Stripper Well Consortium
Vortex Flow, LLC Technical Progress Report
Final Report

Prepared by: Jeff Boothman
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"Downhole Grant"

The scope of our project was divided into two main sections:

1) To test prototypes of a downhole application of the core technology in a lab environment. This included developing prototypes, fabrication and testing in a controlled lab environment. The technology is intended to better lift production from the reservoir to the surface of the well head. These tests were completed by Texas A&M University and Vortex Flow staff.
2) To test the best design, as determined by initial lab tests in a field environment, with a longer tubing string, to confirm whether lab test results would likely be transferable to a field application. These tests were also completed by Texas A&M University and Vortex Flow staff.

As a result of the lab tests, we have determined that a two port design, with chamfered inlets was the most effective design. This design is commonly referred to as the "A2" design in the attached technical reports. Lab tests conducted at Texas A&M University by graduate student Ahsan Ali and Vortex Flow staff indicated that that the "A2" design reduced pressure loss in the tubing string by approximately 15%. A full technical report of this test is attached.

Additional testing in a ~1,200 foot well at Texas A&M University completed by Kartik Ramachandran and Vortex Flow Staff confirmed that the "A2" tool is effective in reducing pressure loss in the tubing string and is an effective means of unloading liquids from wells. A full technical report of this test is attached.

Complete Technical Reports of these two tests, which cover all activities included in this grant in their entirety, are included with this report.

Report 1: Masters Thesis: Investigation of Flow Modifying Tools For the Continuous Unloading of Wet Gas Wells by Ahsan Ali. 103 pages.
Report 2: Field Testing of Vortex Device For Wet Gas Wells by Kartik Ramachandran. 18 pages.

As a result of the work from this grant, we were able to confirm a good tool design (A2) and prove efficacy in a field setting. These tests indicate that field testing of several units in operating wells would most likely be successful.

Experimental Apparatus: For initial lab testing we used a 125 foot test tubing with an inside diameter of 2.049". Full details are available on page 17 of Report 1: Masters Thesis: Investigation of Flow Modifying Tools For the Continuous Unloading of Wet Gas Wells by Ahsan Ali.

For secondary field testing we used a 1,258 foot tubing string with a diameter of 2.375". Full details are on pages 4-8 in Report 2: Field Testing of Vortex Device For Wet Gas Wells by Kartik Ramachandran

Data Reduction: Full data analysis and conclusions are available in the attached reports. The main conclusions drawn from data reduction are as follows:

1) The amount of gas required to lift liquid up the wellbore can reduced by using the Vortex Flow "A2" design of the downhole tool.
2) The pressure loss as gas and liquids travel up the tubing string can be reduced by the flow characteristics imparted by the tool. The pressure loss can be reduced by approximately 15%.
3) The tool is effective as a means of assisting in well unloading of liquids as indicated by tests completed using approximately 1,250 feet of tubing.

Hypothesis and Conclusions:

Initial Hypothesis: The Vortex Downhole tool will organize a two-phase flow. This organized flow allows for a reduction of pressure (via a reduction in the pressure lost to a disorganized flow) in the tubing string which, in turn, allows for greater reservoir optimization (higher production rates and overall recovery) and more efficient lifting of liquids.

Conclusion: The Vortex Downhole tool is effective in reducing pressure loss in a tubing string and allows for the lifting of liquids with much lower gas rates. The degree to which the tool can assist in improving these characteristics will have to be studied to build relationships that define a prescription for use of the technology.