INFRARED (IR) CAMERA

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BACKGROUND:

ABOUT INFRARED (IR) CAMERAS

SAGE HAS TWO DIFFERENT TYPES OF INFRARED (IR) CAMERAS: THE FLIR GF320™ AND THE GASFINDIR™.

GASFINDIR™

GasFindIR™ is the original IR camera used for Optical Gas Imaging (OGI). The GasFindIR contains a cooled Indium Antimonide (InSb) detector. The temperatures ranges from -15°C to +50°C for visualization with the GasFindIR™. The GasFindIR™ operates at 25 Hz PAL (25 images per second). The GasFindIR™ is easily set up to record videos of seen leaks on any off the shelf video recorder.

GF320™

GF320™ is another IR camera used for OGI. This camera visualizes and pinpoints leaks of Volatile Organic Compounds (VOC). The GFI 320™ contains a cooled Indium Antimonide (InSb) detector, which gives this camera the ability to visualize 3.2 - 3.4 micrometer waveband. The temperatures ranges from -40°C to +350°C for visualization with the GF 320™. The GF 320™ operates at 60 Hz PAL (60 images per second). The GF 320™ has built-in removable storage (SD or SDHC memory cards), built-in digital camera (3.2 megapixels), and a built-in laser pointer. The GF 320™ has more than just the IR-imaging capability; it has visual imaging and High Sensitivity Mode (HSM).

The GasFindIR™ and the GF 320™ can detect the following gases:

- Benzene
- Ethanol
- Ethylbenzene
- Heptane
- Hexane
- Isoprene
- Methanol
- MEK
- MIBK
- Octane
- Pentane
- 1-Pentene
- Toluene
- Xylene
- Butane
- Ethane
- Methane
- Propane
- Ethylene
- Propylene

USING THE IR CAMERA TO IDENTIFY EMISSION SOURCES

It is important for public health and safety reasons to identify all sources of emissions associated with natural gas collection and processing.

CONDUCTING IR CAMERA SURVEYS

Sage performs IR camera surveys at all accessible gas well pads and processing facility operating. The IR camera provides a quick and effective means of surveying large areas for equipment leaks. While the IR camera cannot quantify emissions, the extent and density of the IR image provides the experienced operator with an indication of the magnitude to focus the sampling program on when obtaining actual emission quantities from statistically representative sites.

We use a pre-formatted electronic spreadsheet to characterize each source. Each facility visited by the point source inspection team is documented with photographs and a detailed inventory of major onsite equipment, including the number of wells, separators, tanks, dehydration equipment, valves, and estimated connectors. All emissions detected with the IR camera can be video recorded, and the equipment can be photographed with a digital camera.

HI FLOW SAMPLER™

Following the IR camera surveys, emission rates for all safely accessible IR camera emissions can be measured directly using the Bacharach Hi Flow Sampler™ (Hi Flow). The Hi Flow quantifies natural gas emissions as percent methane and as percent of total flow. On occasions where the emission concentration is below the detection limit of the Hi Flow, a Toxic Vapor Analyzer (TVA) is used to sample the Hi Flow exhaust stream so that an emission can be calculated. Speciated emission rates are determined for a select number of emission sources by collecting a canister sample from the exhaust port of the Hi Flow.

Emission points determined by the field crew to be unsafe or potentially damaging to the sampling equipment (e.g., compressor engine exhaust vents, reboiler exhaust vents, dehydrator vents, flare vents, incinerator vents etc.) are not characterized by the Hi Flow or with canister samples. We can still gain useful information by IR video recording of emissions from such sources. Flare combustion efficiency, for instance, is evaluated by the IR camera by viewing the flare plume as it dissipates into the atmosphere. Quick dissipation is an indication of good combustion efficiency, while a long, cohesive plume indicates just the opposite.

Emissions from other inaccessible vents and seals can be similarly evaluated. Produced water tanks at natural gas pad sites are usually equipped with pressure relief equipment (e.g., pressure relief valves, thief hatches, and conservation vents). The integrity of this equipment can quickly be determined with the IR camera. Most of this equipment is accessible to Hi Flow testing. Natural gas well pad production tanks, where oil and/or water is moved from separation equipment and stored, are also

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a source of flashing emissions. One goal of this project is to further understand and characterize flashing emission. Companies can select a number of well pads to study these phenomena.

SPECIATED EMISSION RATES

In order to develop speciated emission rates, we collect a select number of canister samples from the exhaust port of the Hi Flow. Sage coordinates with companies to determine the precise number of canisters required after determining a target number of sites or facilities. Number of canisters (including duplicates) should be budgeted for these types of project. This number may change based upon the number of emission points detected.

We deliver canister samples, along with the appropriate chain-of-custody documentation, to pre-determined labs for analysis. Canister samples are analyzed by PAMS SNMOC for light hydrocarbons (methane) and VOCs. All testing and sample analysis is conducted using standard quality control procedures.

VALIDATING IR CAMERA SENSITIVITY

Prior to use, the IR camera's sensitivity will be validated daily through the following procedures:

IR CAMERA

1. A flow of propane gas approximately equal to 5 grams/hour is established and the furthest distance from which the camera operator can reliably detect the gas flow is documented and a video record saved.
2. The gas flow is increased to approximately 25 grams/hour and Step 1 is repeated.
3. The following meteorological conditions are recorded, along with the timestamp and measured distances: ambient temperature, wind speed, % relative humidity, barometric pressure, % cloud cover, and degree of ambient light.

BACHARACH HI FLOW SAMPLER™

1. Calibration checks are performed on the Hi Flow each day prior to use with a 2.5% CH4 certified compressed gas standard on both background and gas sampling ports. If the Hi Flow's response is not within +10% of the span standard, the instrument is recalibrated or repaired.
2. Prior to field work on the first day of a new week, the Hi Flow is checked with both a 100% CH4 standard and a 2.5% CH4 standard at both ports. If the Hi Flow's response is not within +10% of either span standard, the instrument is either recalibrated or repaired before being placed into service.

TVA 1000-B

1. The TVA is calibrated daily prior to use with zero air and three upscale certified span gas concentrations: low (~500 ppm CH4), mid (~1000 ppm CH4), and high (~10,000 ppm CH4). An acceptance criterion of +10% accuracy is required for each span calibration point.
2. A drift of the analyzer is performed at the end of each day using the same acceptance criterion.

USING THE IR CAMERA TO IDENTIFY EMISSION SOURCES

CANISTER QUALITY CONTROL PROCEDURES

1. Initial and final canister vacuums are checked and recorded.
2. Canisters are not filled between less than 5-10 inches Hg vacuum.
3. To avoid dilution of the canister sample by ambient air, the canister sample is pulled from the Hi Flow exhaust port at a rate that does not exceed the exhaust (approximately 10 seconds).
4. A duplicate sample is collected for every twenty canister field samples or 5%.
5. All required chain-of-custody documents are shipped with each canister sample.

TESTING AND ANALYSIS

Sage conducts all testing and sample analysis using standard quality control procedures and following guidelines and practices accepted by federal and state regulators. For example, prior to use, the IR camera's sensitivity will be validated daily through the following procedures:

1. Following power on and cool down and after the camera has equilibrated to outside temperatures, a non-uniformity correction (NUC) is performed several times.
2. A flow of propane gas approximately equal to 5 grams/hour is established and the furthest distance from which the camera operator can reliably detect the gas flow is documented and a video record saved.
3. The gas flow is then increased to 25 grams/hour and Step 2 is repeated.
4. The following meteorological conditions are recorded, along with the timestamp and measured distances: ambient temperature, wind speed, % relative humidity, barometric pressure, % cloud cover, and degree of ambient light.

Calibration checks are performed on the Hi Flow sensor each day prior to use with a 2.5% CH4 certified compressed gas standard. Once every 30 days (per the manufacturer), the Hi Flow Sampler is calibrated with zero air, 2.5% CH4, and 100% CH4 certified compressed gas standards.