extend duty times for equipment and machinery service intervals, overhaul schedules and equipment replacement
- Reduce or eliminate disposal fees associated with `business as usual`
- Reduce or eliminate special employee safety procedures needed when working with the many types of chemicals now in use
- Reduce workplace insurance claims and premiums
- Accelerate permitting time and reduce costs for government approvals

We are proud of our line-up of biobased products and eager to demonstrate them to you. Contact us for a free consultation.

The perfect union of nature and man.

Our dedicated goal is to improve the processes, economics and business of working with oils, grease and fats by using only biobased products.

Green Earth products and processes are effective and already being used in the oil & gas, forestry and agricultural industry, as well as hospitality, institutional and transportation segments.

To this outstanding array of proven products, Green Earth adds purpose built equipment for each industry application.

GREEN EARTH ENERGY
SOLUTIONS

www.greenearthenergy.ca