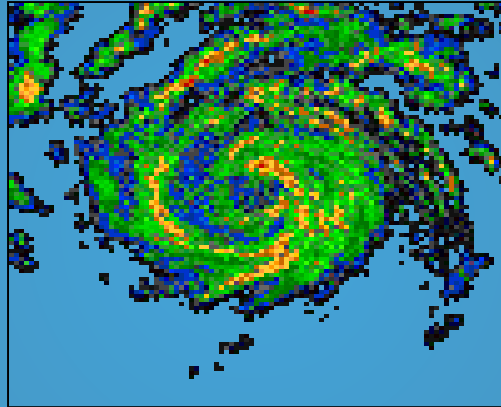


# BAKKEN FRONTIER, LLC

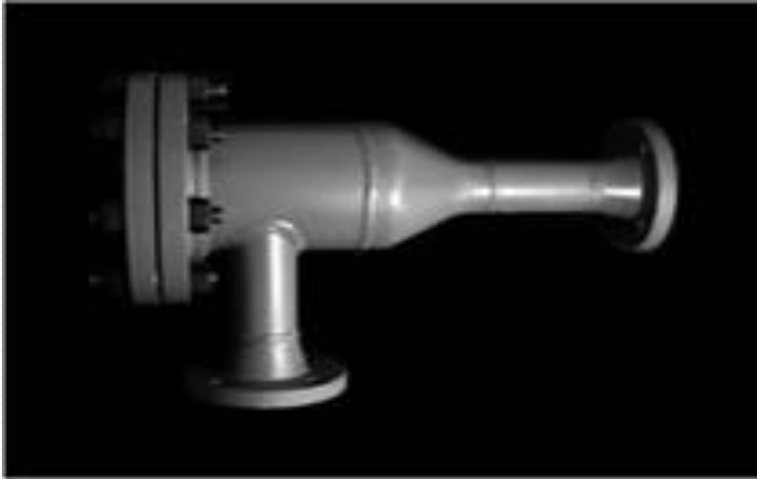


*Mimics Mother Nature's best practices*

## Vortex Tools:

Helps oil and gas operators monetize high-value liquids while reducing the CO<sub>2</sub> impact of burning (flaring).

# The science behind 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.

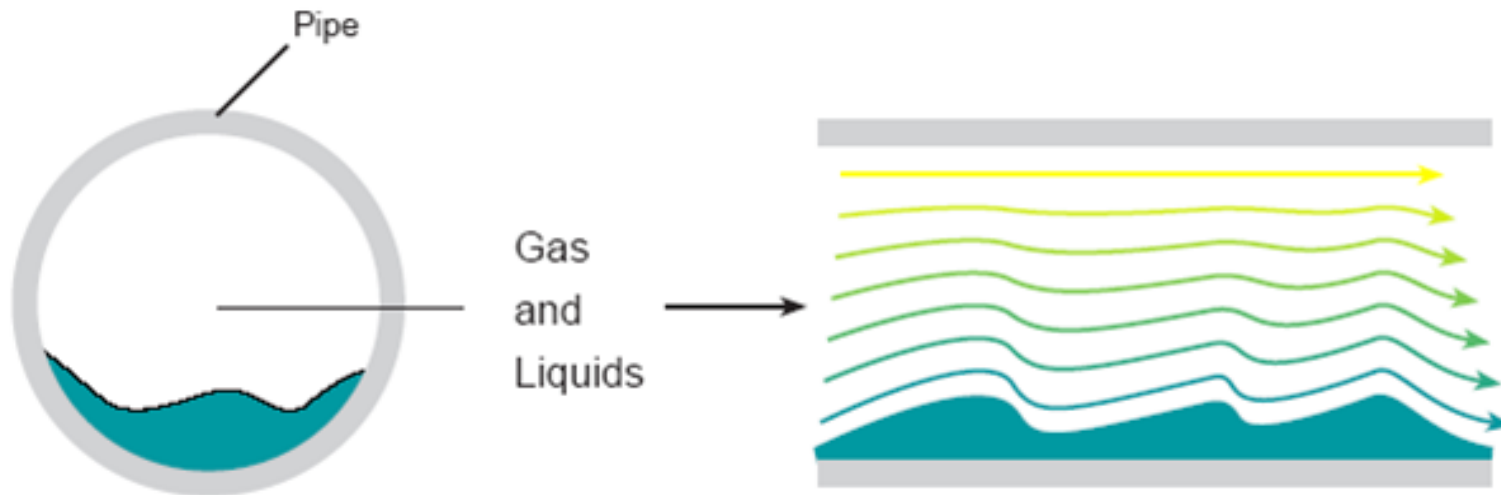
This efficient helix-angle will propagate very long distances. The consequence of the liquid moving (like the rifling on a gun barrel) is that the no-flow boundary at the edge of the central gas flow is moving, resulting in a lower differential velocity between the bulk flow and the outer edge of the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

# The science behind Vortex tools

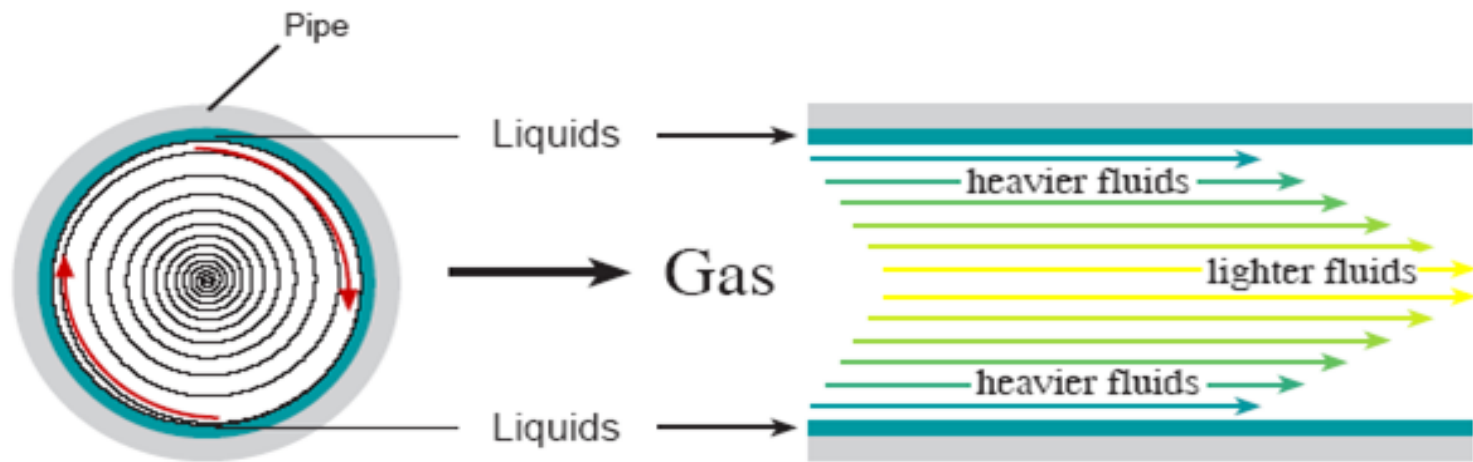
## Surface line without Vortex Tool



*Heavier fluids drop out in low spots leading to increased line pressure and loss of valuable liquids without pigging the line*

# The science behind Vortex tools

## Surface line with Vortex Tool



*Fluids remain entrained within the streamlined Vortex flow, reducing drop-out and liquids travel to the tank for separation and collection*

# The science behind Vortex tools

Vortex directional spiral: Liquids & Gas





# Vortex NGL recovery tool

## **Added value:**

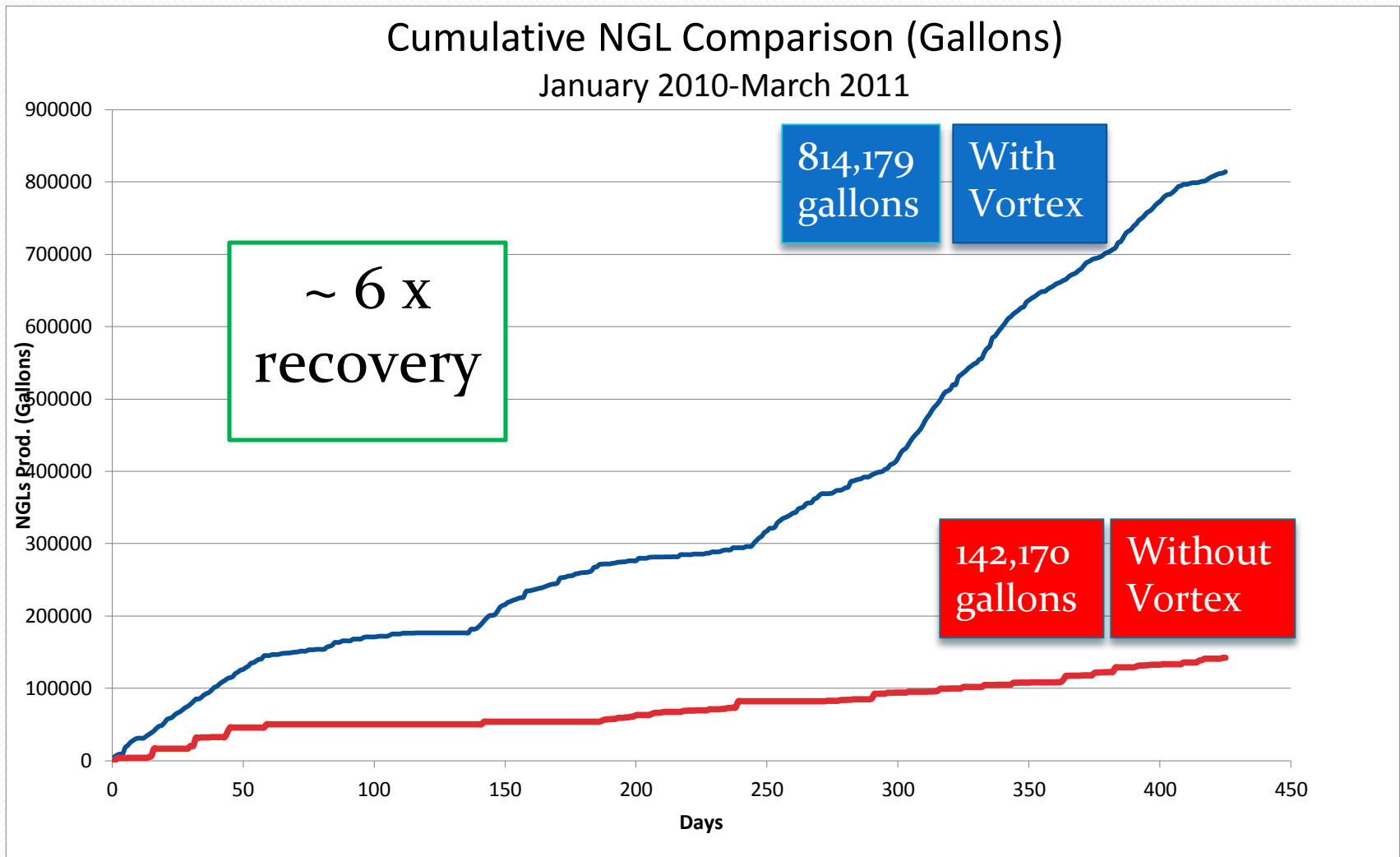
The Vortex tool creates a new revenues stream to the operator as opposed to flaring this valuable product

## **Improved efficiency:**

The flare will not be eliminated, but more liquids removed creates less volume to flare and significantly less polluting emissions.

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# Customer Case Study 2010-2011



# Vortex Skid for the Bakken

The focus for this grant application is based on NGL Recovery at stranded wells. This particular skid will be completed in a few weeks and is contracted to go to an operator site north of Alexander, ND. The unit has a footprint of approximately 8'x 30' is capable of handling gas flow up to 1500 MCF per day.



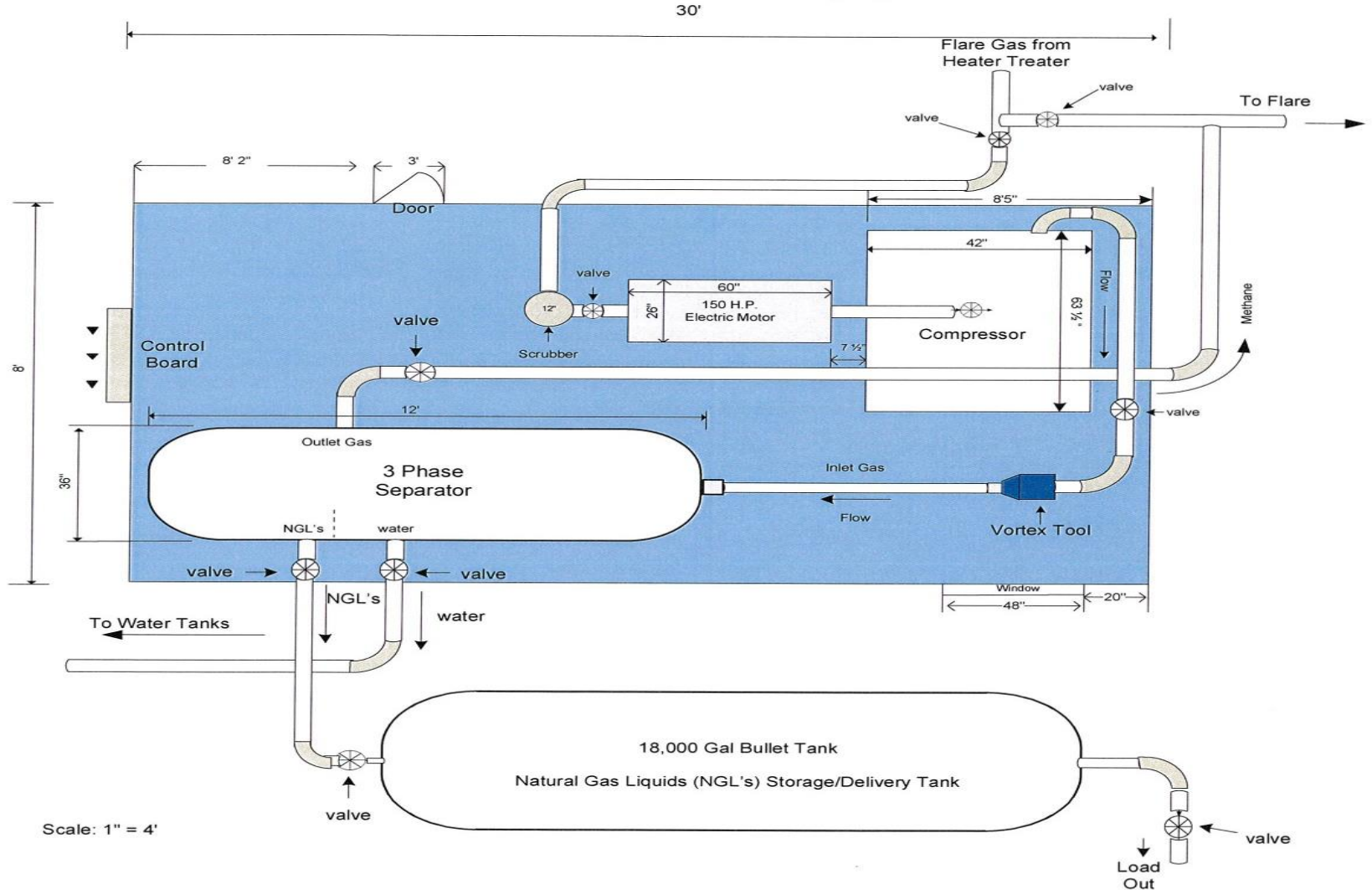


# Vortex Tool & Horizontal Separator



Bakken Frontier, LLC  
 Vortex® Skid System  
 "Natural Gas Liquids Recovery System"

12/8/14



# Economic Projections of Vortex

- Skid production costs – less than \$500,000.00
- Lease to operators is less than \$20,000.00 per month
- Bakken flare gas composition: 8 to 12 gal/per MCF \*
- Using an average net Y grade price of \$.70 per gallon \*\*
- Using the lowest figure of 8 gallons & a recovery rate of 80% on 8 gallons, the ROI is as follows: \*\*\*
  - 1500 MCF/Day flare = \$181,600.00/month – \$2,179,200.00/year
  - 300 MCF/Day flare = \$36,320.00/month - \$435,840.00/year

\* Gallons per MCF taken from EERC Report. \*\* price per gallon received from third party gathering company, \*\*\* Percentage of recovery is a projection based on the high liquid content of Bakken gas.

# Vortex: “Non Revenue Benefits”

1. Reduced Freezing: Customer says he is getting 70% more liquids with Vortex and no freezing. Lines with Vortex tools have not frozen since install. Customer quote: June 12, 2011

*“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 formed a "slush" instead of hydrate blocks and we never froze up, we were pumping some methanol but not near as much as we had the year before and the year before it was not nearly so cold.”*

2. Reduced Pigging: The addition of a vortex tool in flow lines has proven to drastically reduce and in some cases eliminate the need for pigging. Case study data is available to substantiate these successes in the field. Vortex makes a tool that is capable of launching a pig if that action becomes necessary.

3. Slug prevention: The organized flow created by the tool will greatly reduce slugging which is directly related to increased flaring.

4. Reduced Chemical Usage: Greater efficiency with the use of chemicals, If there is a need to use chemicals, the helical pattern produced by the vortex tool will actually move those chemicals to the area of the pipe that requires treatment.

5. Power Generation: With more liquids being removed from the flare gas, the use of a hybrid generator has a greater chance for success.