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Oil Release Due To Microbial Actions

Questions arise from the observed increase in oil recovery that occurs as a result of directed microbial growth and reactions in an oil reservoir. Microbial consortia activity within an oil and gas reservoir is a potentially powerful biological system that can profoundly affect the entire reservoir.

The potential for biological influence can best be illustrated by the progressive souring and plugging of massive reservoirs by sulfate reducing bacteria (SRB). But in a similar manner that will affect the entire reservoir beneficially rather than detrimentally, other species of microorganisms can be manipulated and controlled to release trapped oil in significant and economic quantities.

Fundamentally, it must be understood that the *mechanisms* that govern oil release due to beneficial microbial growth are very much the same as the proven and demonstrable chemical and physical effects derived from well known conventional enhanced oil recovery (EOR) methods and products that are introduced at the surface.

However, even though microbial and conventional systems are similar in terms of the oil-releasing mechanisms, they differ significantly in other ways. The unique attributes of microbial systems are not shared by conventional, non-biological systems that rely on massive additions of product at the injection wellhead.

Biological (i.e., microbial) systems instead function *in-situ* throughout the aqueous phase of the reservoir, including the water-rock, water-oil interfaces, and can be deliberately manipulated and directed to *continually produce*—at the molecular and pore level—gases, solvents, surfactants, and other bio chemicals. These bio-products are well known oil-releasing mechanisms that have a chemical and physical affect on the oil.

Key differences between biological and non-biological systems are cited and compared in the following Table:

	Biological System	Non Biological System
1	Self reproducing units: exponential increase in numbers	Continual dilution and depletion of agent
2	<i>Multiple</i> oil mobilizing agents are produced <i>simultaneously</i> : solvents, organic acids, gases, surfactants, etc.	Usually only a single effect is targeted
3	Mobility: cells move by their own actions	Transport is restricted to injection flow patterns

4	Multiple effects are at pore level and in the pore matrix	Action is mainly at the leading edge of chemical injection
5	<i>Continual in-situ</i> production of oil-releasing <i>agents in all directions</i> from each cell	<i>No in-situ</i> production of agents
6	<i>In-situ</i> utilization of native reservoir constituents	Less favorable interaction with reservoir constituents
7	Superior economics of microbial oil recovery are achieved by the addition of low cost amendments	Threshold and continuing project costs are often prohibitive

The question often asked concerning the ability of microbial cells to release significant quantities of trapped oil is: “*how can something so small have any affect at all on oil production?*” It is a valid question. The answer is: **NUMBERS**; massive numbers of targeted beneficial microbes that produce oil-releasing chemicals and gases during their metabolic life cycle.

More microbes=more gases and chemicals=more oil

The scientific enumeration of these microbes can easily be determined using various techniques; in particular, the serial dilution method. A typical population number of the beneficial microbes in oil reservoir water *before* specialized proprietary nutrient treatments is on the order of two *million* microbes in each barrel of water (42 gallons), whether injected from the surface or already present in the reservoir.

In response to the addition of critical nutrients, these incredible organisms quickly expand in number to 15 *trillion* cells per barrel of water. Importantly, this huge population of cells is positioned in the reservoir at the microscopic pore level of oil-water-rock interface where oil is trapped.

The resulting abundance of bio chemical and gas metabolic byproducts has a profound affect, dramatically upsetting the capillary and interfacial tension forces that trap oil. Oil is released and swept toward the production wells by the mobilizing force of the waterflood, and the process is perpetuated by the continual addition of nutrient product that keeps microbial populations at their peak. In comparison, even though the mechanisms of oil release are similar, conventional non-biological recovery systems can be restrictive as shown in the Table.

It must be emphasized that all the events caused by microbial growth and action will occur *within* the pore matrix, at the molecular pore level, and that such action occurs in all directions simultaneously. The production of bio chemicals and gases *must* occur, as they are the undisputed result of microbial cell growth and metabolic function. The recognition that it is possible to direct and manipulate certain microbial species within the reservoir for beneficial purposes has enabled The LATA Group organization to develop and introduce various oil recovery technologies, products, and applications.

Bio-Competitive Exclusion (BCX) Technology

This oil-releasing/sulfide-destroying biological system has proven its effectiveness in the field and is initiated and sustained by the injection wellhead addition of low cost, award-winning **Max-Well 2000** nutrient products. It functions in-situ as previously described, i.e., continually stimulating targeted *indigenous* beneficial anaerobic microorganisms to produce chemical and physical oil-releasing agents. Importantly, this modification of the reservoir microflora has a concurrent effect of repressing SRB activity and respiration of sulfate, resulting in a significant reduction or total elimination of H₂S/iron sulfide production. The BCX process is used in medium-to-high gravity oil recovery and sour well remediation.