New, Low Cost Technology for Sulfide Control and Increased Oil Recovery
The LATA Group
Petroleum Technologies

Scientific Expertise

Practical Applications

Max-Well Flooding: Tertiary IOR, H2S Removal
Innovative Bio-Technologies

Geo-Microbial Technologies

International Oil & Gas Exploration

Bio-Technology Pioneers Since 1954

Waste Water Systems

Environmental

Bio-Reactor

Heavy Oil Recovery

BCX Improved Oil Recovery

Dual Benefits

R & D:
- Industry
- DOE, DOD, EPA

Eliminate H2S

Heavy Oil Recovery

Bio-Technology Pioneers Since 1954

H2S

R & D:
- Industry
- DOE, DOD, EPA
Bio-Competitive Exclusion (BCX) and Max-Well 2000
The Problem:

Reservoir and Production System \( \text{H}_2\text{S} \) Souring
Global reservoirs and production systems are contaminated with H₂S and iron sulfide solids (FeS)

SRB-generated H₂S is the cause

Biocide control is often ineffective

Effective nitrate-based process developed during last 20 years
The Source of Sulfide

Biogenic $\text{H}_2\text{S}$ is produced by the reduction of sulfate in the water by Sulfate-Reducing-Bacteria (SRB).

$$\text{SRB} + \text{SO}_4 + \text{VFA} \text{ (soluble organics)} + \text{Favorable Growing Conditions} \rightarrow \text{H}_2\text{S}$$
Major Effects of Biogenic Sulfide Generation in Oil Field Operations

1. Health and environmental hazard
2. Increased H$_2$S gas content
3. Iron sulfide scaling/plugging
4. Increased corrosion
5. Increased cost of corrosion resistant material
6. Loss of production
7. Lower oil and gas revenue
FACT: $\text{H}_2\text{S}$ levels will continue to increase until a limiting growth parameter has been reached!
The Solution
Effects are Initiated and Sustained by Patented Nitrate-Based Formulae

BCX *stimulates* beneficial indigenous Nitrate Reducing Bacteria and *stops* harmful Sulfate Reducing Bacteria

Stop Corrosion

Production System

Max-Well 2000 Nutrients

Sweet Oil/Gas

$\text{H}_2\text{S}$
Without Treatment

SRB use VFA and SO$_4$ to make H$_2$S
Initiate Treatment

NRB outcompete SRB for VFA; treatments inhibit SRB and degrade existing H\textsubscript{2}S
With Treatment

NRB Use VFA and metabolize Max-Well product
System is sweetened
Bioproduction of N₂, CO₂, H₂, CH₄, surfactants, solvents
Anaerobic Laboratory Tubes

1 Month after Inoculation with California Produced Water Inoculum

Max-Well Treated: No Sulfide
Untreated: H₂S and Iron Sulfide
Comparison of Max-Well Formulations to Nitrate Only

Sulfide Suppression in Anaerobic Produced Waters

Day 4 Incubation

<table>
<thead>
<tr>
<th></th>
<th>100ppm Max-Well</th>
<th>75ppm Max-Well</th>
<th>100ppm Nitrate Only</th>
<th>Untreated Control</th>
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</thead>
</table>

Day 53 Incubation

<table>
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<th>70ppm Max-Well</th>
<th>50ppm Max-Well</th>
<th>100ppm Nitrate Only</th>
<th>Untreated Control</th>
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</table>
The Results

- Continuous and permanent blocking of hydrogen sulfide production
- Elimination of existing $\text{H}_2\text{S}$ in the production system
- “Green” chemical components are environmentally safe
Results, continued

- The process/products are very low cost
- Increased oil recovery
- Field proven
Field Storage of Max-Well Product

A typical low-cost field installation for product storage.

Shown is a 6,500 gallon tank with a high pressure chemical pump.
H$_2$S Control: Field Examples
25,000 BWPD Pipeline

![Graph showing H2S ppm dissolved in water over time with clear indicators for treatment and well adjustments.]

- **Begin treatment**
- **Reduce Max-Well**
- **Increase Max-Well**

**Graph Details:**
- **X-axis:** Dates from 30th Jan to 2nd Mar
- **Y-axis:** H2S ppm dissolved in water
- **Legend:**
  - Blue line: Upstream of Treatment
  - Pink line: Pipeline Terminal
Produced Water Surface Plant
200,000 BWPD

Kern County, California Water Plant Project:
H₂S Control

Five Months Trial Period
Max-Well 2000 Treatments

Dissolved H₂S ppm

02-Aug-02  01-Sep-02  01-Oct-02  31-Oct-02  30-Nov-02  30-Dec-02  29-Jan-03  28-Feb-03  30-Mar-03  29-Apr-03

Start
Stop

S-8
China Project

China Satellite Plant: H$_2$S in Produced Water

![Graph showing dissolved H$_2$S ppm over time with a peak and decline followed by an increase after a certain date. The graph highlights the start of Max-Well Treatments.]
Max-Well Treatment of West Texas Oil & Gas Production Well

- May 15: Max-Well Single Slug Treatment
- End of Trial

Graph showing H₂S ppm from May 15 to October 28, 1996.
Repairs Reduced: Oklahoma Oil and Gas Well Treatment

Oklahoma Gas Well: $\text{H}_2\text{S}$ and Repairs

- **H$_2$S ppm**
- **Total Well Repairs**

**Years**
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005

**Start Max-Well Treatments**
Full Field H$_2$S Gas Reduction

California Gas Plant: H$_2$S ppm per day

20% H$_2$S Gas Reduction in 250 Wells

Begin Max-Well treatments: July 1, 2004

Pre-treatment trend
Full Field H$_2$S Mass Reduction

California Gas Plant: H$_2$S Mass % in the Produced Gas Stream

Max-Well Treatments Begin: July 1, 2004

30% Reduction in H$_2$S Mass in 250 Wells

Percent

H$_2$S LBS % in Gas Stream
H$_2$S LBS % in Gas Stream Trend
Expon. (H$_2$S LBS % in Gas Stream Trend)
Improved Oil Recovery
Enriched NRB produce metabolites in situ which mimic the effects of conventional IOR methods, but at very low cost.
An *In Situ* Factory of Bio-IOR Products

- Mobilizes residual oil
- Increases oil recovery
- Eliminates H$_2$S corrosion

Gases: N$_2$, CO$_2$, CH$_4$

Surfactants, Solvents
Oil Mobilization

BEFORE TREATMENT

START TREATMENT

WATERFLOOD

RESERVOIR MATRIX

OIL DROPLET

SRB/SULFIDE

NRB

Treatment Formula

NRB BIOPRODUCTS:
GASES, SURFACTANTS,
& SOLVENTS

AFTER TREATMENT: OIL IS MOBILIZED, \( \text{H}_2\text{S} \) IS REMOVED
IOR: Field Examples
Waterflood Production Example #1

U. S. Production Well #1: BOPD

- **Begin Max-Well Treatment**

![Graph showing BOPD and Oil Slope](chart.png)
Waterflood Production Example #2

U. S. Production Well #2: BOPD

Begin Max-Well Treatment

BOPD

BOPD

Oil Slope
Waterflood Production Example #3

U. S. Production Well #3: BOPD

Begin Max-Well Treatment
Current US Oil Recovery Project

Client has documented 54,000 BBLS of Oil Increase

Max-Well Treatment Begins

BOPD


BOPD  Decline Curve
(Client generates decline curve)
Current US Oil Recovery Project

Max-Well Treatment Begins

Client has documented 32,000 BBLS of Oil Increase

BOPD


(BOPD) BOPD  (Decline Curve)
(Client generates decline curve)
Improves the Entire Production System

Surface Systems
• Eliminates $H_2S$ Corrosion
• Eliminates $H_2S$ Toxicity

Production Wells
• Residual oil recovery
• Stops FeS Plugging
• Controls $H_2S$
• Reduces pulls, parts replacement

Nutrient Formulae
• Stimulate Beneficial Microbes
• Inhibit SRB activity

Reservoir Treatment
• Produces IOR agents in situ
• Reduces FeS & Corrosion
Conclusions

- Biogenic H$_2$S pollution is eliminated at its source

- The necessity for the production, transport, and use of hazardous biocidal chemicals can be reduced
Conclusions, continued

- Noxious and dangerous $\text{H}_2\text{S}$ gas emissions are eliminated
- $\text{H}_2\text{S}$ contamination of oil and gas natural resources is cleaned and prevented
Conclusions, continued

- The value of sweet oil and gas is retained
- Iron sulfide plugging of reservoirs and equipment is eliminated
- Oil production is increased
Conclusions, continued

- Equipment infrastructure corrosion costs are reduced
- Human health and safety conditions are greatly improved
Field Projects

- Numerous during the last 10 years

- Projects completed or ongoing in:
  - Wyoming (Teapot Dome)
  - Oklahoma (Independents)
  - Kansas (Independents)
  - Texas (Independents)
  - California (Majors)
  - Canada (Majors)
  - China (Major)
Very Low Cost

• Low Front End Cost
• Low Max-Well Product Cost
• Lower Operating Costs
• Low Manpower
• Safer, Cleaner System
• High $$$ Return Ratio
Presented by:

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