Wave of the Future?

Colorado's Tankless Oilfield Process Facilities

As more and more wells are being drilled near more and more residential neighborhoods the State of Colorado is pressing the oil and gas industry to eliminate all storage tanks. This paper explains why this may be possible and how likely it really is.

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November 2022

INTRODUCTION

There is a new movement in Colorado today. Its focus is population growth into traditional oil and gas producing areas, and how industry might adapt to become a better environmental steward.

The State of Colorado is suggesting (through proposed legislation) that the oil and gas industry should adapt to current pressures by eliminating storage tanks in its process facilities. Storage tanks are notorious for emitting hydrocarbons in high concentrations. Eliminating tanks could significantly reduce oil and gas related emissions.

Doing away with oilfield storage tanks creates a real challenge, but the challenge can be met if and as the industry re-focusses emission control in the design of its process facilities. This paper presents a look at how the right focus can achieve Colorado's goals.

THE AIR POLLUTION BATTLEGROUND

History tells us that in the battle between a polluting industry and the welfare of the public, the health of the general public always wins. Therefore, it seems likely that the State of Colorado will prevail in forcing the oil and gas industry to minimize or eliminate emissions. Eliminating oilfield storage tanks could be the first step.

EXISTING PROCESS EQUIPMENT

The design of most process equipment currently in use in Colorado's oil and gas fields has not materially changed since the industry decline following the Arab oil embargo. During the decades since the end of the embargo the industry's focus has been to reduce CAPEX expenditures while meeting a minimum of industry's process requirements. Ever less costly equipment now dominate the Colorado oil and gas industry. The result is decreased process efficiency and ever-increasing emissions.

As population increases and spreads out, it inevitably gets closer and closer to legacy oilfield operations like those in this picture with the Rocky Mountains in the background. The vertical thin pipes on the lighter colored vertical vessels in this picture represent vent lines that carbon-based pollutants into the atmosphere, while the black vertical pipes represent the stacks (chimneys) of gas fired oil separating vessels which larger volumes of carbon monoxide and carbon dioxide every day. In fact, traditional oilfield fired equipment operates only in the 20-50% efficiency range, which means that a typical heater treater will emit up to five times its rated capacity. This level of inefficiency has been accepted for decades because gas was plentiful and cheap, and because we were wholly unaware of the effects of a large carbon footprint.

Now, with global warming dominating most environmental conversations, it may be time to leave the past in the past and move on and use new 21st century technologies to shrink or eliminate our carbon footprints. If we include computers, software, electronics, the Internet of Things (IoT) and artificial intelligence (AI), we will succeed! We really need a fresh new look at equipment and facility designs that can successfully eliminate all sources of carbon emissions including Colorado's atmospheric storage tanks.

OVERCOMING OLD PARADIGMS

The very first oil well ever drilled produced into a wooden oil storage tank. Most oilfield tanks today are steel, but they are still tanks. They inevitably leak hydrocarbons into the atmosphere. And there are literally hundreds of thousands of them. So, it is no wonder that the State of Colorado has begun to pressure the oil and gas industry to design oilfield process facilities that function without atmospheric storage tanks.

The good news is that this is absolutely possible. The difficult news is that to eliminate tanks we must shift our thought processes away from the use of tanks that started in 1859! In our industry, paradigms die hard, particularly 163-year-old paradigms! And the bad news is that eliminating storage tanks will add to our costs. This is a tough pill to swallow in an industry where limiting CAPEX has been a key driver forever.

WHAT MAKES STORAGE TANKS SO OFFENSIVE?

Oilwells operate at a positive pressure. The smallest leak can be a major environmental offender. Oilfield tanks operate at or very near atmospheric pressure, making it very difficult to keep them leak free and vapor tight. So, they leak … almost no matter what we do. Thousands of drone fly-bys and surveys from space prove that nearly all tanks emit methane ($CH4$) gas. With tens of thousands of tanks in place today, the problem is out of control.

There is no easy fix. So, Colorado is suggesting that the real fix is to eliminate storage tanks altogether.

HOW CAN WE PROCESS WITHOUT TANKS?

In order to eliminate gas emissions from a traditional oil and gas production facility, and to eliminate the tanks, it is necessary to process 100% of the fluids under positive pressure 24/7/365. Doing so eliminates all tank emissions, presumably satisfying Colorado's proposed mandate.

But is this even possible?

The answer is a conditional "Yes".

The conditions are:

1. There must be both local oil, water, and gas pipelines in the proximity of the oilwells.
2. Oil pipeline operators must be more willing to accept oil of lesser quality.

3. Refineries must be willing to accept pipelined crude oil with higher levels of contaminants (i.e., BS&W, aka "basic sediment and water").

WHY ARE THESE CONDITIONS NECESSARY?

If no oil and gas pipelines are nearby, there is no place for the hydrocarbons and produced water to go. The oil and water will have to be stored in tanks. The gas will have to be vented to atmosphere or flared. Both defeat Colorado's goal to reduce emissions by eliminating tanks.

WHAT'S THE SOLUTION?

First the oil and gas industry and the State of Colorado must develop the necessary pipeline infrastructure. Only then will it be feasible to consider eliminating oilfield storage tanks.

WHAT'S NEXT?

Once the pipeline infrastructure is in place, then facility designers can focus on the necessary equipment designs to completely process and transfer liquids and gas under pressure.

Since the industry has been separating oil, gas, water, and solids under pressure for decades, it is easy to assume that the same process equipment we've used for decades will continue to function under the no-tank conditions.

However, easy assumptions often lead to frustration and failure because with no place to store liquids locally, the quality of these liquids must be both higher and more consistent. This will likely translate to better and more efficient process equipment designs.

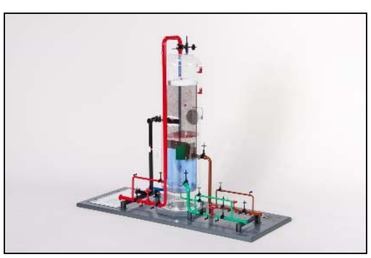
In addition, the entire oil and gas production (upstream) industry has been going through a dramatic transition for about 15 years. The transition is from vertically drilled and completed oil and gas wells to long-lateral horizontally completed wells. These horizontal wells are significantly more prolific than the here-to-fore conventional vertically completed wells. For example, a vertically completed new well in 1990 might average 250-400 barrels of oil per day, 50-75 barrels of water per day, and 750,000 cubic feet of natural gas. A horizontal well drilled into the same formation today might produce 1,200 to 2,000 barrels of oil per day, 1,000 to 4,000 barrels of water per day, and 6-8 million cubic feet of natural gas. It is no surprise that the process equipment used in the former case usually fails to perform in the later because the conditions are so different.

This simply means that the focus should shift from the standards of the past to new designs that improve separation efficiency and equipment performance for today's new process equipment.

THE DEVIL IS IN THE DETAILS: PRIMARY SEPARATION

The first stage of oilfield separation is an inlet separator designed to separate gas from liquids and to conduit the gas off-site to a gas sales pipeline. Separating oil and water from gas is the goal, but the goal has always been a moving target. Separators with no separation-improvement internals depend on gravity and time to do the job of separating liquids from gasses, but as price pressures push for lower CAPEX, many are smaller and cheaper than they should be. Furthering this, the traditional bid process has translated to the purchase of ever-cheaper separation systems based on bid prices and which often have fewer, simpler, and less efficient separation internals.

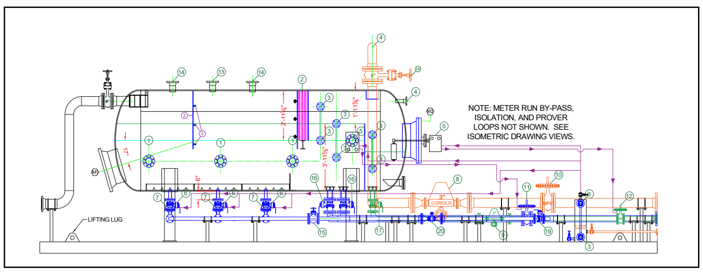
The result has been for the industry to experience a dramatic reduction in separation efficiency over the past several decades, resulting in the need to store more and more oil and water in local storage tanks. This is the trend Colorado seeks to reverse.



In the past, the typical oil-gas separator was a vertical vessel with an impact inlet diverter, a centrifugal, wire mesh, or no demister, a very limited capacity, and an inability to tolerate fluctuations in flow (slugs and/or heads). That vertical separator was commonly used from about 1930 through the turn of the century and was typically a 30" OD x 10' high 250-500 PSIG working pressure designed for vertical flow and a capacity of 1.5 MMSCFD gas and 500 B/D each of water and oil at a skidded and piped cost of about $25,000.

Today, a properly designed horizontal equivalent is needed to meet Colorado's future "no-tank" regulations.

This could be a 36"-48" OD x 15'-20' long 250-500 PSIG working pressure horizontal flow vessel like the one depicted below. It would be designed for today's process conditions and beyond. It would have an engineered inlet diverter to avoid droplet shearing, a wave breaking baffle, a Lamella-style serpentine vane defoamer-demister (breaking foam and removing oil droplets down to about 5 microns), separating all 2-4,000 BOPD from 3-7,000 BWPD through engineered anti-vortex liquid outlets, and all 10 MMSCFD of natural gas. This vessel could cost about $65-80,000 and might also be fitted with desanding internals capable of the necessary overall separation in today's more prolific fluids and frac sand volumes common in today's horizontally completed wells.



The key point here is that all these design details are necessary to allow this vessel to function reliably under Colorado's proposed tankless facility mandates.

However additional processing will be needed. The oil leaving the separator will not meet pipeline quality standards. The water leaving the separator will still contain 0.5-2% oil. The water will be sent offsite to a saltwater processing and disposal site, but the oil must be completely processed on-site so it can be sold into the local oil pipeline system.

OIL PROCESSING: THE COMMON HEATER TREATER

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In the past, with oil storage tanks in place, oil was processed through "combination" vessels like the one pictured here. These are horizontal heater treaters with vertical separators built in, and they are traditional in Colorado. Often these horizontal vessels (green arrow) are fitted with pre-heat tubes to heat the incoming well fluids. Once heated the fluids flow through the separator to separate the liquids from the gas. The liquids then fall into the horizontal heater treater for final crude oil dehydration (water separation). When no local gas pipeline is close enough, gas is sent to a flare (red arrow) and burned. The carbon footprint of these systems can be significant, since the heater treater burns at least 60,000 cubic feet of natural gas daily and the flare may burn up to 75,000 cubic feet more.

Furthermore, these comparatively inexpensive units often carry over 0.5% to 2% crude oil with the gas to the flare, adding to the carbon footprint and reducing the sales volume of the producer's crude oil. Also, these units do not reliably process the crude oil to normal pipeline specifications (<0.5% contaminants, aka: BS&W), forcing the operator to divert the crude oil to the same storage tanks the State of Colorado is attempting to eliminate.

Clearly, a better system is needed.

THE 21ST CENTURY L-POD®

The L-POD® was developed several years ago to bring an efficient, state-of-the-art, self-controlled, self-managed, highly energy efficient and fully automatic crude oil processing unit to the upstream oil industry. It was way ahead of its time!

Since it was first invented it has been improved several times. In the Gen2 iteration dual BS&W monitors were added and the PLC software was modified with feed-forward logic to manage the input flow rate, treating heat, and chemical demulsifier addition rate. In Gen3 we added an ultra-efficient plate and frame heat exchanger to pre-heat incoming cold crude, reducing the heat retransfer needs of the overall system and its carbon footprint. In Gen4 we added a second plate and frame heat exchanger as a backup to the first, eliminating the downtime cost of cleaning one or the other. In Gen5 we took a technology leap forward by replacing the gravity coalescing section with an electrostatic coalescing section, nearly doubling the capacity of the L-POD®.

And the latest iteration is by far the most inventive and environmentally friendly. In Gen 6 we have eliminated the gas burner, pilot, and firetube altogether, replacing these carbon emitting components with a series of electric immersion heaters. This type of heat has been used in electric water heaters in households around the world for decades, but has yet to find a home in a heater treater until now. The huge advantage of the electric heater is that 100% of the heat generated is transferred into the fluids making it the most thermally efficient design known.

In Gen6 of the L-POD®, the conventional gas pilot, burner, and firetube are replaced with electric immersion heaters. Where gas pilots, burners, and firetubes may transfer only 20% or less heat into the produced oilfield fluids, sending all remaining CO and CO_2 up the stack (chimney) to atmosphere, the electric immersion heaters transfer 100% of the heat generated into the process fluids and without generating any carbon footprint (CO/CO_2) whatsoever.

The electric heating elements simplify the heater treater design, allowing it to be further optimized with a shorter heating compartment, and a larger electrostatic compartment adding further to its capacity, coalescing capacity, and the quality of the oil leaving it. And now, with pipeline quality assured, the need for storage tanks is eliminated.

CONCLUSIONS

The State of Colorado is challenging the upstream oil industry to do something it has never done before. To meet this challenge the industry needs to abandon the cost driven equipment designs of the past and adopt fresh, new, and efficient 21st century equipment technologies.

By marrying a properly designed inlet gas separator with a Gen 6 L-POD® Unit all gas can be separated and sent into local gas gathering pipelines eliminating the horrible cost of oil-in-gas carryover typical of many current systems.

All produced water can be separated and piped directly off-site to a SWD plant or on-site disposal well without the need for local storage tanks.

The L-POD® will process all oil to better than pipeline specifications and transfer it under pressure directly through a local LACT unit an into a local sales oil pipeline without the need for local storage tanks.

And by employing a production processing system that needs no local storage tanks, the proposed "no-tanks" legislation in the State of Colorado can be fully achieved.

CONTACT INFORMATION

To get more information on the latest, most efficient upstream facility designs please call Bill Ball at 918-231-9698, and/or for more information about the L-POD® system, please contact Gary Johnson at 918-630-1616.

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