



ENERGY PIPELINE

COVERING THE ENERGY INDUSTRY IN THE ROCKY MOUNTAIN REGION

OIL PRICES

Oil prices will need to climb higher
to kick-start stalled drilling
in Weld County

OIL & GAS HEALTH

Weld County health incidents
level with rest of state despite
more oil & gas development

GREENHOUSE GASES

Energy industry helps
lower carbon dioxide
gases

PDC PLANS CHANGE

PDC Energy abandons
west Greeley
relocation plans

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TECH TALK

Converting flared gas to electricity at the tank battery

BY GARY BEERS • FOR ENERGY PIPELINE

FLARING GAS IS BURNING MONEY

Bright lights dot many oilfields due to the common practice of burning off natural gas during oil/gas drilling and production to release pressure – a process called flaring. An estimated one-third of the natural gas produced during the fracking boom in North Dakota's Bakken oilfield was flared (Fortune, K. Fehrenbacher, July 13 2016). These flares are essentially burning money. Using a supermaterial, a start-up company called Alphabet Energy has developed a solid-state technology to convert the exhaust heat of an enclosed flare into electricity. A well pad operator can offset thousands of dollars per month that would have been spent on generator fuel, rental and maintenance cost – all while ensuring reliability. Further, the generation of 2.5 kW of electricity with this technology is enough for operators to optimize production and ensure site safety by running a variety of site electronics (i.e., process equipment and SCADA) (M.Pahl, Vice President, Alphabet Energy).

The substitution of this new technology will reduce methane emissions and will eliminate diesel and natural-gas powered generators as sources of carbon dioxide and nitrous oxide gases. An initial installation is present in Ohio's Utica Shale region with follow-on installations at Encana overseas operations.

THERMOELECTRIC POWER GENERATION: TETRAHEDRITE

To appreciate the above break-through recognition and use of a specific thermoelectric material, the following scientific background is helpful "Thermoelectric materials can turn temperature difference into electricity by exploiting the flow of electrons from a warmer area to a cooler one. Thus,

they can theoretically turn waste heat into a power source. But an efficient thermoelectric material has to conduct electricity well without conducting heat well, because otherwise the temperature across the material would soon equalize. Most materials that are good electrical conductors are also good thermal conductors, and the few materials that researchers have been able to develop with good thermoelectric properties have been rare, expensive, or toxic." (Thermoelectric Material to Hit Market Later This Year, S. Jacobs, Technology Review, July 15, 2016)

The break-through centers on the use of tetrahedrite, which is an abundant, naturally occurring mineral that is a nontoxic thermoelectric material. This mineral, at \$1.81 per pound, is cheaper than other thermoelectric materials, which have to be processed and/or manufactured with a cost of between \$10.89 to \$66.22 per pound. Also, while other thermoelectric materials have achieved typically about 2.5 efficiency, tetrahedrite can reach 5 percent to 10 percent efficiency. (CEO, Alphabet Energy, July 2016).

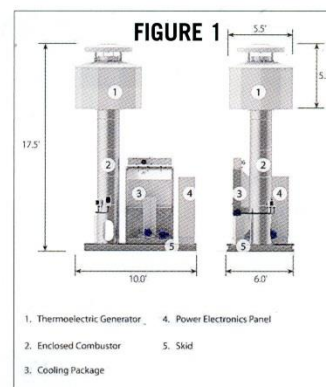
Further detailed scientific information on tetrahedrite is available ("Naturally occurring mineral for thermoelectric power generation, Journal of Applied Physics, Jan. 28, 2013).

HOW DOES A SOLID-STATE GENERATOR CAP ON ENCLOSED FLARE GENERATE ELECTRICITY?

The Power Generating Combustor (PGC) shown in Figure 1 is a joint effort by two companies, Alphabet Energy and Coyote North. The unit which is about 18 feet tall on a 10 foot long skid consists of a vertical cylinder (enclosed combustor for flare gas), a cap-like housing for the thermoelectric generator, a larger box housing the cooling package, and a



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smaller box housing the power electronics panel.

The thermoelectric generator has no moving parts and can be visualized as a "solar panel" for converting heat to electricity. High temperature exhaust heat (across a range of fuel inputs and combustion temperatures) is passed across heat exchangers containing tetrahydrite ("PowerModules") which produce electricity. The requirement for minimum flare gas flow is in the range of 500 to 1,667 cubic feet per hour with a minimum heat output of 1.7 million Btu per hour.

OTHER APPLICATIONS IN OIL FIELD

Obviously, there are many other applications of the platform technology based on tetrahydrite-based heat exchangers. Exchangers can be bolted on diesel or gas powered generators to convert the exhaust to electricity, including truck engines. Exchangers can be wrapped around pipes transporting high-temperature liquids to generate electricity.

This solid-state technology is scalable and should have many applications in the oilfield operations, especially in remote settings. Obviously, surplus electricity from flare gas utilization could be supplied to electrical operations on adjacent land uses (i.e., water pumps, electricity for homes/barns, power stations for electric vehicles). Everyone is familiar with the scalable solid-state technology is present in solar panels (i.e., small panels for stand-alone signs or monitoring equipment in remote areas, large arrays of panels in solar farms). ♦

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