THE USE OF INFRARED THERMOGRAPHY TO OPTIMIZE PRODUCTION IN OIL AND GAS FIELDS WHILE PROMOTING SAFE AND ENVIRONMENTALLY RESPONSIBLE WORK PRACTICES

Joe Flud, Pioneer Natural Resources
Sophia J. Panos, The Marshall-Teichert Group

1. INTRODUCTION: THE CASE FOR INFRARED THERMOGRAPHY

Historically, gas recovery was not considered a profitable proposition for producers in the Permian Basin. Today's commodity gas pricing makes it a viable revenue generator with a 10:1 recovery payback. Safety and environmental incident prevention, lost profit potential, responsibility to shareholders, and the economics and feasibility of thermal imaging create a convincing case for investing in infrared thermography. Pioneer Natural Resources operates 5600 producing wells and 1617 tank storage batteries, with more than 2,000 miles of flow and transmission line in the Permian asset. In 2007 the company invested in a gas leak detection camera and a thermographer. The economics, safety and environmental benefits proved so compelling that a second camera and thermographer were added in 2008.

2. INFRARED THERMOGRAPHY: A PRIMER[1]

Thermography or thermal imaging is the use of an infrared imaging and measurement camera to record the emission or existence of thermal or infrared radiation in the form of heat. The camera "sees" and "measures" thermal energy emitted from an object. Thermal, or infrared energy, is light that is not visible because its wavelength is too long to be detected by the human eye; it's the part of the electromagnetic spectrum that we perceive as heat. Unlike visible light, in the infrared world, everything with a temperature above absolute zero emits heat. Even very cold objects, like ice cubes, emit infrared. The higher the object's temperature, the greater the infrared or IR radiation emitted. Infrared allows us to see what our eyes cannot. Infrared thermography cameras produce images of invisible infrared or "heat" radiation and provide precise non-contact temperature measurement.

Thermography is employed in many areas such as building diagnostics, non-destructive testing, military, maintenance, electrical, law enforcement, security, veterinary, medical, and astronomy. Thermal imaging is also used in infrared satellites to monitor the Earth's weather & vegetation patterns. These are just a few of the areas where thermography is used to identify or diagnose potential problems. Since nearly everything that uses or transmits power gets hot before it fails, the camera is also used to isolate 'hot spots' that can lead to equipment failure.

Although thermal imaging can be used in the daylight, thermography allows one to "see" in the dark, as it does not rely on the reflectance of light within the "visible" range of the electromagnetic (EM) spectrum in order to record imagery. All objects at temperatures above Absolute Zero (0 K or -273.15 °C) emit some sort of thermal radiation or heat, many within the infrared portion of the EM spectrum.

Thermography refers to the wavelengths within the EM spectrum in units of nanometers, micrometers, or microns. The commonly referred to ranges within the spectrum are gamma rays, x-rays, UV rays, visible, infrared (IR), microwave, and radio. Some objects that are very hot such as the Sun emit thermal radiation viewable within multiple parts of the EM spectrum: the "visible", "ultraviolet" (UV) and "infrared" areas.

[1] FLIR Thermal Infrared Camera Systems website; used with permission; www.FLIR.com

3. HOW THERMAL IMAGING INFRARED CAMERAS WORK[2]

An infrared camera detects infrared energy in the form of heat and converts it to an electronic signal which produces a thermal image on a video monitor with temperature calculations. Heat sensed by an infrared camera can be precisely and instantly measured, allowing the relative severity of heat-related problems to be determined and documented. Instantaneous reporting and analysis of inspection results make timely repairs possible.

The Thermacam GasFindIR Infrared Camera used by Pioneer, and manufactured by FLIR Systems, Inc., is capable of detecting the following gases: Benzene, Ethanol, Ethylbenzene, Heptane, Hexane, Isoprene, Methanol, MEK, MIBK, Octane, Pentane, 1-Pentene, Toluene, Xylene, Butane, Ethane, Methane, Propane, Ethylene, and Propylene.

4. APPLICATIONS FOR INFRARED THERMOGRAPHY IN OIL AND GAS PRODUCING FIELDS

The majority of gas leaks in oil and gas fields are imperceptible to human smell and sight. Pioneer uses thermography to detect gas leaks on pumping units, flow lines, gas sales lines, heater treaters, vapor recovery units, tanks and vessels. When thermographers detect a leak, they determine the root cause and report it to Pioneer Operations, at which time the leak is logged and promptly repaired. The thermographer records the leak location using digital video, and quantifies the loss. Approximately 15 days following the repair, the thermographer returns to the repair location to take a follow up measurement, verifying the effectiveness of the repair and the amount of loss avoidance. The table below contains examples of gas leaks detected by Pioneer thermographers.

Most gas leaks are relatively small in size, and the cost of repair relatively low. However, small leaks become large leaks if undetected and not repaired. Pictures 1 and 2 below show a leak due to a hole in a scrub pot that supplies gas to water and oil dumps.

The volume of Pioneer wells, batteries, and flow lines in the Permian necessitates prioritizing thermographer gas leak inspection work. New oil tank storage batteries and their accompanying flow lines are of highest priority, since a new well put on production is at the height of its production lifecycle. Additionally, problems detected at a new battery should be fixed while the construction work is still under vendor warranty. After new battery locations, thermographers inspect battery locations by produced gas volume, from most to least. Once all batteries are inspected, operator routes are inspected according to route volume.

At Pioneer, lease operators in the Permian bear a responsibility for conducting routine checks for gas leaks, using a Gas Leak Check Sheet. If a leak is suspected, or if the operator is not meeting targeted gas production, a thermographer may be contacted. The thermographer deviates from his inspection schedule to respond to such requests for help.

5. DATA COLLECTION AND RESULTS

Pioneer thermographers gather data on each well and battery inspected and save it to a common shared drive for access by field personnel. Leaks and repairs are tracked and losses quantified.

The following chart captures the financial benefit of gas leak detection to Pioneer. For Pioneer, economic, safety and environmental considerations justify the focus placed on gas recovery.

6. SAFETY AND ENVIRONMENTAL INCIDENT PREVENTION

At Pioneer, thermal imaging plays a role in safety and environmental incident prevention. Leaks are often extremely difficult to detect by human sight or smell, and can cause unsafe work conditions. For example, starting a truck engine in close proximity to an undetected leak can pose a safety risk for field personnel. From an environmental standpoint, unintentional venting of gas in violation of environmental laws can lead to costly fines.

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[2] FLIR Thermal Infrared Camera Systems website; used with permission; www.FLIR.com

Additionally, hurricanes in the Gulf Coast area that cause interruptions in gas line transmission and result in temporary gas plant closures are often responsible for dangerous and abnormally high line pressure. Following recent hurricane events, Pioneer thermographers checked for leaks on high volume leases where pressure build up was likely to be greatest.

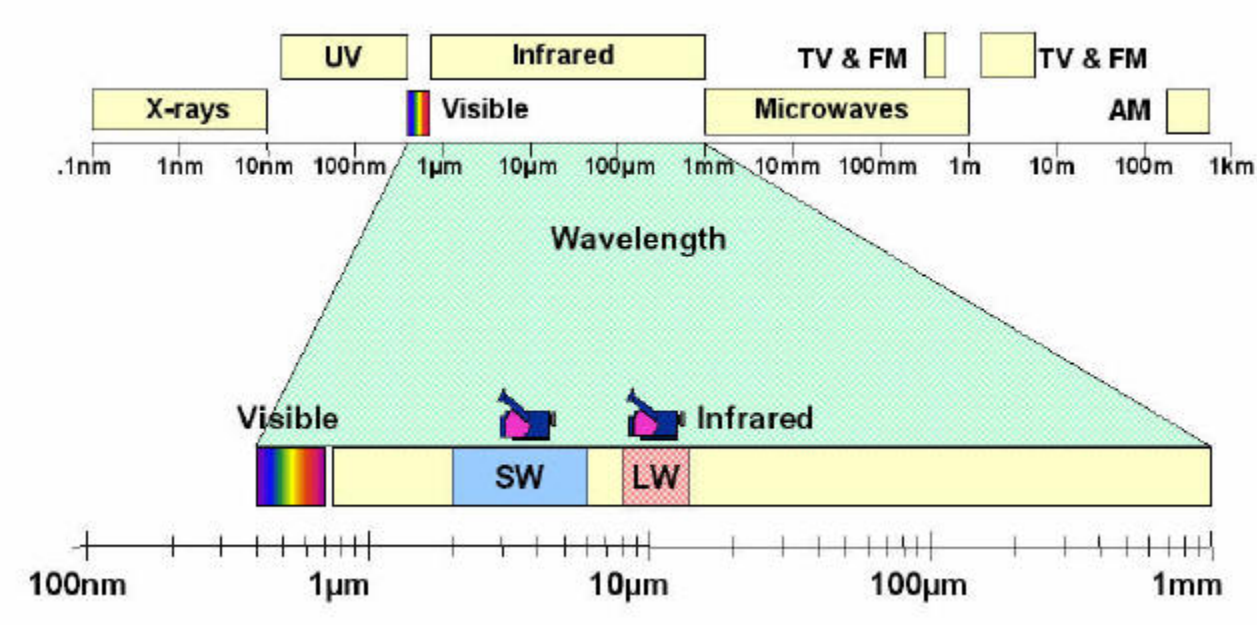
7. GAINS THROUGH EMISSION REDUCTION

Emerging federal legislation has been introduced into Congress in response to concerns over climate change and the desire to reduce green house gases (GHGs). Federal 'cap and trade' legislation is expected to pass in late 2009 or early 2010, with the first compliance period falling in the 2012 to 2013 timeframe. If this GHG legislation passes, compliance will result in the need for producers to increase leak detection, reduce emissions, improve compressor performance, and increase vapor recovery efforts. Businesses that meet standards specified by carbon legislation are expected to become eligible for carbon compliance credits. Some speculate that these compliance credits will spawn a commodity market for credits with real economic benefit to producers.

8. CONCLUSION

Today's commodity gas prices, as well as safety and environmental considerations offer a compelling business case for investing in gas leak detection technology. In addition to a reliance on thermography, a future trend in gas leak detection includes greater use of Supervisory Control and Data Acquisition (SCADA) on gas meters to remotely monitor drops in volume, signaling potential leaks.

The use of infrared thermography is especially relevant for producers experiencing aggressive growth with accompanying increases in the numbers of producing wells, batteries, vessels and flow lines, which can mean a greater opportunity for leaks. Proactive gas leak detection is a way for producers to prevent safety and environmental incidents, while deriving the financial benefits of recovery.



The Electromagnetic Spectrum

Examples of Gas Leaks Detected by Pioneer Permian Using Infrared Thermography				
Location Of Leak	**Type Of Leak**	**Root Cause**	**Volume of Loss Per Day**	**Annualized Recovery @ $10 per mcf**
Gas Sales Line	Hole in Line	Normal Wear	30 mcf	$109,500
Tank Storage Battery	Dump Valves	Seats Worn	20 mcf	$73,000
Pumping Unit	Hole in Casing Down Hole	Normal Wear & Corrosion	30 mcf	$109,500
Heater Treater	Pop Off Valve	Malfunctioning Pop Off Valve	6 mcf	$21,900
Water Storage Tank	Roll Line Venting	Valve Left Open On Roll Line	22 mcf	$80,300

Picture 1 -Leak on a scrub pot that supplies gas to water and oil dumps.

Picture 2 - Same location as above following repair.

Pioneer Permian Gas Leak Detection Results
December 2007 through February 2009