



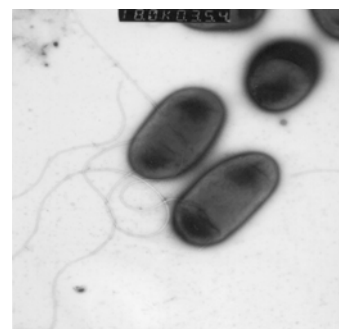
- GBI launches Butane Biostimulation Technologies™ to enhance oil recovery and prevent metal incrustation at production well screens
- GBI utilizes an All Natural Process
- Butane Biostimulation Technologies™ decisively superior to inoculation methods
- The survivability of inoculum in the subsurface has never been adequately demonstrated
- Butane is the most soluble of the gaseous alkanes, having four times the solubility of methane, and more than twice that of propane
- Biostimulation Technologies™ employ air and butane injection to accelerate and enhance oil recovery at production wells
- Butane Biostimulation Technologies™ realize cost savings up to 50 percent as compared to conventional technologies
- Butane injection increases the miscibility of crude oil and salt water thereby inherently promoting enhanced oil recovery and increased oil production

## GBI UNVEILS ANTI-FOULING TECHNOLOGY FOR WATER SUPPLY WELLS AND OIL PRODUCTION WELLS

Chemical and biological incrustation are major causes of decreased well performance and eventual failure. Fouling can be described as well screen clogging and failure due to the growth of iron and manganese bacteria including oxide and hydroxide deposition and incrustation caused by the activities of the iron and manganese bacteria. Iron bacteria produce accumulations of slimy material that has a gelatinous consistency. In addition, they precipitate dissolved iron and manganese. The dual effect of the growing bacteria and the precipitating minerals can plug and close well screen slots within a relatively short period of time.

Iron bacteria, such as Crenothrix, Leptothrix, Gallionella, Clonothrix, and Pseudomonas can change dissolved iron to insoluble ferric iron, which is subsequently deposited in the sheaths of the bacterial cells. The sheaths create a gel-like slime that eventually clogs well screen slots. Some of the known iron and manganese bacteria belong to a class of filamentous bacteria.

Iron and manganese fouling at well screens is a global problem for water and petroleum injection and recovery wells. During an eighteen month pilot study at a hazardous waste site in New England, the dissolved iron concentration in the groundwater was approximately 55 to 60 parts per million (ppm). The operating butane and air injection wells, however, showed no indication of fouling at the well screens.



*Transmission Electron Micrograph of  
Butane-utilizing Bacteria™*

In addition, a shallow water recovery well at the Site, which normally required frequent treatment to clean iron precipitation prior to the implementation of the butane sparging program, remained clear of fouling for the entire study. Since implementation of the field pilot study, dissolved metals precipitation is no longer a problem at the Site in the butane biotreatment zone. The dissolved iron concentration around the butane injection wells dropped to levels between 2 and 5 ppm.

Typical injection wells are used for water supply, groundwater control, solution mining, waste disposal, geothermal energy and to increase oil production. Typical recovery wells are used for groundwater control, capture and treatment, municipal water supplies, domestic water supplies and in the oil and geothermal

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## GBI'S ENHANCED OIL RECOVERY PROCESS

One major application for anti-fouling technology is the petroleum industry. Most of the U.S. oil wells are currently in secondary recovery; that is, the oil no longer flows up a recovery well under natural pressure and energy. It is the energy in natural gas and/or salt water acting under high pressures with the oil that furnishes the requisite force to displace the oil in the subsurface into the recovery or production wells. Today, oil production includes the recovery of oil and salt

water through forced pumping activities (artificial lift methods). The salt water is separated from the recovered oil and is re-injected into the oil-bearing formation through a series of injection wells. The re-injected salt water also assists in "pushing" or "herding" oil remaining in the subsurface toward recovery wells where it is then pumped back to the surface through the forced pumping activities. At the surface, oxygen

*Since butane has the highest solubility of any of the gaseous hydrocarbons, butane enrichment enhances microbial activity by increasing substrate availability.*

*Butane Biostimulation Technologies™ are a low cost alternative to the Vyredox system.*

*Butane Biostimulation Technologies™ never employ inoculation methods which could lead to well plugging.*

## GBI UNVEILS ANTI-FOULING TECHNOLOGY FOR WATER SUPPLY WELLS AND OIL PRODUCTION WELLS (CONT.)

industries.

As a conventional treatment method, oxygenated water is injected into the wells to oxidize iron in solution and promote the growth of iron bacteria so that little iron reaches the production well. For most wells where incrusting material cannot be removed before reaching a production well, caustic chemicals are added to clear biofouling and free the production well screen. These practices are costly, time consuming and require that the production well is brought off-line, thus disrupting service to paying custom-

ers. Most importantly, the chemicals and their toxic fumes may cause serious injury or death to the technicians injecting them into the production well. Other methods to control iron bacteria are heat, explosives, ultrasonics, radiation and anoxic blocks.

Butane injection will also increase the miscibility of oil and water. Butane can be used to reduce fouling at wellheads and to create a miscible flood within the oil-bearing reservoir. This will inherently promote enhanced oil recovery and increase oil production beyond that achievable with con-

ventional treatment methods.



## GBI'S ENHANCED OIL RECOVERY PROCESS (CONT.)

is introduced naturally into the salt water. When this water is re-injected, increased fouling is observed at the injection well screens and is most probably due to the growth of iron and manganese oxidizing bacteria and associated oxide and hydroxide incrustations. The re-injected water contains a higher concentration of

dissolved oxygen. The increase in dissolved oxygen may also accelerate the oxidation of the metal oxides and hydroxides which exacerbates the fouling problem.

GBI's anti-fouling technology will alleviate this problem by preventing the biological component of the fouling process.

Butane injection is a patented, field tested and low cost treatment technology proven effective at abating and preventing metal fouling at injection and recovery wellheads by oxidizing dissolved metal concentrations and immobilizing them from the production and supply routes.

### NO RISK COST SAVINGS

GBI offers water and oil producers "no risk" in-situ bioenhanced treatment technologies guaranteed to increase profitability. Butane Biostimulation Technologies™ will realize producers cost savings as high as 50 percent compared to conventional technologies. Inoculation methods are never employed – the survivability of inoculum has never been adequately demonstrated. Butane Biostimulation stimulates native bacterial populations to enhance metal precipitation on aquifer solids,

thereby reducing soluble metal concentrations which leads to metal incrustation and eventual well failure. Butane Biostimulation enhances indigenous microbial populations, not engineered strains. Butane Biostimulation will rejuvenate shrinking yields and prolong well activity and performance.

