Vortex Tools: NGL Technology Solution for Operators with Enhanced Recovery and Improved ROI

Abstract

Since 2001, over 1,450 patented Vortex tools have been sold into markets worldwide. On the surface, these Vortex tools set up a stable spiraling flow that keeps liquids from dropping out, prevents freezing, reduces pressures and mitigates paraffin build-up. Downhole, Vortex tools enable wells to flow below the critical rate as well as lowering the bottom hole pressure and reducing surfactant use by up to 50%. With no moving parts, all Vortex tools are virtually maintenance free.

In 2009, a Texas independent producer began installing Vortex tools on gathering lines to recover substantially more natural gas liquids (NGLs) than they were previously getting with pigging and/or drip systems, all with marginal affect to the value of the gas (7-12 BTU). After collecting 15 months worth of comparable data (lines with Vortex to lines without Vortex), the data concluded the following: Over 1.2 million gallons of additional NGLs were recovered from three gathering lines with the Vortex tools in a single year, translating to over $2 million in additional revenues. An average well line with Vortex paid for itself in less than 60 days (including the cost of the Vortex tool and associated tanks and installation). There were also additional "non-revenue" benefits like reduced pigging, lower methanol use, reduced hydrate formation and zero line freeze-ups on gathering lines with Vortex. These "non-revenue" benefits (and more) have been confirmed by university studies, Department of Energy (DoE) testing, case studies and various White Papers, including SPE 84136.

As a result of these additional revenues, improved ROI and operational benefits, the Vortex tools are now a part of this Texas independent producer's new well completion program. The customer continues to look for new areas to profit from the Vortex tools and has found additional success in replacing vapor recovery units (VRUs) and reducing the time to get oil and gas to sales (instead of flare) on flowbacks.

Overview

Vortex Tools, LLC (Vortex) introduced its patented spiral flow technology to the oil & gas sector in 2001. Since that time, over 1,450 Vortex tools have been sold throughout the U.S., Canada, Australia and the Middle East.

The initial focus of this proprietary process was in lowering surface line pressures in marginal gas wells and reducing liquid drop-out, reducing freeze-ups in winter as well as helping to mitigate against paraffin accumulation. After an extensive study at Texas A&M, an SPE White Paper (84136) was published detailing the benefits of this patented technology in lowering the critical rate and extending the free-flowing life of a marginal gas well. After this, Vortex turned its primary attention downhole to well-bore solutions.

18 months ago, a Texas independent producer looked at the Vortex technology in a completely different application and has helped Vortex refocus its efforts in the recovery of liquids. With this application of our technology, Vortex is not just eliminating a problem, but generating substantial additional revenues

for an operator from the efficient recovery of natural gas liquids (NGLs).

The operator's initial plan involved the analysis of the current value of recovering liquids through pigging and drips to the processing plant. After this analysis, the operator then developed a comparable recovery model that, given the high prices of NGLs, hypothecated a field recovery solution using the Vortex technology would provide an economic benefit. Though NGLs were only at $50/barrel at the time, this hypothesis proved true and the results substantially outpaced the projected benefits.

Historic Recovery Solution

Recovery of NGLs from these condensate wells is in two stages. The majority of the NGLs are recovered at the wellhead and collected in production tanks. The remaining NGLs that dropped out during transportation in the gathering lines were recovered by pigging the line and recovering the liquids as a BS&W at the sales meter. Like most processing plant contracts, any NGLs that dropped out thereafter were apportioned to the operator on an "allocated basis"—where NGLs are allocated on the basis of the gas BTU measured at the meter (versus NGLs recovered at the first separator in the processing plant).

The Vortex Solution

The Vortex NGL solution is a field processing solution in which the beneficial spiraling flow developed by Vortex can maintain NGLs in a liquefied (as opposed to gaseous) form for long distances.

Using the principles of a spiraling, organized flow, different components of a two-phase flow are separated by this "tornado in a pipe" and then travel as a separated co-flow for long distances (up to six miles measured during the study).

Using the Vortex tool resulted in more NGLs in the operators' tanks and affected BTU only marginally (usually 7 to 12 BTU). This gas was 1,150-1,275 BTU. The higher the BTU, the more liquids were recovered in the operators tanks. Like most processing plants, the price for the NGLs in the operators' tanks ($73/bbl) was substantially higher than what was allocated for NGLs recovered by the plant. NGLs from the processing plant are based on $42/bbl (after transportation and processing fees, shares, etc.) and are often shared between operators on a theoretical (as opposed to actual) basis.

The results of the field trial were significant, with over 1.2 million gallons of additional NGLs recovered from three gathering lines in a single year, translating to over $2 million of additional revenues.

An average well line with Vortex paid for itself in less than 60 days (including the cost of the Vortex tool, its associated tanks and installation).

There were additional "non-revenue" benefits like less pigging, reduced methanol use, reduced hydrate formation and zero line freeze-ups on the gathering lines with Vortex.

The NGL experience also led the operator to consider using the Vortex tool in new well flowbacks to enhance well recovery rates and improve well payback through reduced pit flaring. Vortex tools were also used to replace vapor recovery units (VRUs) and to keep vapors in a liquefied form.

Additional Benefits – Less Line Freezing, Reduced Methanol Use and Reduced Hydrates

2010/2011 was an unusually harsh winter in the East Texas area. With the Vortex tools in place, the operator saw significantly less cold weather problems on lines with Vortex tools.

The words of the operator best describe these benefits:

> *"During last winter, the ambient temperature got down to 9° F. The gas temperature got as low as 34° F. With the Vortex tool in the line, water vapors were liquefied and formed a "slush" that the separators dumped to the water tank instead of forming hydrate blocks. We never froze up on lines with Vortex. The low ambient temperatures and the Vortex Tools helped the operator legally recover more NGLs in its tanks.*
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> *"We were still pumping some methanol, but not nearly as much as we had in the year before and the year before, it was not nearly as cold as this past winter."*

Technical Description of the Vortex Tools

As a stream of gases and liquids enters the flow modifying device, it is forced by a "bluff body" in the flow stream to spin rapidly. The high angular acceleration slings the heavier liquid towards the pipe wall. As this spinning flow moves through the device, the configuration allows the spin angle to relax to a very efficient value.

This efficient helix-angle will propagate very long distances. The consequence of the liquid moving (like the rifling on a gun barrel) is that the no-flow boundary at the edge of the central gas flow is moving, resulting in a lower differential velocity between the bulk flow and the outer edge of the flow, which yields a lower shear force and a lower pressure drop due to friction.

A second benefit is provided by eliminating the slip between liquid droplets in the flow and the gas stream. Removing this slip force reduces the amount of work the gas must do as it moves – reducing the total pressure drop.

Source: David Simpson, P.E. Muleshoe Engineering

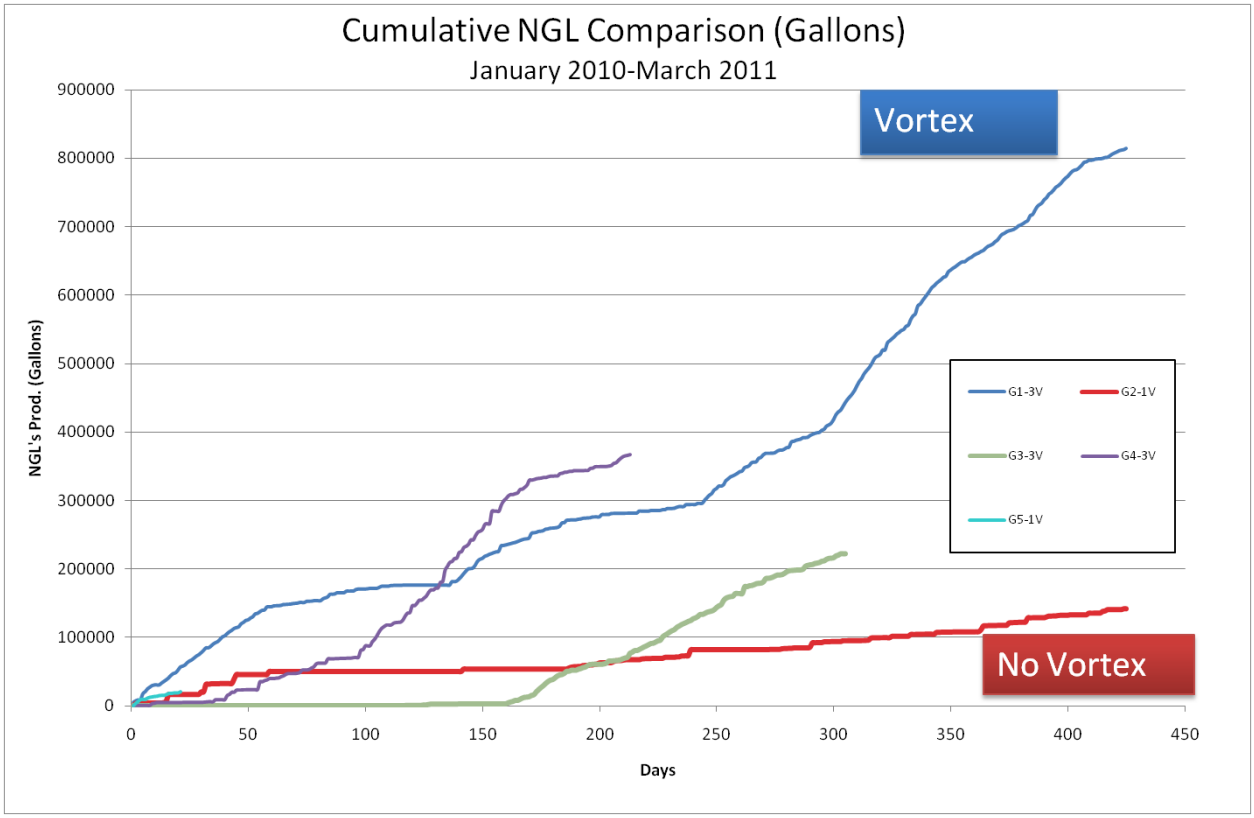
How Long Do the Vortex Benefits Last?

Vortex has developed a database of successful installations. Using this information together with specific customer data, Vortex believes that the benefits of the Vortex flow last several miles – even though the visual of the spiral disappears after a relatively short distance. The data suggested that the benefits, in most cases, diminish after 1-2 miles. However, in this case, the multi-phase flow benefits continued for longer distances:

> *"On one line in particular we know that the "spin" from the Vortex flow continued over six miles in a line that had many elevation changes from creek bores and wetlands bores. You can imagine the centrifugal action that would occur over that distance."*

NGL Test Program Results:

Data was gathered on producing wells with and without the Vortex solution over a 15-month period. The following graph compares three gathering systems with a Vortex tool on each line to a system without any Vortex tools over that same 15-month trial period. The blue line (Vortex) shows the NGLs recovered with the Vortex tools (814,179 gallons) compared to the red line (drips) where only 142,170 gallons of NGLs were recovered.



Here are the words of the operator in describing his experience with the Vortex tool in NGL recovery:

> *"As an operator, we installed a Vortex tool on a 6" line with 6MMcf/day of gas, 45 barrels/day of condensate and 10 barrels/day of water operating at about 600-700 psi. The spiral carried the*

entire line length of six miles. Our SCADA system allowed us to see graphically the production in the propane and water tanks. With the Vortex tool in place, it went from slug flow, or pigging to a steady, constant dumping of liquids, condensate and water into the tanks. The condensate gravity was typically 51° so we went into pressure tanks rather than lose half of the volume in flash to a production tank. The higher the volume/velocity, the more effective the tool is.

"The 45 barrels/day of NGLs was from turning vapors into liquid with the Vortex tool. We then added the Vortex tools to three other pipelines with similar results. It amounted overall to an additional $2,000,000 dollars in NGL sales in one year."

In describing the consistency of the product delivered with the Vortex solution, the same operator stated:

"We had relatively severe emulsion problems in East Texas with drilling mud and paraffin in a fractured carbonate reservoir. Bottom hole temps were from 260° to 360° F. Wellhead flowing temps were from 205° down to 160° F initially, then down to almost ambient later in the hyperbolic decline. We did use some chemicals but, this winter, we cut them back. Ambient temps got down to 9° F and after installing a Vortex tool between the initial separator and the HtrTrtr, to my knowledge, we never had a tank turned down, over many tank batteries and made about 3,000 bbls/d of production with Vortex tools. "

Use of Vortex in Flowbacks and VRU Replacement

After witnessing the efficacy of the tools, the operator started thinking about other applications and provided the following comments:

"We put a Vortex tool between the high and low pressure separators on our well testing units. These wells are horizontal in fractured carbonates. They have a hyperbolic decline curve and start out between 10 and 20 mmcf/d with 1,000-5,000 b/d of condensate, and 2,000-4,000 b/d of water and 12.5-18.0# drilling mud. The wells used to take ten days to clean up enough to go through the production system. We could sell gas after the second day and recover some oil, with chemical treatment on the third or fourth day. The first two days were through a hydraulic choke and straight to the burn pit.

"With the Vortex Tool we were able to break the condensate/water/drilling mud emulsion so much more quickly that we went to sales in one day or less. On the first well that amounted to $500,000 to sales rather than the burn pit, 18 mmcf/d gas and 4,600 bbls condensate. That, obviously, is the way it has been done since, saving/making literally millions of dollars rather than watch it all go up in smoke. Emissions were reduced tremendously as well, as a consequence of the Vortex solution.

"With the high volumes, we were having a flash gas emissions problem, explosion and environmental risk at the production tanks. Vapor Recovery Units (VRUs), are expensive and have their own set of operational problems. We decided to try a Vortex Tool instead of a VRU. We had gone to a two phase HP sep, (900 psi), to a three phase LP sep, (60 psi), to the tanks with a VRU. Now, it is a two phase HP sep, (900 psi), with a Vortex Tool on the liquid discharge line, to a three phase HtrTrtr, (30 psi), and to the tanks.

"The Vortex tool liquefies the flash vapors on the way to the HtrTrtr and they blend with the condensate to eliminate flash off of the tanks. The flash from the HtrTrtr goes to a LP compressor, which we had anyway, and down the gas line. Our flash flare is from pilot light to 6" high, at the most.

"Additionally, the flash is sold at liquid prices instead of gas prices. By the way, on wells where this system was used, there has never been a load of condensate turned down because of BS&W where on wells without this system, there were one or two every other month."

Summary

In this producer's operations, the Vortex tools made money by knocking out NGLs in the gathering lines, reducing line freeze ups, eliminating free liquids in gas meters, yielding better measurement and lowering maintenance and repairs, reducing free liquids through dehydrators, reducing glycol cost and filter cost and tremendously reducing production tank flash emissions.

Over 1.2 million gallons of additional NGLs recovered from three gathering lines in a single year, translating to over $2 million of additional revenues. An average well line with Vortex paid for itself in less than 60 days (including the cost of the Vortex tool and associated tanks and installation). Additional "non-revenue" benefits like less pigging, reduced methanol use, reduced hydrate formation and zero line freeze-ups on gathering lines with Vortex also bolstered the value of these tools.

The Vortex tools are now a part of this customer's new well completion program, with a Vortex tool between the HP and LP separators on flowbacks, a Vortex Tool between the HP separator and the HtrTrtr in the production system and a Vortex surface line tool placed on each new flowline. The customer continues to look for new areas to profit from the Vortex tools.

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