Facilities Cost Estimates Drivers in the Oil and Gas Field Development.

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Abstract

The paper reviews the drivers of oil and gas cost estimate and facilities concept selection. It explores the effects of varying fluid composition can have on the development concept, processing facilities and cost impact. Analysing and interpreting reservoir data and fluid composition is time -consuming exercise and remains a challenge with inherent risks and uncertainty in the outcome results.

However, adequate analysis and understanding of the reservoir fluid composition is the driving factor and solid rock on which every field facilities development can be successful. This paper brings a clear understanding of the driver of oil and gas field development concept cost, This includes the various cost associated with developing various types of reservoir fluid composition such as Carbon Dioxide (CO_2), Hydrogen Sulphide (H2S) and Mercury (Hg) and the areas of uncertainty with respect to estimating the cost. An example of an estimate for a typical processing facility of different reservoir composition is provided. Cost comparisons are made between each development concept estimate to show cost variance along with an overview of the variances and their causes. Conclusions and recommendations for improving the quality of field development oil facilities cost estimates are provided.

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Oil and gas reservoir

An oil and gas reservoir is a porous and permeable subsurface sedimentary (buried underground) rocks formed millions of years ago with a trap and a seal which stores a naturally occurring hydrocarbon/crude generated from a source rock (the kitchen) which is low in permeability and not capable to store the hydrocarbon, hence the hydrocarbon migrates to a reservoir rock.

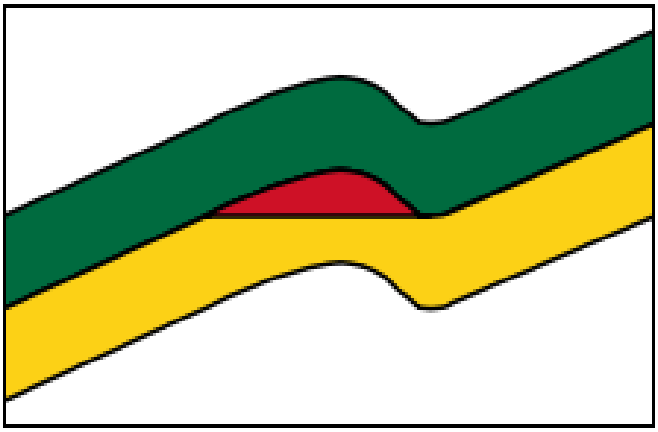

Figure 1

Figure 1 showed a schematic reservoir structure with trapped hydrocarbon.

Reservoir fluid composition

Reservoir fluid is a mixture that comprises organic compounds and non-organic gas, dissolved salt from underlying aquifer etc. The composition defers across geographical region which largely depend on organic matters depositional environment, formation, reservoir pressure and temperature.

Classification of hydrocarbon fluid composition:

Sweet crude – Little (less than 0.5%) or no sulphur content

Sour Crude- Contains sulphur, greater than 1% and contains carbon dioxide. (Venezuela)

Light crude – high API, 32-42 API degrees

Medium crude- low API, less than 22-31 API degrees

A hydrocarbon could be categorised as light and sweet, light and sour, heavy and sweet, heavy and sour etc. depending on the fluid composition and the fluid viscosity.

Field development

Oil and gas field facilities development is the third stage in field development process after exploration and reservoir data evaluation is completed. At this stage an adequate development facilities concept and material are selected based on the reservoir fluid composition analysis result and the fluid content risk to production and sales quality.

A reservoir fluid composition containing non-organic gas such as CO_2, H_2S and Hg forms the basis of field development concept selection and drive cost. The cost to develop a field with these gases cost more when compared with burn light crude.

Oil processing facilities cost driver

Oil and gas facilities concept selection and development entirely rely on the understanding of fluid composition and type. The hydrocarbon is nature's gift and the composition can't be changed. Companies are only left to explore options to produce with a profitable margin as much as reasonable practical in lieu of the development cost.

Crude Oil type and category

West Texas Intermediate (WTI); light, sweet crude with an API gravity of 39.6 degrees It contains 0.24% sulphur with a specific gravity of 0.827

Brent Crude; from the North Sea; a light, sweet crude with an API gravity of 38.06, sulphur content is 0.37%.

Dubai Crude; light and sour, with an API gravity of 31 degrees and a specific gravity of 0.871. Its sulphur content is 2%, making processing equipment more expensive because of the sulphur content.

Bonny Light; Bonny light comes from Nigeria and is a light, sweet oil. It has an API gravity of 32.9 and a sulphur content of 0.16%, low field development and processing cost.

API Gravity is a measure of how heavy or how light a petroleum liquid is compared to water. If its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks. Most values fall between 10 and 70 API gravity degrees.

The cost of processing facilities and refining predominantly depend on the above reservoir fluid composition, light and sweet crude composition is more cost –effective in terms of cost of material selection, and number of processing unit to remove sulphur, mercury etc. Whereas cost of crude desulfurization and mercury removal make processing, corrosion inhibition and refining of sour crude to required specification for sale make more expensive adding significant cost impact on a development processing facilities concept.

Facilities Material Selection.

Mainly carbon steel material is required to process a light and sweet crude whereas a stainless steel material would be used for a sour fluid increasing the material cost by a factor of 1.7

Example Oil processing facility cost trend based on fluid composition

For example, the processing facilities cost to produce a total reserve of 54 million barrel of oil equivalent (MMBOE) would differ in different geographical location based on fluid composition.

Sweet Crude (less sulphur content)

Let assume the installed facilities cost to produce a sweet crude of the above reserve is $37million.

Sour Crude (higher sulphur content)

The installed facilities cost for a sour crude of the same reserve would probably increase by 15% as a result of the cost stainless steel totalling (1.15 * $37 million) = $42.55 million.

Let assume as sour crude Sulphur removal facilities cost impact of 10% of total installed cost = $46.81 million

Let's assume a mercury removal facilities cost impact assuming 5% of total installed cost = $49.15 million.

Let assume it would cost $49.15 million to develop a sour crude oil processing facilities against $37 million for sweet crude. The cost increase would be $12.15 million or 24.72% increase.

Facilities development Cost impact

Sweet Crude Facilities cost	**Sour Crude Stainless Steel material Cost Cost 15%**	**Sulphur removal facilities 10%**	**Mercury content removal Facilities 5%**
$37 M	$5.55M	$4.26M	$2.34M

Table 1

Table 1 showed the assumed facilities for producing and processing a 54 MMBOE of a sweet crude and also showed the increasing cost of processing a sour crude of the same volume based on the fluid composition.

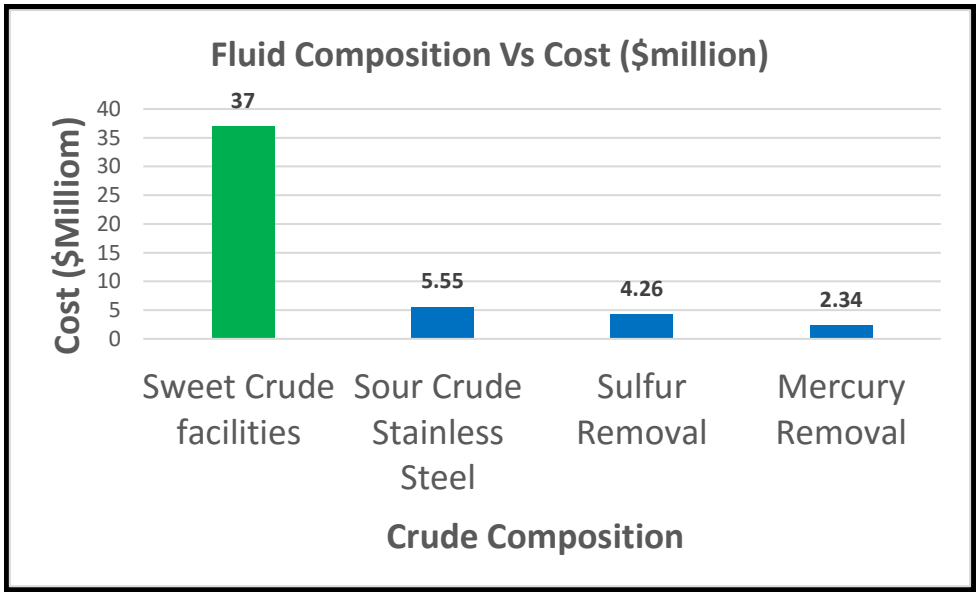

Figure 2

Figure 2 showed the facilities cost comparison for sweet and sour crude cost impact due to cost of stainless steel, sulphur and mercury removal.

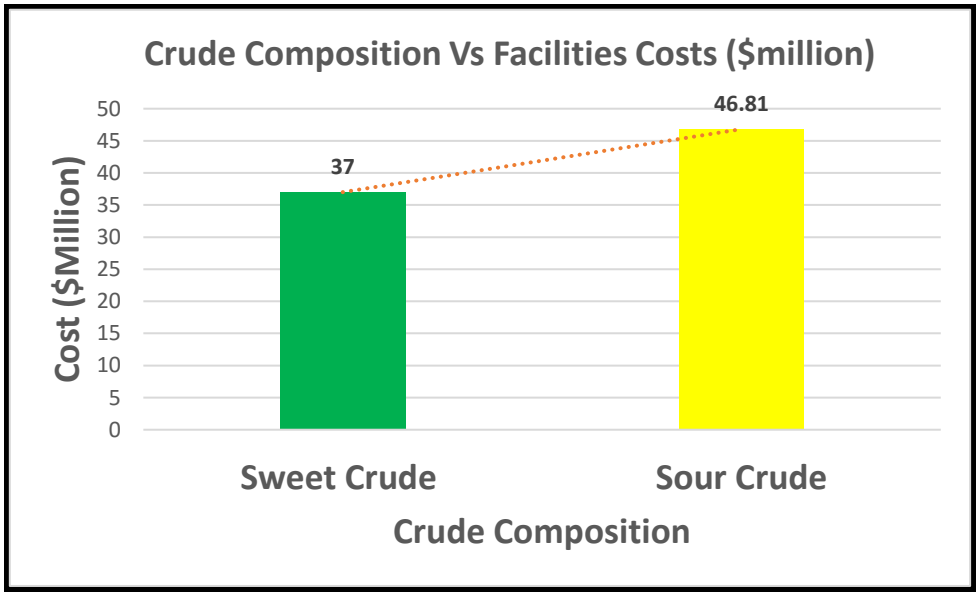

Figure 3

Figure 3 showed the total facilities cost for the sweet crude compared with sour crude. The increase in sour facilities cost is driven by the stainless steel, sulphur and mercury removal cost.

Table 1 showed the assumed facilities for producing and processing a 54 MMBOE for a sweet crude and also showed the increasing cost of processing a sour crude of the same volume based on the fluid composition.

Conclusion

Obviously, the reservoir fluid composition is the major driver of the oil and gas field facilities development and will continue to be the basis of oil and gas facilities concept selection and cost estimate for a successful field development as processing equipment cost remains significant part of capital and installed costs irrespective of the development concept.

Recommendation

First, understand the reservoir fluid composition to underpin facilities concept selection and project cost estimating. Ignoring effort to understand a reservoir fluid causes a ripple effects in an oil and field development leading to project recycle and increasing cost impact.

Reference

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