# IRT Newsletter

## Fall 2017

International Reservoir Technologies, Inc.

Our mission is to provide the highest quality engineering and geoscience consulting services to the petroleum industry in a creative, technologically rigorous, ethical, and cost effective fashion.

***"Slowly but Surely" is the mantra for 2017!***

As the industry recovers from the fall in oil prices, many companies are realizing that stability has returned to market and they are starting to pursue development of newly acquired or existing properties.

Let IRT assist you with any subsurface needs you may have. With the continuing oil price recovery, it is time to re-evaluate and dust-off those projects that have been deferred or downsized. IRT feels that there is no better time than right now to look into the feasibility of any Enhance Oil Recovery ( EOR) project you may be considering.

***Ethane EOR Update***

Industry estimates of nearly 400 billion barrels (BBbls) of remaining oil in place (ROIP) is one of the reasons behind using Ethane EOR as a miscible injectant.

Why Ethane and not CO2? The supply of CO2 is limited by geographic area and Ethane is now abundant throughout the U. S. and very cheap. Not only is Ethane a better solvent than CO2 for EOR injection with lower miscibility pressure, Ethane does not present the metallurgical issues that arise with CO2.

Ethane could recover an additional 15-25% of the remaining oil. Ethane can also improve oil recovery in tight oil reservoirs and many of the unconventional reservoirs that are active today.

IRT sees great potential using Ethane with a substantial return on investment for many reservoirs screened to date. Below are two examples.

**Cushing Field, Oklahoma**

Only the southern end of Cushing Oil Field was evaluated, or about 20% of the Bartlesville Sand reservoir. A screening template of 16 reservoir parameters (depth, porosity, oil API, etc.) is used to assess an Ethane EOR project. The screening parameters are put into a stop-light matrix of Good (green), Caution (yellow), and Warning (pink) categories depending on each individual parameter. Parameters that fall into the Caution and Warning categories are not "show-stoppers" but simply mean that additional analysis is necessary.

Of the remaining 220 MMBO in this portion of the Cushing Field, about 55.5 MMBO is estimated to be recovered through Ethane EOR (assumes Ethane recovers 25% of the ROIP). Assuming a net oil price of $27 per barrel (after tax, royalty, and operating expenses), the EOR prize is quite substantial ($1503MM).

### Cushing Screening Data

| | | Good / Caution / Warning |
|---|---|---|
| Depth | ft | 2800 |
| Oil Gravity | API | 38 |
| Solution Gas | Pb/Pi | UNKNOWN |
| Temperature | degF | 108 |
| Permeability | md | 250 |
| Net Pay | ft | 100 |
| Remaining Oil Sat | v/v | 55% |
| Oil Viscosity | cp | 5 |
| Water Cut | % | 99 |
| Heterogeneity | | UNKNOWN |
| Compartments | | UNKNOWN |
| Dual Porosity | | Single |
| Distance to NGL | miles | 18 |
| Distance to Gas Plant | miles | 33 |
| OOIP | MMstb | 1568 |
| Recovery Factor WF | % | 29% |
| | | |
| Remaining | MMstb | 1110 |
| Remaining | MMstb | 222 |
| EOR Target Oil | MMstb | 55.5 |
| **EOR Prize** | **$MM** | **1503** |
| | | |
| **Gross Utilization** | Mscf/stb | 3.75 |
| MI required | Bscf | 208.1 |
| 15 yr MI compression reqd | MMscf/d | 38.0 |
| **Net Utilization** | Mscf/stb | 1.64 |
| MI required | Bscf | 91.0 |
| 15 yr MI purchase rate | MMscf/d | 16.6 |

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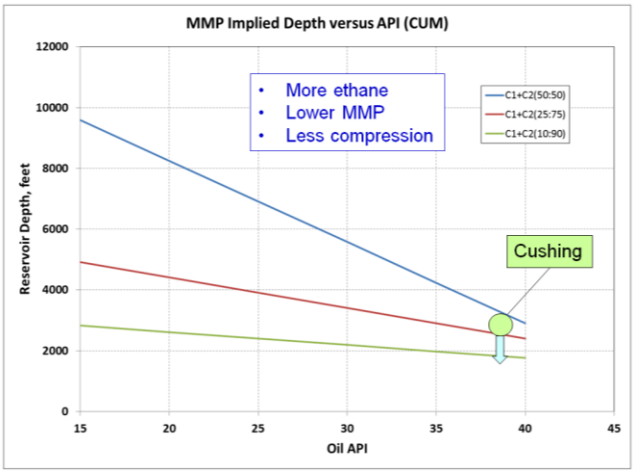
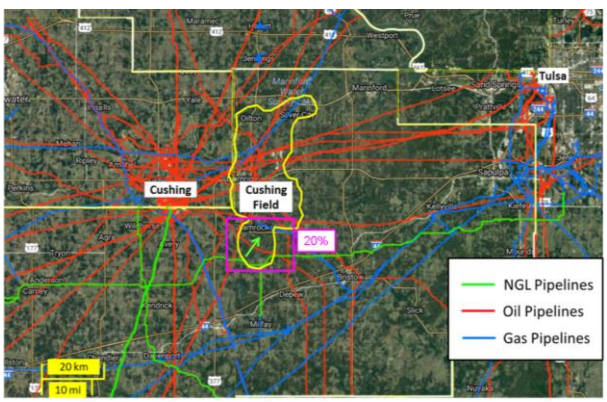
A plot of oil API versus reservoir depth is used to estimate the miscibility pressure and the amount of Ethane enrichment needed to maximize recovery. A shallow depth of around 3000 feet for the Cushing Field suggests about 60-65% Ethane enrichment is required for this reservoir. Lower injection pressures require even more additional Ethane enrichment (blue arrow).

### Ethane Blending vs Compression




The map for Cushing Field shows the location of all pipelines, with the location of the nearest NGL (green) and gas (blue) pipelines needed for the miscible injectant. All pipelines are just a short distance from this portion of the field.

### Cushing Map Showing Pipelines




**House Creek Field, Wyoming**

The Sussex Sandstone reservoir of House Creek is much deeper and hotter than the previous Cushing example. A successful waterflood has recovered 31% of the original oil in place, which leaves 109.1 MMBO remaining. IRT estimates that an additional 27MMBO can be recovered by Ethane (25% of ROIP) which gives an EOR prize of $780MM (assuming a net oil price of $29 per barrel).

### House Creek Screening Data

| | | Good / Caution / Warning |
|---|---|---|
| Depth | ft | 8111 |
| Oil Gravity | API | 36 |
| Solution Gas | Pb/Pi | UNKNOWN |
| Temperature | degF | 176 |
| Permeability | md | 6.9 |
| Net Pay | ft | 14 |
| Remaining Oil Sat | v/v | 0.51 |
| Oil Viscosity | cp | 1.1 |
| Water Cut | % | 87% |
| Heterogeneity | | 0.88 |
| Compartments | | >Spacing |
| Dual Porosity | | Single |
| Distance to NGL | miles | 0 |
| OOIP | MMstb | 159 |
| Recovery Factor | % | 31% |
| | | |
| Produced | MMstb | 49.9 |
| Remaining | MMstb | 109.1 |
| EOR Target Oil | MMstb | 27.3 |
| **EOR Prize** | **$MM** | **780** |
| | | |
| **Gross Utilization** | Mscf/stb | 3.75 |
| MI required | Bscf | 102.3 |
| 15 yr MI compression reqd | MMscf/d | 18.7 |
| **Net Utilization** | Mscf/stb | 1.64 |
| MI required | Bscf | 44.7 |
| 15 yr MI purchase rate | MMscf/d | 8.2 |

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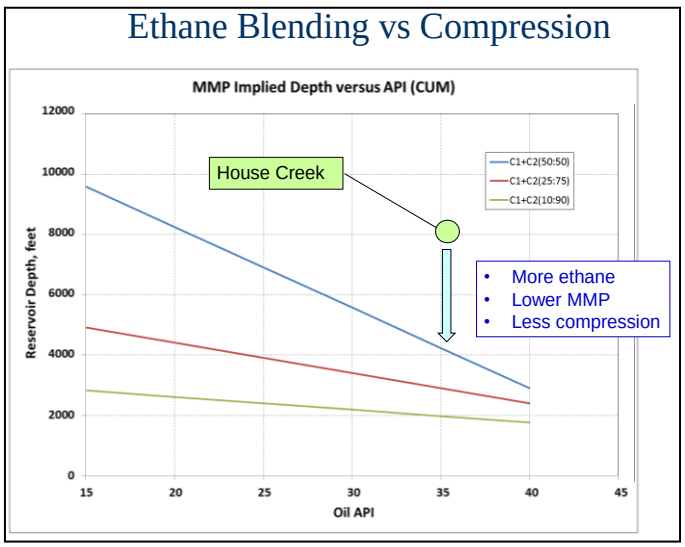
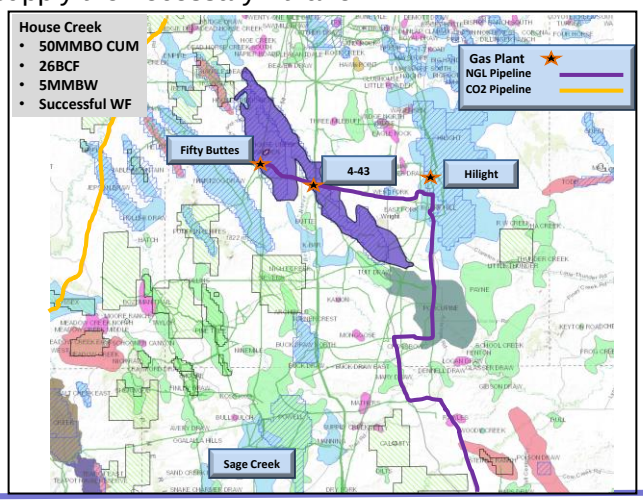
Due to the deeper depth, the injectant would require much less Ethane enrichment to achieve miscibility at House Creek (20-30%) compared to the previous Cushing example.




The blue arrow on the plot again shows that lower compression and flood pressure requirements require a higher percentage of Ethane to achieve miscibility of the enriched injectant.

The map below shows the location of House Creek Field, which has an NGL pipeline (purple) as well as several gas plants (orange stars) nearby that could supply the necessary Ethane.




**Ethane EOR Screening Offer**

IRT is offering free screening of your potential Ethane EOR reservoirs. The screening template of 16 reservoir parameters (depth, porosity, oil API, etc.) is evaluated for Ethane EOR. The screening will estimate the remaining EOR prize and the amount of miscible injectant needed.

If Ethane EOR looks promising, then a phased approach is recommended to further refine the Ethane EOR potential:

1. Mechanistic Model: 1 injector and 1 producer model to refine recovery factor, gross and net injection efficiency, and estimate an initial return on investment (ROI) for the project.
2. Type Pattern Model: 2 or more injectors with offset producers to develop a more detailed geologic description that would help design a future field test or pilot area for Ethane injection.
3. Full Field Model: If the Type Pattern model and potential field test prove successful, the final step is to develop a full field development plan by creating both a static and dynamic reservoir model using the best petrophysical, geologic, and engineering information available. The final reservoir model is calibrated to historic field production data and creates a base case field development plan for Ethane EOR.

All data sent to IRT for the initial screening offer will be held in strict confidentiality and could provide your company with valuable information for any future EOR project.

For further information, please contact:

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**http://www.irt-inc.com/eor-more-information.html**