TOOLS FOR TURNING STRANDED GAS INTO CASH
Environmentally Friendly Drilling / Petroleum Technology Transfer Council

Jeremy Viscomi
Richard Haut, Ph.D.

11.13.2014
CONTENTS

Development TOOLS DESIGNED TO MONETIZE NATURAL GAS.........................3
PROBLEM IDENTIFICATION WORKSHOPS.....................................................3
IDENTIFYING THE ISSUES...........................................................................4
KEY FINDINGS.............................................................................................5

FOR MORE INFORMATION ABOUT HOW YOU CAN PARTICIPATE PLEASE CONTACT:

RICH HAUT
RHAUT@HARCRESEARCH.ORG
281.364.6093

TOM WILLIAMS
TWILLIAMS@LEIDLLC.COM
713.201.3866
Development of Useful Tools Designed to Monetize Stranded Gas

As emerging regulations related to the flaring of associated gas during the production of oil wells across the country continue to impact the oil and gas industry operators are faced with potentially having to install and utilize equipment aimed at the reduction of natural gas flaring. While natural gas flaring is seen as a considerably less polluting alternative to venting methane directly into the atmosphere rules slated to go into effect from the EPA this January will ultimately force operators to find an alternative to the flaring of natural gas. The process dubbed ‘green completion’ promotes the use of stranded gas at the well site or nearby communities by use of various technologies available in the marketplace. However for most operators evaluating these technologies and selecting the correct one for that particular region can be a daunting task.

Recently the Houston Advanced Research Center (HARC) and the Petroleum Technology Transfer Council (PTTC) have joined together to develop and implement a research effort to address the issue of gas flaring and stranded gas by utilizing existing novel technologies aimed at monetizing gas at the wellhead. Recognizing the aforementioned emerging regulations as well as the economic benefits of flaring the overall objective of the Flaring Issues, Solutions and Technologies (FIST) project is to develop and demonstrate technologies specifically designed to utilize stranded gas and even reduce or eliminate the need to flare emissions associated with oil production in the first place. In other words HARC and PTTC hope to help operators make money from their stranded gas while conforming to new EPA rules.

Problem Identification

The FIST project team is developing program in 4 primary phases. Phase 1 of the project begins with seeking information from oil and gas operators working in various regions to better understand their specific needs and the potential impact of emerging regulations. Specifically phase one is looking at gas quality, quantity, current amount gas being flared and wells currently shut for lack of sufficient infrastructure, proximity to infrastructure such as power lines, roads and liquid pipe lines, and regional regulatory barriers to name a few.

This paper outlines the findings of three problem identification workshops held in key flaring markets in the lower 48 states. This information will be used to aid in the development of a screening tool prototype that can be used to begin the evaluation of flaring of existing flaring technologies. A Technical Readiness Level (TRL) Assessment on each technology identified will be conducted.
Phase 2 objectives include documenting selection criteria, selecting field test sites and developing a detailed planning for phases 2 and 4. Phase 3 will include detailed engineering and design for field demonstrations as selected by partnering companies. Phase 4 will include field trials, documentation and the continuation of the program to maintain the web site, additional field testing, and training.

**Identifying The Issues**

Each problem identification workshop was conducted in similar fashion beginning with opening remarks aimed at introducing the topic, operator question and answer where operators shared their specific issues related to flaring, industry presentations aimed at the evaluation of existing technologies, and regulatory presentations.

**Houston, Texas:** The first problem identification workshop was held in Houston and began with Dr. Rich Haut from EFD presenting an overview of the topic of using novel technologies to monetize gas at the wellhead. Following his remarks Dr. Haut led an operator discussion aimed at identifying the specific needs of the operators in the room. After this discussion John Westerheid, General Manager: Unconventional Resources Vertical for GE discussed Gas Monetization Networks. Then Audry Mascarenhas, President and CEO of Questor Technologies discussed their work in combustion, heat recovery, and power generation. Finally Rob Stewart from Bingo Interests discussed how Bingo approaches the issue of Flaring.

**Morgantown, West Virginia:** Later the same month the next problem identification workshop was held in Morgantown West Virginia. As with the Houston event the day began with a presentation from Rich Haut highlighting the issues for the group immediately followed by a question and answer session led by Dr. Haut. Following the Problem identification workshop Audry Mascarenhas from Questor Technology discussed revisited here discussion from Houston. Don Moss from Wellhead Energy Systems discussed Bill Pollock, Managing Partner at NEOgas North America, Inc. discussed options in the field for converting flare gas to alternate energy sources. Dr Mike McCawley from the WVU Department of Occupation and Environmental Health Sciences discussed Direct-Reading Monitoring of Horizontal Gas Well Flaring Operations. Finally the day concluded with a panel discussion with Robert Keatley from the West Virginia DEP, Scott Kell, OH DNR and Marvin Combs from the KY DNR.
Flaring Issues, Solutions and Technologies (F.I.S.T)

For more information about how you can participate please contact:

Rich Haut
rhaut@HARCResearch.org
281.364.6093

Tom Williams
twilliams@LEIDLLC.com
713.201.3866

Denver, Colorado: In October the group conducted its third problem identification workshop in Denver. Once again opening remarks were made by Rich Haut who once again provided an overview of the program followed by the question and answer session. After Dr. Haut Gary Kaufman from Holland and Hart discussed Colorado and North Dakota Air Regulations. Later that day Audrey Mascarenhas from Questor Technology revisited her presentation for the Colorado audience after which John Fox from ElectraTherm discussed Unconventional Flare to Power. Finally, Jakob Norman from Mesa Natural Gas Solutions LLC discussed Natural Gas-powered engines.

Key Findings

- In Denver participating operators discussed the fact that wellhead gas is inconsistent in its composition and therefor in its BTU delivery.
- Dealing with the liquids is very expensive when thinking about transportation, stability and price.
- Dual fuel engines that are being used to power drilling rigs can use CNG, but they still need diesel because of variation in the load on the engines.
- For significant horsepower needs, operators still need diesel, the CNG does not deliver the necessary power.
- It takes a lot of processing to remove impurities and raise the volume of gas to the correct pressure of 3600 psi for transport and once at the wellhead the pressure has to be reduced to go into the engine.
- Operators state that Bakken’s #1 problem is gas supply because of significant pressure drop in the system when gas processing plants are put in the gathering system.
- LNG will be very important but it is much more expensive to make the economics favorable need to build a big plant and have cooperation from multiple producers.
- Multi-well drilling and production pads are advantageous because gas produced from one well can be converted to CNG and used for drilling successive wells. The CNG can also be used for heating facilities and frac fluid.
- Designing the gathering lines to include new technologies in an effective way is a possible area for technological advance.
- Another problem with many of the shale oil plays is the rapid increase and decline in gas volume over time. This makes it more difficult to plan and utilize a supply of gas that is ephemeral in nature.
- Royalty issues are becoming a big deal. If you produce and use on the same site that is provided for in most leases, but if you use the gas from
one lease to help drill the well on a separate lease then you have a problem. A royalty payment may be required. Who is responsible to pay, the company producing the oil and associated gas, the company using the gas to create the CNG and transport to next site? Laws have not caught up with the variety of situations that are being encountered.

- Continental is avoiding the problem in the Bakken by paying full royalties on everything being produced including gas that is flared.
- Need for modeling software to deal with multiple wells with flow variations and variations in consumer requirements.
- Need a steady stream of production.
- Need to find ways to deal with slugs of liquids (water and hydrocarbons).
- On public and federal lands there is a long process to get approval for flaring gas. Government is royalty holder. For these reasons companies don’t want to be involved with federal land.
- Distance from infrastructure – distance and capacity of pipelines, pressure requirements at the pipeline. Hydrocarbon liquids are a real problem. There is currently a glut, pipelines are full and trucking the liquids is expensive.
- Distinguishing the type of liquid can be critical. Condensates produced from gas wells can be sold outside of the country because the prohibitions on selling oil products do not apply.
- CO2 regulation by EPA is important. CO2 is a byproduct of methane burn.
- Aggregate facilities and save money – create coops. These are difficult to negotiate between companies, but could ultimately create the economy of scale to make some of these technologies work for smaller companies.
- Distance between pad producing energy and pad needing energy. Once again reducing this distance through pad drilling can be critical.
- Permitting new technologies - the EPA likes know technologies and tend to be very slow to approve new technology.
- Fugitive emissions: There was some conflicting discussion of what FLIR guns (infrared cameras) are showing around wellsite tanks. Discussion that FLIR guns are actually showing VOCs not methane.
- Uses for the methane: heat, cool, water vaporization, lighten hydrocarbons. Use the heat produced from flare gas to vaporize waste water to avoid injection or heat fluids for fracing.
- Issues surrounding variations in gas production related to rapid decline. Economic factors make it less feasible to build significant gas gathering lines if production is going to drop. Once again having multi-well pads can mitigate these costs.
- At the session at WVU operators point was that drilling either under-balanced (as has been the common practice in the vertical section) or
over-balanced will affect the volume of gas going through the flare. This can be controlled somewhat by managed-pressure drilling.

- One participating company operates 60-70% with field gas or LNG; the goal is to have no diesel on site.
- The cost of conversion to LNG and to winterize the equipment were factors to be considered.
- The change in engine technology, with more dual-fuel options, has been beneficial.
- Regarding the source of field gas used as on-pad fuel was addressed by the operator working with both high- and low-pressure gathering systems, so they can gather and compress flare gas on-site with a mobile unit, use what they need and sell remaining product, or put it in line with produced gas for sale.
- Al Yost (NETL) offered additional comments on “energy assist” in which 20-30% of the water is replaced by natural gas.
- Gas turbines generate electricity for the frac pumps. Again, the goal is to eliminate diesel engines on the frac trucks.
- Initially, water flows back but as the volume of water decreases and gas flow increases, a decision point is reached that flaring is necessary. The second decision point is reached when gas goes into the line and flaring is stopped.
- In regard to pressure that is too high to complete their program limiting pressure to 80% of burst pressure, using a bigger wellhead, or running an oscillation sleeve could provide positive results.
- The electricity is regulated in PA, but not in WV, so it is easier to get electricity onto the grid in PA, is harder in WV.
- More importantly, the low cost of electricity produced by coal-fired power plants results in a lower market price for any electricity generated on-site for sale.
- This drastically effects the economics on on-site production of electricity for sale versus on-site use.
Flaring Issues, Solutions and Technologies

The Petroleum Technology Transfer Council and the Environmentally Friendly Drilling (EFD) program, managed by the Houston Advanced Research Center (HARC), have joined together to develop and implement a research effort to address gas flaring and stranded gas by utilizing novel technologies to monetize gas at the wellhead. PTTC will organize and run various workshops related to problem identification and technology transfer/training. EFD, a nonprofit organization, will manage the program.

The overall objective of the Flaring Issues, Solutions and Technologies (FIST) project is to develop and demonstrate technologies to monetize stranded gas and to reduce or eliminate gas flaring and/or methane emissions associated with gas production in a manner that results in monetization of the valuable gases.

The FIST project team is developing a budget, program schedule & sponsor participation fees. The fees may scale in degrees of funding by Phase (4 proposed phases), participation levels, adding service providers, including levels for operator type (small independent/mid size/major) or by regions.

Phase 1 of the project will develop a prototype screening tool and begin the screening of technologies. A Technical Readiness Level (TRL) Assessment on each technology identified will be conducted. In addition a White Paper will capture regionally specific findings from various workshops such as gas quality, quantity, current amount gas being flared and wells currently shut for lack of sufficient infrastructure, proximity to infrastructure such as power lines, roads and liquid pipe lines, regional regulatory barriers, etc.

Phase 2 consists of performing an initial evaluation of various technologies and to refine the screening tool. (This is a model for going forward). Outcomes of Phase 2 include documenting selection criteria, selecting field test sites and developing a detailed budget for Phase 2 and 4.

Phase 3 will include detailed engineering and design for field demonstrations as selected by the sponsors.

Phase 4 will include field trials, documentation and the continuation of the program to maintain the web site, additional field testing, provide training. There are various technologies that will be identified and screened as potential applications. Any of these technologies may be more applicable under conditions identified in our study. This will evolve as new plays are being developed, new regulations are passed, changes in the economics of the market and the technologies being applied.

For further information contact:
Rich Haut
rhaut@HARCresearch.org
(281) 364-6093

Tom Williams
twilliams@LEIDLLC.com
(713) 201-3866

FOR MORE INFORMATION ABOUT HOW YOU CAN PARTICIPATE
PLEASE CONTACT:

RICH HAUT          TOM WILLIAMS
RHAUT@HARCRESEARCH.ORG           TWILLIAMS@LEIDLLC.COM
281.364.6093          713.201.3866
FOR MORE INFORMATION ABOUT HOW YOU CAN PARTICIPATE
PLEASE CONTACT:

RICH HAUT
RHAUT@HARCRESERCH.ORG
281.364.6093

TOM WILLIAMS
TWILLIAMS@LEIDLLC.COM
713.201.3866