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Waste Fluid Disposal vs. Oil and Gas Production in Western Canada - Compare and Contrast: Drilling, Completions, Regulations and Reservoirs

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Hydrocarbon production and waste fluid disposal; you can't have one without the other. By being joined at the hip in Western Canada, these two segments share obvious striking similarities. But stark differences in how wells are drilled, evaluated and operated, regulations governing each, and reservoir requirements to meet the needs of each will be discussed.

After 30 years of broad geological, land, regulatory, reservoir and operations experience in oil and gas, primarily in Western Canada, Kim Kingsmith started a new 14 year career in fluid disposal with Secure Energy. Over the past 4 years, Kelly Kingsmith has been going through the same process in his current position with Secure Energy. It is this transition experience that will be discussed, and give examples of why knowing everything about oil and gas may still result in a steep learning curve to master the niche nuances of disposal.

It may be best to first point out the SIMILARITIES between the two.

Both require a detailed understanding of the geological formation, the depositional environment, the facies and the structure. However, the reasons are slightly different. In oil and gas this detailed technical review is required to find the hydrocarbon traps within that formation. In disposal it is required to stay away from the hydrocarbon traps and find the areas of highest pore volume and best reservoir quality in an otherwise wet reservoir.

Both require a detailed understanding of the reservoir parameters. Over the past decade, oil and gas has been developed in and produced from primarily unconventional reservoirs with low permeability ranging to less than one millidarcy (mD). Disposal requires significantly higher permeability, generally 15 mD and higher, regardless of whether vertical or horizontal wells are being used for disposal.

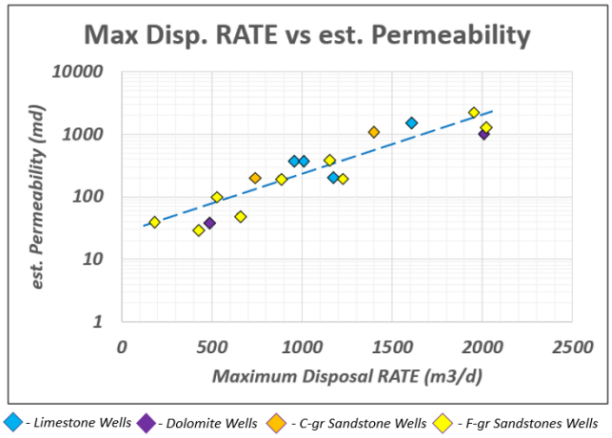
It is the DIFFERENCES between the two that are the reason for a steep learning curve when transitioning from oil and gas to disposal.

Well Bore Configurations: Oil and gas well bores are designed for efficient production while disposal wells have a priority relating to fluid containment, ground water protection and safety.

Disposal wells require a production packer to be set within 15 meters of the perforations while production wells don't require having a packer set. The annulus created in disposal wells (between the tubing, casing and packer) must remain free of disposed fluids. There is more strict regulation relating to full length casing cement, casing integrity and ground water protection. Disposal tubing is often coated to prevent chemical and biological related corrosion of the tubing. This is to ensure all fluids go down the tubing directly into the disposal zone with no risk of fluid escaping into other zones, contaminating ground water or escaping to the surface. With high rate disposal wells, friction is a concern so wells are often optimized by drilling wide diameter holes to accommodate large diameter casing and large diameter tubing compared to production wells.

Well Testing: Step Rate Injection Test vs Flow Test: Oil and gas wells are often subjected to a flow test to measure the productive capacity of a well. If bottom hole gauges are run and the flow test is followed by a significant build-up period, useful data can be gathered and interpreted relating to reservoir parameters, pressures and ultimate recoverable reserves. The disposal equivalent to this is the Step Rate Injection Test that disposal wells are often subjected to. The disposal rate can be estimated from this test, but a primary use is to collect data so that a Maximum Well Head Injection Pressure (MWHIP) can be calculated. When the test is properly conducted and data gathered and plotted (rate vs injection pressure), it is the primary method for the regulators to determine the maximum well head injection pressure that a disposal well can be operated at without fracturing the disposal formation. If the step rate test, with bottom hole gauges in place, is followed by a steady rate injection period and a significant shut in period to allow the reservoir to stabilize, these data can be gathered and interpreted supplying reservoir parameters, pressures, boundaries and limits.

Reservoir Quality and Cutoffs: For disposal, one of the keys for success is pore volume (porosity x thickness x area). It is the pores in the rock that hold the disposed fluid so the higher the pore volume, the higher the ability of the reservoir to store fluid. In oil and gas, the most important factor is in place reserves. Although pore volume is one of the factors in determining in place reserves, commercial hydrocarbons can be trapped and recovered in pools that are not commercially viable for disposal. A key reservoir parameter that makes a significant difference is permeability. Hydrocarbons can be commercially produced from very low perm reservoirs (< 1 mD) while commercial disposal wells require higher perms in order to achieve commercial rates (> 15 mD). The following graph has plotted Select Disposal Formations Disposal Rate vs Permeability.



Regulatory Differences: The oil and gas industry is very well regulated with clear guidelines relating to conservation, reservoir management, hydrocarbon recovery and well spacing. Disposal is not quite as well regulated and often issues relating to well spacing and reservoir management are left in the hands of operators. As well, issues relating to pore space ownership (fluid is stored in those pores) has been an ongoing challenge. The oversight and number of regulatory submissions (D51 and D65) for disposal are greater than for oil and gas. Yet both require consent from or ownership of PNG rights holders in order to produce or dispose. This is ironic since disposal operations utilize only the pore space, cannot recover hydrocarbons, and cannot have a negative impact on hydrocarbon production or recovery.

Use of Horizontal Wells: For over a decade, the oil and gas industry has developed nearly all reserves and production in Western Canada from horizontal wells, with significant amounts coming from low permeability reservoirs in resource plays. Yet the disposal industry still relies to a large degree on vertical wells; why is that? It boils down to why drill horizontal wells if vertical wells work. Industry has drilled horizontal disposal and injection wells, but the most success has been in high permeability reservoirs. Horizontal production wells, stimulated with multi-stage fracture stimulations, have been successful in commercially tapping hydrocarbon reserves that were uneconomic using vertical wells. Pushing hydrocarbons out of lower perm reservoirs has shown to be much more effective than pushing high density waste fluid through low perm reservoirs. Horizontal disposal wells drilled in lower perm reservoirs may achieve commercial rates for a period of time as the fluid fills the fracture enhanced reservoir. But eventually the fluid has to move through the original low perm reservoir to fill that pore space, and that is where the problem arises. For most reservoirs in Western Canada a minimum permeability required for sustainable commercial disposal is 15 mD, and the higher the permeability is, the better the rate will be. Permeability measured in the 10's or 100's mD should be targeted for a quality disposal zone. Commercial hydrocarbon production can be achieved with permeability less than 1 mD.

Summary

The designs, procedures, operations, reservoir cutoffs, evaluations and regulation differences between a successful oil and gas project versus a successful waste fluid disposal operation have some similarities, but significant differences. It is the knowledge of these differences that will allow for a successful transition from oil and gas to disposal.