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OIL & GAS CONSULTING

UPSTREAM & MIDSTREAM PIPELINES AND FACILITIES

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Oil Transportation Basics

Moving Oil from Point A to Point B

As environmental mandates have required different regional and seasonal qualities of gasoline, the required batching for transport and segregation for storage has increased substantially. The logistics flexibility inherent in a product's interchangeability – the ability to substitute one shipment for another, to exchange between regions, for instance, has all but disappeared. While this is invisible to consumers during normal times, it contributes to market upheavals and price spikes due to supply and demand. There are two basic modes of transportation for oil: tankers and pipelines. Tankers have made global transport of oil possible, and they are low cost, efficient, and flexible. Pipelines, on the other hand, are the mode of choice for transcontinental oil movements.

Tankers

Not all tanker trade routes use the same size ship. Each route usually has one size that is the clear economic choice. The comparison is based on trip length, port & canal constraints and volume. Typically crude exports from the Middle East – high volumes that travel long distances – are moved mainly by Very Large Crude Carriers (VLCC's). The VLCC's economy of scale outweigh the constraints imposed, i.e. they are too large for most ports in the US except the Louisiana Offshore Oil Port (LOOP). They must have some or all of their cargo transferred to smaller vessels, either at sea (lightering) or at an offshore port (transshipment). In contrast, ships out of the Caribbean and South America are routinely smaller and enter ports in the US directly. Because of such ship size differences, a long voyage can sometimes be cheaper on a per barrel basis than a short one.

Pipelines

Pipelines are critical for landlocked oil and also complement tankers at certain key locations by relieving bottlenecks or providing shortcuts. The only inter-regional trade that currently relies solely on pipelines is crude from Russia to Europe. Export pipelines are also needed for production from the Caspian Sea region, where the protracted commercial and political debate illustrates the greatest negative for pipelines crossing national boundaries – their political vulnerability.

Pipelines come into their own in intra-regional trade. They are the primary option for transcontinental transportation, because they are at least an order of magnitude cheaper than any alternative such as rail, barge, or road, and because political vulnerability is normally a small or non-existent issue within a nation's border or between neighbors such as the United States and Canada.

The development of large diameter pipelines during World War II allowed the development of the vast pipeline network in the US that moves crude oil and product within Canada, from Canada into the US, and within the US. The US also relies heavily on pipelines to transport petroleum products from refining centers, such as the Gulf Coast, to consuming regions, like the East Coast.

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Flaring Issues

<u>Overview</u>

Flaring by the petroleum industry has been receiving allot of attention lately by regulators, communities, and environmental interests. Issues associated with flaring include local health and welfare concerns, claimed global climate change, and the potential loss of revenue from consumption of a natural resource.

Health and welfare and climate change concerns are closely related to flare efficiency. To help avoid local health and welfare impacts and minimize gas emissions, a flare should efficiently convert its hydrocarbon feed to the intended products – carbon dioxide and water.

<u>Recommendations</u>

The following recommendations, in roughly prioritized order, provide guidance for assuring high flare efficiencies and minimizing the environmental impacts of flares:

1. Avoid flaring wherever possible. Look for opportunities to recover and use gas. (Exception – flaring is generally preferable to uncontrolled venting.)
2. Assure that flares are lit when in use. From a greenhouse gas standpoint, one day of emissions from an unlit flare (i.e., a vent) is equivalent to about eight days of emissions from a lit flare.
3. Provide flares with adequate knock-out / liquids separation to remove all of the hydrocarbon droplets from the gas. Liquid carry-over is the major cause of flare inefficiency.
4. Give special consideration to low-Btu gases.
   - Gases with heating values below about 300 Btu/ft^3 (11.2 MJ/m^3) are prone to inefficient combustion. If possible, these gases should be combined with higher heating value streams before flaring.
   - Gases with heating values from about 300 Btu/ft^3 (11.2 MJ/m^3) to 800 Btu/ft^3 (30 MJ/m^3) are susceptible to inefficient combustion under high wind conditions. Flares for these gases should be located so to minimize wind impacts and/or equipped with wind guards to protect the flare tip, and should be designed to assure sufficient stack exit velocity to provide stabilization against the wind.

5. Gas streams containing primarily hydrocarbons, with heat contents of about 800 Btu/ft^3 (30 MJ/m^3) or greater, will usually burn efficiently even under high wind conditions. Nonetheless, if possible, location to avoid high wind exposure is preferable.
6. Where feasible, soot should be controlled, as by air or steam injection. Alternatively, flares can be designed to operate smokelessly with high pressure, high exit velocity "sonic" flare tips. Soot is undesirable from a visual standpoint and, consisting of highly condensed hydrocarbons, could potentially present a human health impact. However, even in sooty flames, soot typically represents a very small fraction of the hydrocarbon feed, and does not significantly influence overall flare efficiency.
7. Locate flares to minimize impacts, real or perceived, on the surrounding community.

The term "flare efficiency" refers to the percentage conversion of the carbon in the hydrocarbon feed to a flare to carbon dioxide.

Upstream Revenue Development for Modeling

In upstream development projects the subsurface team's role is to provide estimates of the recoverable volume of the hydrocarbon accumulation, the types of hydrocarbon expected, and the rate of extraction for alternative well configurations and production facilities.

For cost modeling, ultimate hydrocarbon recovery or production uncertainty often appears at or near the top of project value tornados indicating it to be one of the largest project economic risks. For this reason, mischaracterization of the uncertainty range for ultimate hydrocarbon recovery or production, particularly if the potential low end of the distribution is not recognized can lead to significant value erosion.

Also because understanding of resources and production rates is assumed to be a core competency of an oil and gas company, poor prediction of volumes is significantly punished by the market.

It is important to consider the optimal rate of developing a project and bringing new facilities on production. Project analysis through benchmarking has determined that meeting early time production forecasts is not something the oil and gas industry has historically performed well.

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To place this in context, a five percent shortfall in production attainment (which is defined by actual versus the projected production for the months seven to twelve of a project) for a typical upstream project is equivalent to a 25% acceleration of the project schedule, a 7% facilities cost reduction or a 17% well construction cost reduction. This is one example of how important correctly assessing ultimate hydrocarbon recovery, production and the ability to fill a facility in a timely fashion is to project economics.

The above illustrates the importance of developing probabilistic forecasts of production and ultimate hydrocarbon recovery that portray a realistic picture of reservoir performance and our degree of confidence in the estimates.

A robust and experienced reservoir management team's production forecasting process can help the upstream development teams accomplish this goal. Use of a structured process can help project teams:

- Avoid bias which leads to unrepresentative views of a project's uncertainty
- Properly assess uncertainty ranges
- Ensure that forecasts are representative of the quantity and quality of information available to the team

A strong subsurface representation in the decision analysis model enables a good economic analysis of the alternatives.

Building a tornado diagram using a single production metric (e.g., maximum rate or NPV of annual production) for the value axis assists in identifying key inputs that control production outcome.