G-022-048

Final Report

ND Oil & Gas Research Program
Project # G-022-048
Project Title: "**Wellhead Gas Capture Via CNG Technologies**"
Applicant: Bakken Express, LLC
Principal Investigator: Tim Maloney
Report Date: October 1, 2011

Following is the Final Report for OGRP project # G-022-048. The project has been very successful meeting the original project objectives and has also identified areas for improvement going forward.

Executive Summary

Contract #G-022-048 was executed by the ND Industrial Commission on October 4, 2010. The scope, as amended November 19, 2010, called for the installation of 3-5 compressor units for a total project cost of $3.0 million to demonstrate the technical and economic viability to capture stranded natural gas and transport it to market using CNG technologies. As of August 12, 2011, Bakken Express began transporting stranded natural gas from 3 compressor units using CNG technologies to compress, transport and discharge to a low pressure gathering pipeline approximately 25 miles away. The initial capacity captured is above 700 mcfpd and should rise to 1.5 mmscfpd as modifications are made to the equipment. A number of technical hurdles were overcome during the project. The project demonstrated this method of gas capture and transport as economically viable for both service company and producing company.

Schedule

The project was completed within the 12 month time frame, though it followed a different path from the original schedule. Securing a commitment from a producer took longer than expected, which resulted in following a single fabrication phase (rather than the two step approach contemplated). The detailed engineering design phase took longer than expected due to a number of technical hurdles identified along the way. However, while delayed, startup and commissioning went relatively smoothly. The original schedule should have included a ramp-up period to account for the process and equipment improvements that are needed to optimize the full operation.

Budget

As previously communicated, the total project costs came in higher than the original budget ($3.0 vs. $2.1 million), with the main factor being higher costs for the wellsite compressor skids and the discharge station. However, a third party joined the project and contributed some of the required capital, so the NDIC funding remained unchanged. Following is the final budget:

OGRP G-022-048 "WELLSITE GAS CAPTURE" - BUDGET (FINAL 10/1/2011)
12 Month Project: Capture & Transport Gas from 3-5 Wells with Peak Rate 1500-2500 mcfpd

Expense Type	Total	NDIC	%	BX Cash	%	BX In-kind	%	Other	%	%
Well Skids Capital	$ 2,100,000	$ 750,000	36%	$ 350,000	17%	$ -	0%	$ 1,000,000	48%	100%
Tube Trailer Leasing	$ 220,000	$ 110,000	50%	$ 110,000	50%	$ -	0%	$ -	0%	100%
Discharge Facility	$ 320,000	$ 13,300	4%	$ 156,700	49%	$ -	0%	$ 150,000	47%	100%
Operator & Maintenance	$ 69,400	$ -	0%	$ 69,400	100%	$ -	0%	$ -	0%	100%
Supervisory, Engineering and Mgmt Consult	$ 61,800	$ -	0%	$ 61,800	100%	$ -	0%	$ -	0%	100%
Principals	$ 230,400	$ -	0%	$ -	0%	$ 230,400	100%	$ -	0%	100%
TOTAL	$ 3,001,600	$ 873,300	29%	$ 747,900	25%	$ 230,400	8%	$ 1,150,000	38%	

Technology

Significant improvements to the compressor and discharge skid designs were incorporated over the project period. The original premise of simply "porting existing technologies" from the CNG industry to the oilfield didn't work out as planned. Several factors were unfamiliar to the CNG industry: lack of local utilities, high gas liquids content and unmanned 24/7 operation. These required more customization than originally anticipated. However, in the end, this has resulted in a cost competitive and economic solution for capturing and transporting stranded Bakken gas.

Compressor Skid --- The purpose of the compressor skid is to capture the gas off the heater treater, remove water vapor to a very low dew point (0.5#/mmcf vs standard pipeline spec of 7.0#/mmcf), and compress the gas to 3500 psig for transport. The skid also needs to be self-sufficient and portable. The applicant developed several solutions to address these unique conditions. The skids require no utilities from the wellsite (all that is needed is a feed gas line and a "return to flare" line). The skids are extremely portable (everything is in a single enclosure with multiple lifting methods and an integrated concrete foundation for vibration adsorption). The skids use a natural gas engine, which meet EPA spark ignited stationary NSPS standards, to drive four stages of compression. In addition, the skid is designed for "zero VOC emissions", which is accomplished by designing the dryer regen gas and the instrument gas to be routed to the return to flare line for combustion.

Discharge Skid --- The purpose of the discharge skid is to blow down the high pressure in the tube cylinders into a low pressure pipeline system. The main two challenges are 1) managing the extreme low temperatures from the J-T effect of rapid pressure drop and liquid re-vaporization, and 2) accomplishing the blow down rapidly (to turnaround the tube trailers quickly). Often this function is accomplished with a simple bath 'line heater' approach, which maintains the gas temps by direct heating. The solution developed by the applicant is to instead use a catalytic heater, which uses less fuel, enables faster discharge times and has no direct fire combustion.

Results

Three compressor skids were installed to capture up to 1500 mscfpd of stranded natural gas in order to transport gas at 3000 psig in CNG tube containers approximately 25 miles away and discharge it through an unloading station into a low pressure gathering pipeline. The compression process removes the water from the gas, but leaves a majority of the natural gas liquids. These liquids are transported in the tube containers as a dense phase and then are discharged along with the gas phase into the gathering pipeline. Due to the cooling effect during the discharge cycle, it would be possible to separate the NGLs from the gas and truck these off separately, if desired.

While several factors affect the economics of the operation, the all-in capital and operating costs for gas capture, transport and discharge can be under $3.00 per MCF, which leaves significant profit potential given this rich gas can sell for $4-$8 per MCF depending on the value of gas liquids recouped by producer.

Startup Pictures

Following are pictures of the initial operations events:

Delivering First Compressor Skid

Ready to Startup Three Skids

Loading First CNG Tube Containers

Unloading First Tube Container

Selling First Gas to Pipeline

Improvement Opportunities

To refine the overall operation and further enhance the economics of flared gas recovery, following are the areas of improvement: improve volumetric efficiency of compression skids, improve reliability of compression skids, reduce offloading cycle time, and improve capital efficiency of compression and unloading skids.

Implications

The project demonstrates that using CNG technologies to capture stranded associated natural gas from Bakken wells is viable both technically and economically. Technically, all wells, no matter how low their flowrates, could use this approach to capture stranded natural gas. However, given the capital cost, the most economic application of this technology is on relatively new wells still producing at high gas rates (above 300 mcfpd). Again, technically, wells in the most distant locations could use this approach; however, the most economic are wells located within 40 miles of a pipeline discharge point. So, the most attractive economics occur when the skids are moved to an unconnected well just after the drilling/frac is completed and remain there until the pipeline is connected, or until the flow rates drop off dramatically. The other factor to scaling up this solution field wide is to ensure discharge stations are accessible. In order to capture a majority of the flared gas across the Bakken play, approximately 15-20 discharge stations would ensure this maximum economic distance is met.

Overall, this NDIC supported pilot project is a solid success, which will become an even more attractive solution to the stranded gas problem during the next iteration of loading and unloading skid designs and overall operational improvements.