

## PTTC Workshop Summary Report Eastern Region – Appalachian Basin

**Title/Topic:** “Natural Gas Power for Shale Development/Using Natural Gas for Drilling and Hydraulic Fracturing”  
**Date:** September 5, 2013  
**Location:** Canonsburg, PA  
**Co-Sponsor:** Environmentally Friendly Drilling (EFD) Systems Program  
**Speaker(s):** Thirteen plus a panel discussion at the end (**see attached schedule**)  
**Method Used To Advertise/Promote:** E-mail distribution list among 10 local geological societies and SPE chapters, several local universities, independent oil & gas associations of several states, DOE-NETL, USGS and Appalachian basin state geological surveys; placed on national PTTC website/calendar; placed on EFD’s website requested all speakers to distribute to members of their organization  
**Fee:** \$150 for professionals; \$40 for students; \$250 for both days  
**Attendees:** Industry: 35 Others: 9 Total: 44

### Synopsis/Overall Assessment:

The workshop was modeled after a workshop on the same theme hosted by EFD earlier in the year in Texas. That particular workshop attracted nearly 150 attendees, and provided us with the incentive to offer a similar workshop in this area.

The PTTC Regional Director could not attend the entire workshop. However, he did receive a summary of the workshop from Renu Chakrabarty, one of the workshop speakers who is employed by the WV Department of Natural Resources. Her unedited summary notes are below.

I attended a workshop last week on Sept. 5, 2013 regarding Using Natural Gas Power for Drilling and Hydraulic Fracturing. The presentations will be posted to the Environmentally Friendly Drilling-WVU consortium website (<http://www.efdsystems.org/>). My notes are below.

- There can be reductions in criteria pollutants and HAPs *\*if\** catalysts are *also* used along with the fuel-switch/supplement along with on-going engine maintenance.
- While not widespread, there are already dual-fuel and bi-fueled drill rigs and frac engines out on drill sites currently. There are at least a couple gas-fired drill rigs in WV (not all are actually using their natural gas capability). The goal is to replace and/or supplement diesel fueled engines with some form of natural gas (field gas, pipeline gas, compressed natural gas, or liquefied natural gas). When switching from diesel to diesel and natural gas combined, CO and NOx emissions go up. A CO catalyst is needed to meet the non-road engine standards; a NOx catalyst is usually also needed to meet the NOx+NMHC standard.
- Engines must be maintained in order for the dual-fuel mixes to properly combust and work most efficiently; this includes tune-ups and air filters. Each engine is unique and an off-the-shelf approach will not realize the efficiency, performance and emissions that are theoretically possible.

- For diesel-supplemented-with-natural gas, Cummins is running about a 50-60% natural gas supplement to the diesel for the overall fire to maximize engine efficiency and minimize knocks and emissions.
- Reasons given for switching to natural gas included:
  - Building demand and infrastructure for natural gas powered engines to help promote their industry
    - That is, the industry should use its own fuel to the extent possible to expand the demand and growth potential for natural gas
  - Less truck traffic and congestion to/from/on pads
    - Less logistics/cost for them, as well as less road/transportation safety issues
  - Older engines need to be repowered anyway, so doing the fuel changes at this point in the life of the engine makes sense
  - Sustainable operations
  - Better for the environment
    - Emissions reductions and less noise
  - Safe when operated correctly
  - At least one mfg noted that natural gas engines were **\*not\*** cheaper than diesel
    - Another mfg noted that over time, fuel cost savings may be realized as the technology was developed and more widely available
- Some manufacturers are exploring diesel supplemented with natural gas, others are developing engines that switch between either 100% diesel –or- 100% natural gas.
- While it seems the industry is retrofitting reciprocating internal combustion engines (for example, Cummins and Caterpillar), a new entry seems to be gas-fired turbines (for example, GE). The noise from turbines is higher than for natural gas, and the turbine has not been as widely field tested yet.
- The engine manufacturers all indicated that the long-term effects of dual-fuel firing on the engines were not yet known.
- Of the group present at the workshop, the consensus seemed to be for LNG (over field gas, pipeline gas, and compressed gas) due to the consistent fuel quality and reduced truckloads (compared to diesel) to get the fuel to the well pads. The tradeoff is the (currently) slightly higher cost due to less supply.
  - Some areas have very dry field gas, and are ideal for fueling engines in the field (inc. some areas of PA). Wetter gas areas are not ideal.
    - There can be tradeoffs to using more field gas – for example, more engine knocks/loss of efficiency and potential lowered engine life
  - Compressed natural gas was a last choice due to the quantities needed.
  - Pipeline quality natural gas is logistically not possible at most sites currently; this may change over time.
- Given the current deficit of LNG relative to potential demand, operators want their engines to maintain the ability to run on diesel so they will not miss operating time.
- EPA's off-road tiered engine emissions standards were discussed in the context of original equipment and repowering engines. There was some confusion among the group, and there will be some follow-up with EPA. The general thinking seemed to be

- that EPA would not allow Tier IV, interim and Tier IV engines (the latest ones) to be dual-fuel (or else it would be considered to be 'tampering'). However, they thought that Tier O, I, II, and III engines could be changed over to dual-fuel capability if they were re-certified to meet the Tier IV engine emission requirements.
- Some metrics used by drill operators at the conference that may be useful in estimating emissions are:
    - Frac engines are approx. 2,250 – 2,500 hp each
    - ~2,000 gal diesel fuel used per frac stage (per Universal)
    - 12,800 gal diesel/day: 80 gal diesel/hr per frack pump; 16 pumps per site; 2 hr per stage; 5 stages per day (per Prometheus)
    - Avg drill rig uses ~1,500 gal diesel/day
    - Avg frac engines operate 300 days a year
  - Diesel gas equivalents (DGE) were used as a metric for comparing the LNG fuel needs to the standard diesel fuel needs.
  - An odorant is added to LNG gas as a safety measure in case of leaks. There are also emergency shutoff devices (ESDs) located throughout the rig, control room and pad in case a leak is detected.
    - Methane detectors and hand held units are also located throughout the site.
  - The size/weight of LNG trucks is limited by dept of transportation road worthy rules
  - Natural gas fuel line purging/emissions: can be purged with N2 and piped offsite –or- burned in the engines –or- pump N2 into the line and then back into the engine
  - My presentation on air quality and unconventional drilling operations was well-received. However, there were **\*many\*** follow-up questions focusing on noise (both the results of the study, and ways to measure and mitigate). My interpretation of the direction the questions took is that the industry is hearing a lot of citizen complaints regarding noise and truck traffic, and may be starting to realize their public image is involved.

(from Renu Chakrabarty, 9/20/13 e-mail)

A list of the presentations and speakers is included as the first attachment to this report.

### **Participant Feedback (Implies Feedback Form Is Measuring Following):**

#### Evaluation of Speaker(s):

Fifty nine percent of the respondents gave the speakers a 5 out of 5; 100% at least a 4 out of 5.

#### Did the workshop content deliver what advertising/promotional material promised?

Twenty nine percent graded the workshop as 5 out of 5 based on its meeting their expectations; 94% graded it at least a 4 out of 5.

#### What was the most valuable part of the workshop?

Probably the number and variety of speakers and the broad spectrum of topics covered, in particular, the information presented on how to retrofit engines to allow dual-fuel capability in the field.

What was the least valuable part of the workshop?

The workshop was designed to concentrate on emissions and how they could be reduced if operators switched from diesel to a combination of diesel and natural gas to power drilling and fracturing. But, many of those present wanted to discuss issues other than emissions, which probably reflected the type of complaints they were being forced to deal with as they develop the shale plays in this area.

Appropriateness of attendee fee (too low, about right, too high)?

One hundred percent thought the fee was about right.

All things considered, was the workshop worth your time & money (Y/N)?

Yes; 71% thought the workshop was well organized (scored 5 of 5) and 100% gave it at least 4 out of 5.

Will you be able to use the information received and in what time frame (now, near future, at some undefined future date)?

Difficult to say from the questions asked. Only 4 of 14 persons who answered the question indicated that they had used information gained at a previous PTTC workshop; five of 15 expressed a willingness to share something they had learned, but only one person, apparently from Chevron, offered a specific example of what they would share.

Individual Written Comments of Note:

“-Facilitation excellent and on schedule”

“Very good spectrum of speakers with several perspectives”



## WORKSHOP

Natural Gas Power for Shale Development  
Using Natural Gas Power for Drilling and Hydraulic Fracturing  
Hilton Garden Inn, Canonsburg, PA  
September 5 2013



- 08:30 – 08:40 **Rich Haut**, HARC Environmentally Friendly Drilling  
*Welcome and Introductions / The EFD Program – Unbiased Science to Address Environmental issues*
- 08:40 – 08:55 **Carolyn LaFleur**, HARC Environmentally Friendly Drilling  
*PbNG / Powered by Natural Gas*
- 08:55 – 09:20 **Renu Chakrabarty**, West Virginia Department of Environmental Protection  
*Air Quality Issues and the Expanded Use of Natural Gas Fuel*
- 09:20 – 09:40 **Susan Stuver**, Texas A&M Institute of Renewable Resources  
*Know the Facts about Emission Factors*
- 09:40 – 10:00 **Shane Cannon**, Cummins, Inc  
*Advances in High Horsepower Dual-Fuel Technology*
- 10:00 – 10:30 BREAK/Exhibitors
- 10:30 – 10:55 **Tom Hausfeld**, GE Power & Water  
*Electric Fracturing Equipment / Evolution Well Services*
- 10:55 – 11:25 **James Durand**, The Ohio State University Center for Automotive Research  
*Cost Effective Well-Site Management Support of Energy, Environmental & Regulatory Issues*
- 11:25 – 12:00 **Mike Fradette**, Prometheus Energy  
*LNG Fueling Systems and Logistics*
- 12:00 – 01:00 LUNCH
- 01:00 – 01:20 **Sam Thigpen**, Thigpen Energy, LLC  
*Natural Gas Fueling Solutions for Drilling and Pressure Pumping Applications*
- 01:20 – 01:40 **Mike Kloecker**, Universal Well Services  
*Using Natural Gas for High Horsepower Hydraulic Fracturing Operations*
- 01:40 – 02:00 **James Stewart**, Keane Group  
*Reducing Shale Development Site Footprint with Natural Gas Fuel*
- 02:00 – 02:20 **Brett Stephanow**, Chevron  
*LNG Adaptation & Process Change*
- 02:20 – 02:40 **Todd Fox**, Nabors Drilling  
*Drilling Rig Natural Gas Technology*
- 02:40 – 03:00 BREAK
- 03:00 – 04:00 **Susan Stuver**, Moderator - Panel Discussion, all presenters

**Natural Gas Power for Shale Development/Using Natural Gas for  
Drilling and Hydraulic Fracturing  
September 5, 2013; Canonsburg, PA**

**Attendees**

<b>First Name</b>	<b>Last Name</b>	<b>Company</b>	<b>City, State</b>
***John	Allen	Keane Group	
***Kathleen	Antoine	Hess	Woodbridge, NJ
***Robin	Anthony	PA-DCNR	Pittsburgh, PA
***Jerry	Armentrout	Cummins Crosspoint	White Hall, WV
***David	Belcher	WV DEP	Charleston, WV
***Matt	Beltrondo	Mt. Supply & Services	Triadelphia, WV
**Linda	Berndt	Encana Natural Gas	Plano, TX
***Joe	Campbell	The Ohio State Univ	Columbus, OH
**Shane	Cannon	Cummins	
***Renu	Chakrabarty	WV DEP	Charleston, WV
**Fabio	Chiara	The Ohio State Univ	Columbus, OH
***Jeff	Daniels	The Ohio State Univ	Columbus, OH
***Carolyn	Debrick	Statoil	
**James	Durand	TOSU Center for Automotive Research	Columbus, OH
**Todd	Fox	Nabors Industries	
**Michael	Fradette	Prometheus Energy Gp	
**Rusty	Gilbert	Chevron	Moon Township, PA
**Ryan	Gibson	Caterpillar	Hunker, PA
**Tom	Hausfeld	GE Power & Water	
***Rich	Haut	HARC	Houston, TX
**William	Hayward	Hayward Nat Resources	White Oak, PA

**David	Herr	Shell Appalachia	Sewickley, PA
**Dawson	Hoffman	CONSOL Energy, Inc	South Park, PA
***Brian	Keane	Keane Group	
***Michael	Kloecker	Universal Well Services	Meadville, PA
***Olga	Koper	Battelle	Columbus, OH
***Carolyn	LaFleur	EFD Systems Program	Houston, TX
***Andrew	Lowther	Energy Corp of America	Charleston, WV
**David	Mazon	EQT	Washington, PA
***Pete	Penoyer	National Park Service	
***Kevin	Reese	Tenaris	
***Gary	Rodvelt	Halliburton	Canonsburg, PA
***Russell	Roundtree	Noble Energy	Canonsburg, PA
***Natalya	Sachivichik	Chevron	Moon, PA
**Lanfer	Simpson	EQT	Washington, PA
***James	Slutz	Global Energy Strategies	
**Brett	Stephanow	Chevron	
***James	Stewart	Keane Group	
**Susan	Stuver	Texas A&M Institute of Renewable Natural Res	San Antonio, TX
**Sam	Thigpen	Thigpen Energy	
***Paul	Weiksner	Cummins Power Systems	Williamsport, PA
***Andra	Wilcox	EFD Systems Program	Houston, TX
***Tom	Williams	EFD Systems Program	Houston, TX
**Richard	Winschel	CONSOL Energy Inc	South Park, PA

\*\*Attended second day only

\*\*\*Attended both days

## EVALUATION SUMMARY

### ***“Natural Gas Power for Shale Development – Using Natural Gas Fuel for Drilling and Hydraulic Fracturing”***

September 5, 2013

Canonsburg, PA

1. How did you hear about the workshop?  

<u>0</u> Direct mailing	<u>0</u> Periodical	<u>1</u> Phone
<u>7</u> E-mail	<u>2</u> Internet/www	<u>7</u> Other
  
2. What additional topics would you like to see in future Focused Technology Workshops?  
  
-production analysis for unconventional ways to recomplete older horizontals  
-waste water management
  
3. Are you a(n):  

<u>6</u> Operator (field supervisor, geologist, engineer)
<u>5</u> Service Company employee
<u>0</u> Consultant
<u>2</u> Educational Institution employee
<u>3</u> State/Federal Government employee
  
4. Please circle the response that best indicates your agreement, with 5 being the strongest:  

A) The program met my expectations	5(11)	4(5)	3 (1)	2	1
B) The speakers/facilities were acceptable	5(10)	4(7)	3	2	1
C) The program was well organized	5 (12)	4(5)	3	2	1
  
5. The workshop fee was: 0 too low 17 OK 0 too high
  
6. Additional comments: (Please use back of page if needed).
  - Facilitation excellent and on schedule
  - very good spectrum of speakers with several perspectives
  - need to have better microphones for speakers
  - nice to have speaker bios
  - please make sure that these presentations are available online!
  
7. Please indicate which tech transfer method is most helpful to you. Rank from 1 to 5, with 5 being the most helpful:  

Workshop	5(7)	4(4)	3(1)	2 (0)	1(2)
Individual assistance	5(6)	4(0)	3(4)	2(3)	1(1)
Reports/Case studies	5(5)	4(3)	3(4)	2(2)	1(0)



Internet 5(2) 4(4) 3(2) 2(4) 1(2)

Newsletters 5(4) 4(2) 3(1) 2(4) 1(3)

8. Have you attended other PTTC events? 5 Yes (how many?) 10 No

Have you used any new technologies based on knowledge gained through PTTC events? 4 Yes 10 No If yes, please describe (in general) the application/results. (PTTC will only use your response with your permission.)

-AB Well Evaluation/Ranking

-events on environmentally friendly drilling

9. Would you be willing to share with others any technology innovations or best practices?

5 Yes 10 No If yes, briefly list topics/information you are willing to share.

-ways to create effective communications with stakeholders, what Chevron is doing to lower emissions, dropping sound levels to create long-term Marcellus drilling sustainability.

- gas turbines

- appropriate to situation (?)