RRD-GAS-06

ORW GAS PROPERTIES

RECOMMENDED REQUIREMENTS DOCUMENT

Subject: **Observation Relief Well (ORW) Gas Properties**

1.0 Background

The Blue Ribbon Commission (BRC) Gas Group recommends that reducing and maintaining methane gas formation pressures in the Mississippi River Alluvial Aquifer (MRAA) to equal to hydrostatic pressure across the Bayou Corne gas area as one metric necessary in order to lift the mandatory evacuation order. This Recommended Requirements Document (RRD) defines the technical requirements for obtaining gas properties from the MRAA and aquitard units needed to address this overall objective. The intent of this RRD is to provide recommended requirements for use by the appropriate state agencies when directing the development of a comprehensive work plan for addressing the RRD objective.

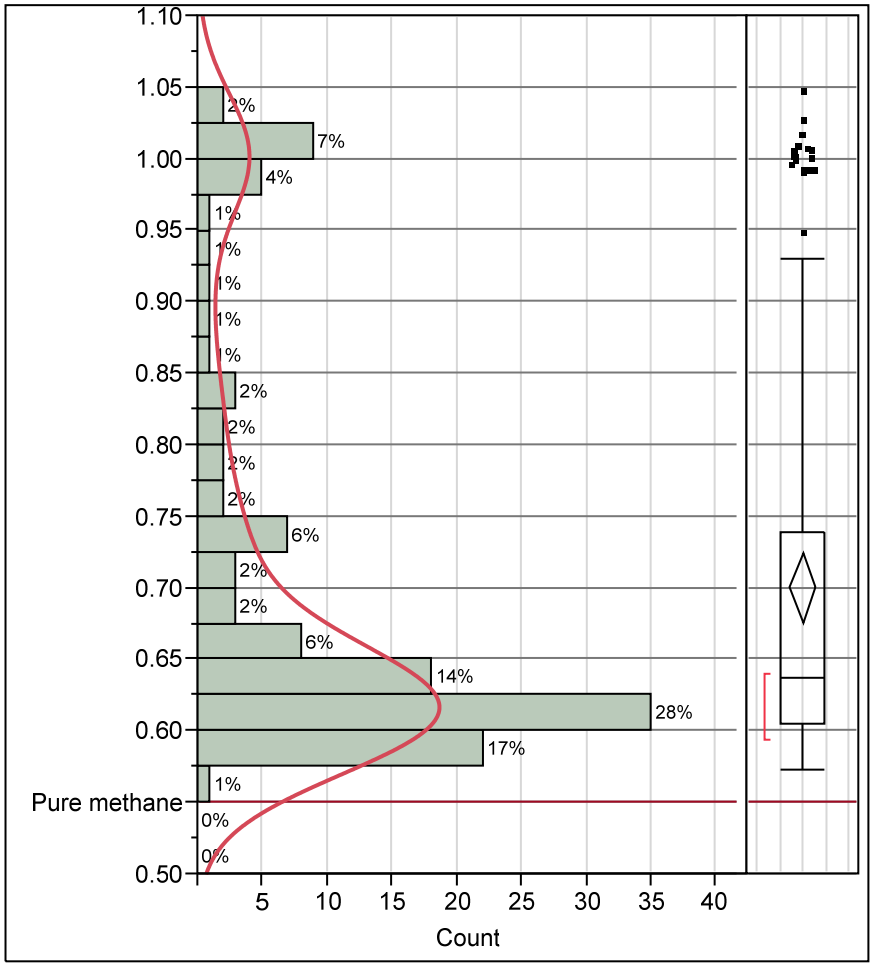
This RRD for collecting gas properties data has been prepared with consideration of the following site conditions and data requirements:

- Methane gas bubbling to the surface has been observed for over a year. While four or five of the 90 bubble sites have exhibited declining bubble intensity, the majority of the sites have remained essentially constant in terms of intensity.
- The attempts at venting gas from the MRAA have not had a measurable effect on reducing gas pressures in the MRAA.
- Gas migration modeling or similar quantitative analysis is necessary to determine if venting operations can reduce gas pressures to the point where migration to the surface stops, if venting can reduce the pressures, and what timeframe will be required to meet the necessary reductions.
- Critical input parameters for gas migration analysis are the gas/water interfacial tension, density and viscosity of the gas being vented. The reason that site-specific data are needed for these parameters is that gas being vented is not pure methane. The gas is a mixture of gases and the gas is also "wet", i.e. there are heavier compounds in the gas as opposed to being pure methane. As presented on **Figure 1**, the specific gravity (gas sample density/pure air density) of the gas samples ranges from 0.55 to over 1.0 with a mean of 0.70. For reference, the specific gravity of pure methane is 0.55 (0.668 (methane density)/1.205 (air density) kg/m^3). For these reasons, it is anticipated that the interfacial tension, density and viscosity of the vent gas is different than pure methane.
- If the viscosity of the gas is greater than that of pure methane, there will be more resistance to gas migration through the formation in comparison to pure methane. Whether viscosity differences are sufficient to impact gas mitigation efforts is not known at present because these data are not available.

- The gas/water interfacial tension and density of the gas is important for comprehensive analysis of gas migration with regard to changes in gas pressure and how the gas pressure relates to hydrostatic pressures.

This RRD has been prepared as part of the overall GAS-08 BRC task. This BRC task addresses the need for ORW gas characteristics from the MRAA and aquitard for use in quantitative evaluations of gas migration and mitigation.

Figure 1. Distribution of Gas Sample Specific Gravity



Smooth Curve, Nonparametric Density. Kernel Std = 0.040

Quantiles			Summary Statistics	
100.0%	maximum	1.048	Mean	0.7005
99.5%		1.048	Std Dev	0.1394
97.5%		1.016	Std Err Mean	0.01237
90.0%		0.994	Upper 95% Mean	0.7250
75.0%	quartile	0.738	Lower 95% Mean	0.6760
50.0%	median	0.637	N	127
25.0%	quartile	0.605		

Quantiles			Summary Statistics	
10.0%		0.597		
2.5%		0.581		
0.5%		0.572		
0.0%	minimum	0.572		

2.0 Objective

The technical objective of this RRD is to obtain representative gas density and viscosity data on the gas currently in the MRAA and overlying aquitard. The specific laboratory and testing programs should be specified in the work plan.

3.0 Requirements

The requirements of this RRD for ORW gas properties data are:

- Collect MRAA gas samples from 20 ORWs or pressure monitoring wells and 10 shallow Geoprobe wells. At the time of sampling, the gas temperature and wellhead pressure should be measured and recorded. **Appendix 1** presents one method for collecting the samples.
- The gas/water interfacial tension, density, and viscosity of the gas samples should be measured at a qualified laboratory. If possible, the measurements should be taken as close to the field temperature as practicable.
- To be able to correlate the data obtained in this RRD to all of the gas sample results for the site, a standard compositional analysis plus hydrogen sulfide and carbon and hydrogen isotopes should also be conducted on each sample.
- Because of the multiphase nature of the gas migration, it is recommended that, if water is present in the gas sample well and it is feasible to do so, a water sample should be collected from each well. The water samples should be analyzed for density, viscosity, total dissolved solids, major cations and anions, and compositional gas plus hydrogen sulfide. Isotopic analysis of the methane is not required on the water samples.

APPENDIX 1

SUGGESTED GAS SAMPLE PROCEDURES

1.0 Introduction

This appendix is intended for use as a procedural reference for obtaining the data required in the RRD. The procedures in this section have been used by one or more BRC members to obtain or generate the data specified in Section 2.0 of this RRD. In preparing the work plan to address this RRD, optional procedures can be substituted as long as the work plan demonstrates that those procedures have been successfully used to obtain the data necessary to address the objectives and scopes in Section 2.0.

2.0 Contract Services

Gas and water samples submitted for compositional gas analysis and isotopes should be submitted to Isotech Laboratories, Inc. in Champaign, Illinois or an equivalent laboratory specializing in gas and dissolved gas analysis.

A qualified petroleum laboratory shall be used for testing the gas density and viscosity, along with light petroleum hydrocarbons and sulfides.

A qualified water analysis laboratory shall be used for analysis of the water samples for total dissolved solids, density, viscosity, and major cations and anions.

A laboratory specializing in multiphase parameter measurement should be used to measure the gas/water interfacial tension.

3.0 Specialized Field Equipment

3.1 Sampling Supplies

Appropriate sample containers (sufficient quantity for the number of anticipated samples), coolers, labels, chain-of-custody forms, nitrile or latex gloves, sample tubing, field documentation forms, and miscellaneous sampling supplies necessary to complete the field activities shall be obtained and brought to the site for each sampling event. For the gas temperature measurement, an electronic thermometer with an accuracy of 0.1° C is recommended. For water samples, pH specific conductance, and temperature water field instruments are required.

3.2 Sample Containers

Samples obtained from each well are recommended to be stored in the following containers until relinquished to a designated lab:

- Tedlar® gas bag
- Cali-5-Bond® gas bag
- SUMMA canister
- Appropriate water sample containers

4.0 Definitions

The following definitions are applicable to this appendix:

- **Cali-5 Bond bag—** Cali-5 Bond bags are air/gas sampling bags specially designed for easy and reliable collection of air and gas samples. The non-permeable, opaque and chemically inert properties of the bags ensure that the collected gases remain uncontaminated and unaltered.
- **Summa Canister—**A summa canister is a stainless steel electropolished passivated vessel used to collect a whole air sample. To collect a sample for the purpose intended in this RRD (gas sample collection), the summa canister is connected to the well, the valve is opened and the canister is allowed to fill for a designated period of time in order to achieve a representative sample. At the conclusion of the designated time period the valve is closed and the canister is sent to the laboratory for analysis.
- **Tedlar Bags—**Tedlar bags are air/gas sampling bags manufactured from poly-vinyl fluoride (PVF) film. They are generally considered inert and can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, and many other classes of compounds.

5.0 Procedure

The gas sampling activities should be performed consistent with the following recommendations. These recommendations have been successfully used to collect gases for physical properties and chemical laboratory analyses at many sites.

5.1 Well Operator

The well operator or designated person will open the well master valve, the adjustable choke, the ball valve between the adjustable choke and the orifice plate and the ball valve associated with the orifice plate. The operator will remain on site until sampling is complete and will aid the sampler in terms of ORW gas flow rate and other well associated work tasks. The operator will be responsible for all equipment and for opening and closing all valves related to the well. For the sampling of the shallow Geoprobe wells, a designated person should also be present to assist in the well access and sampling activities.

5.2 Gas Sampling

The sampler will connect to the well using a threaded barb with flex tubing and a needle valve to collect samples in the Tedlar® and Cali-5-Bond® gas bags. Instructions for the collection of samples into the gas bags are presented in **Attachment 1**. A portion of the sample shall be collected in a separate bag/container and the temperature of the gas measured in the field immediately following collection.

In filling the SUMMA container, the sampler can remove the needle valve and connect the flex tubing directly to the SUMMA canisters' quick connect. The instructions using the summa canister are included in **Attachment 2**.

5.3 Water Sampling

The construction of the various wells with gas pressure is such that purging of the well for water sampling may be difficult. Therefore conventional purging is not required for these wells. The water samples should collected using standard methods. Field parameters of temperature, specific conductance, and pH should be measured at the time of sample collection.

5.4 Sample Handling and Shipment

Samples should be properly packed for shipping to the appropriate laboratory. If necessary/required, the samples should be packed in ice. Complete the chain-of custody forms and relinquish to the transporter or laboratory. Transport the samples to the appropriate laboratory via hand delivery, laboratory courier, or common carrier (i.e. Fed-Ex or UPS).

5.5 Sample Analysis

The gas and water samples from each well will be submitted to the appropriate laboratories, following proper chain-of-custody procedures, for analyses. The following analyses will be requested:

5.5.1 Isotech Laboratories (or equivalent laboratory)

The Isobags (gas and water samples) should be submitted to Isotech Laboratories in Champaign, Illinois or equivalent dissolved gas laboratory for testing of the following:

- Compositional gases
- Hydrogen Sulfide
- Carbon and Hydrogen Isotopes (not required for water samples)

5.5.2 Petroleum Laboratory

Gas and water samples should be submitted to a qualified petroleum laboratory for testing of the following:

- Density
- Viscosity
- Light Hydrocarbon Gases (Nitrogen, Carbon Dioxide, Methane, Ethane, Propane, Iso-butane, n-butane, Iso-pentane, n-Pentane, Hexanes, Heptanes+)
- Sulfides (including hydrogen sulfides, mercaptans, disulfides, along with thiophene and thiophane)
- Interfacial tension between the gas and water samples from each well.

5.5.3 Water Samples

- Water samples should be submitted to a qualified water analysis laboratory for testing of the following:Total dissolved solids

- Major cations and anions (calcium, magnesium sodium, potassium, alkalinity, chloride, sulfate)

5.6 Submittal of Data

All field activities should be documented and reported to LDNR in an electronic format and reasonable time frame. Upon receipt, analytical results shall also be submitted to LDNR in PDF and Excel or similar electronic data transfer format.

6.0 Attachments

- ***Attachment 1***— Collection Of Gas Samples Using a Hand Pump and Gas Bags
- ***Attachment 2***— Summa Canister Sampling Instructions

7.0 Forms

Field Activity Daily Log

ATTACHMENT 1

COLLECTION OF GAS SAMPLES USING A HAND PUMP AND GAS BAGS

ISOTECH®
ISOTECH LABORATORIES INC
1308 Parkland Court Champaign, IL 61821 • (877) 362-4190 • www.isotechlabs.com

Collection of Gas Samples Using a Hand Pump and Gas Bags

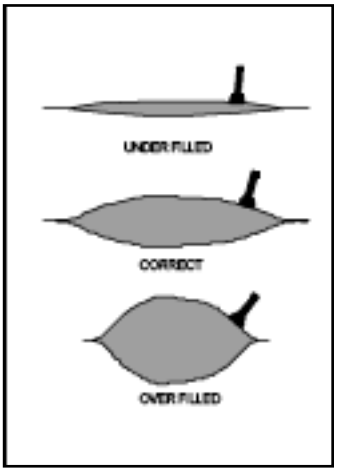
1. Attach the inlet tubing of the hand pump provided (black end) to the monitoring probe or sampling point and pump for a sufficient length of time to purge the system of air. The purge gas may be vented to the atmosphere.

2. Remove a gas bag from its shipping container and while pumping slowly, insert the male luer fitting on the outlet of the hand pump (clear end) into the luer-fit valve on the gas bag with a slight twisting motion. Inserting the male luer fitting depresses the valve stem and opens the valve. The tapered design of this fitting allows for a leak-tight friction fit.

3. The bag can be filled with about twenty squeezes of the bulb. To allow space for expansion during shipment, the bag should only be filled to about 2/3 of capacity. The bag is properly filled when it is about 1 1/2 inches thick, as shown in the drawing.

4. Once the bag is filled, remove the fitting from the bag (be careful because if the fitting is pressed into the valve too tightly, the top of the valve can separate from the main valve body when attempting to remove the fitting). Although these bags are durable, they can be damaged if not handled properly. Be careful not to crease or puncture the bags.

5. Record the pertinent information on the tag attached to the bag and on the chain of custody form provided and return the bag to the shipping container in which it was received. Samples should be shipped to the laboratory for analysis as soon as possible. If the samples are suspected to be flammable (>5% methane) they must be identified as hazardous and shipped according to the enclosed shipping instructions.



In preparing the sampling equipment described above we have tried to provide the user with the equipment and instructions necessary for the safe collection of gas samples under normal conditions. These have been prepared assuming that they will be used by someone who is familiar with the collection of natural gas samples and is fully aware of standard safety procedures and precautions. Isotech is not responsible for accidents resulting from improper use of this equipment or from use of unsafe practices.

ATTACHMENT 2

SUMMA CANISTER SAMPLING INSTRUCTIONS

SUMMA CANISTER SAMPLING INSTRUCTIONS

Grab Sample Collection

1. Remove the summa canister cap. Do not open the canister valve!!!!!
2. Place canister in desired location. If sampling from a vapor stream connect inert tubing to canister sampling port. Sample collection tubing is not supplied.
3. Record date and time on the sample label and chain of custody.
4. Open sampling valve by turning knob counter clockwise until the knob moves easily. For Summas equipped with a "lever" valve, move the lever to the "open" position to initiate sample collection.
5. An audible "hiss" indicates sampling has initiated. When hissing stops, close valve and replace cap.
6. Grab sample collection completes in approximately 20 seconds.

Timed Sample Collection Using Flow Controllers

The flow controller is calibrated to the client's specifications prior to shipping. The calibration valve is covered with a protective lock cap and must never be adjusted by the client.

1. *Caution* – Ambient air sampling during rainy weather may result in clogging of the flow controller filter causing reduction or stoppage of flow. Sampling during rainy weather should be avoided.
2. Remove the cap on the summa canister and the 1/4" plug on the flow controller. Do not open the summa canister!
3. Connect the flow controller to the canister by hand tightening the Swagelok fitting. Lightly snug the fitting with a wrench. Improperly seated flow controllers are the most frequent sources of leaks, which can invalidate the sampling episode.
4. Open sampling valve by turning knob counter clockwise. Turn knob until it moves easily. The vacuum gauge should read approximately 30"hg (vac) when opened.
5. Record start date and time on the sample label and chain of custody.
6. When sampling has been completed, close the valve tightly. Do not over tighten the valve. Over tightening can permanently damage the seal.
7. Remove flow controller and place the cap on the sampling port.
8. Place flow controller back into the protective package used for shipping. Controllers can be easily damaged if mishandled.

General Handling Instructions

* Record sampling stop date and time on label and chain of custody.
* Transport canisters at ambient temperature. Icing or refrigeration is not required.
* Please do not mark or place adhesive labels on Canisters or flow controllers.
* Please do not attach Non-Accutest equipment to canisters or flow controllers. This hardware employs Swagelok threaded connections, which is not compatible with NP threading
* Swagelok connections do not require excessive tightening or Teflon taping.
* If difficulties are encountered during sampling, contact your Accutest representative (732) 329-0200.

Accutest Laboratories certifies the vacuum integrity of summa canisters for a period of two months from the date of final canister evacuation. The expiration date is documented on the back of the label of each canister.