JISKOOT™ QUALITY SYSTEMS

TECHNICAL PAPER TS004-1102-4

Natural Gas Sampling An Overview

by Robert J. J. Jiskoot

Summary

Once a by-product of oil production discarded and flared off, natural gas has become an increasingly valuable energy source. The ability to verify the composition of the hydrocarbon gas is critical to the determination of its commercial value, be this in gathering, transportation or loading systems.

Accurate and reliable sampling allows both buyer and seller to be confident of a fair transaction. The investment associated with the purchase and installation of a composite gas sampling system, correctly designed to provide a representative sample, will be quickly recouped.

This paper attempts to outline the correct procedures and considerations that are necessary to obtain a representative gas sample.

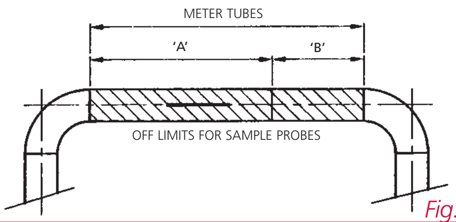

Fig.1a

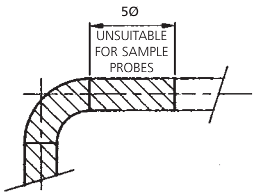

Fig.1b

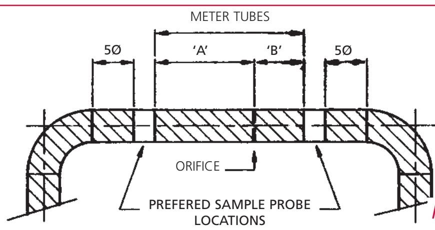

Fig.1c

Gas sampling

The American Gas Processors Association in its publication 2166-68 states that the object of any sampling procedure is to obtain a representative sample of hydrocarbons from the system under consideration.

Representative sampling is fundamental to the correct determination of the composition of the product and therefore its value. To provide this, the system must be correctly designed, installed, maintained and once the sample has been obtained must be handled and analysed correctly. Failure to meet any of these requirements invalidates the sample.

Most gas produced today is "wet", with contaminants and some heavy hydrocarbons that will condense and contaminate the gas stream if incorrectly handled. These contaminants need to be eliminated from the sample or maintained in equilibrium within the sample at all stages of handling so as not to have a detrimental effect on the final analysis.

Design considerations

Sampling of natural gas requires that the gaseous state of the sample must be maintained at all times at conditions that are representative of the gas in the pipeline.

Consideration must be given to each of the following elements:

- *Location of the sample point.*
- *The sample probe.*
- *Sample extraction devices.*
- *Sampler controller.*
- *Sample receivers.*

Location of the sample point

The sample point should be located in a section of the pipeline in a region of *undisturbed* flow. Any flow turbulence caused by pipeline elements, elbows, tee's, reducers, piping headers, manifolds, meter tubes, valves, orifice plates etc. all potentially generate aerosols which will cause the heavy products and liquids to spray off the pipe wall and bias the sample. These aerosols may also cause additional equipment problems such as blockage or slugging in the sample loop and valve seating difficulties.

If we examine this in more detail, the ideal location of the sample probe is in an area of minimum turbulence. Typical examples are shown in *figure 1*, it should be noted that the sample probe should not be located within the limits (A & B of figure 1) of a metering run.

The effects of aerosols generated by turbulence are velocity dependent, thus, the preferred sample probe location should be at least 5, but ideally 20 pipe diameters downstream of any potential flow disturbance, preferably in a horizontal line, thus eliminating any potential sampling handling problems that may occur should the free liquids get into the sample receiver.

The sampler probe

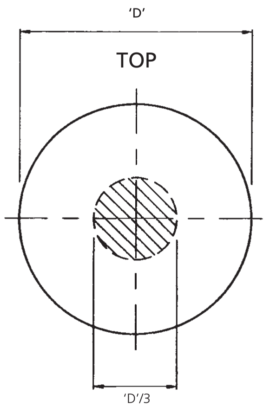

Figure 2

In order to obtain a representative sample, the sample must be extracted from the optimum location, ideally in the central 1/3rd of the pipeline as shown in *figure 2*. The sample probe should also be mounted vertically in the top of a horizontal pipe run to prevent any potential build up of liquid.

Consideration should also be given to the design of the sample probe. It must be simple, reliable, robust, have sufficient strength to withstand any bending moments caused by pipeline flow and resist vibrations caused by vortex shedding. The probe should have a bevelled inlet profile and face directly into the flowing stream. Sample probes are generally fixed installations, but can be withdrawable.

There are currently several types of sample probe in service, the design is dependant upon the installation and process requirements. Designs range from a bi-directional dual flow style to single flow conventional probes, as shown in *figures 3, 4 and 5*, where the sample is extracted from an area of high pressure and the return tapping is to a low pressure area of the system or by venting the return to atmosphere via a regulator, thus inducing a slipstream flow to the sampler pump.

Figures 6, 7 and 8 show some typical acceptable sample loops. These sample loops should be as short as possible to ensure that the sample being presented to the sample pump for extraction is constantly refreshed. The sample extractor should be mounted above and as close as possible to the sample take off point. The lines to the sampler should be sloped back towards the sample probe to allow any free liquid to drain back into the pipeline and eliminate any potential liquid traps. The size of the sample loop should be kept to a minimum, ideally 1/4" bore stainless steel, however, a larger bore will not only decrease the pressure drop round the loop but also decrease the flow velocity if the bore of the sample probe remains constant.

Gas is a fragile product and to obtain a representative sample at line conditions, not only should the sample be captured at line pressure and temperature but the flow velocity in the sample loop should also be considered. Under ideal conditions, the flow velocity in the sample loop should be *equal* to the mainline flow velocity, however, in practice this is not achievable, but should be considered within reasonable limits.

Sample extraction devices

The sampler pump provides a means of collecting a fixed, repeatable sample volume from the line and displacing it into the sample receiver under line conditions. Consideration should be given to the process conditions, the sampling batch size or interval and the sample volume required. The sample size should be adjustable and once set remain constant. Generally the greater the number of samples taken in a batch the more representative the sample. The selection of the sample size is dependant upon the sample receiver volume and the sampling interval as shown on the next page in *figure 9.*

In the interests of reliability the sample pump, *figure 10*, should be a simple mechanical device, have fully balanced seals to minimise seal wear and maintain a uniform grab size as well as being easy to maintain. It should be pneumatically operated, actuated via a contact closure from a sampler controller operating in a flow proportional or time proportional basis. In exceptional circumstances where an air supply is not available, regulated line gas may be utilised.

The sample pump design should minimise any crevices and dead pockets thus eliminating any potential contamination.

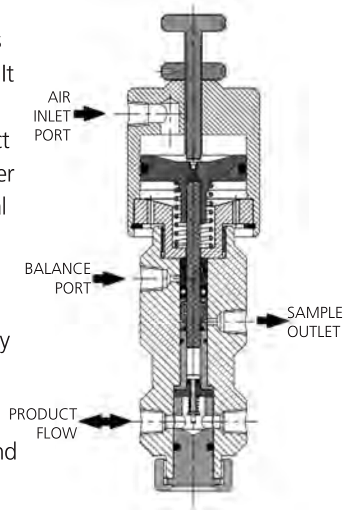

Figure 10

Sampler controller

Controllers can vary in complexity from simple dividers to microprocessor based units. The main consideration is the application and operational requirements. Where the pipeline flow varies a flow meter is required to pace the sampler. This will give the most accurate and representative sample. However, if the pipeline flow rate is stable (± 10%) the sampler may be actuated in a time proportional manner.

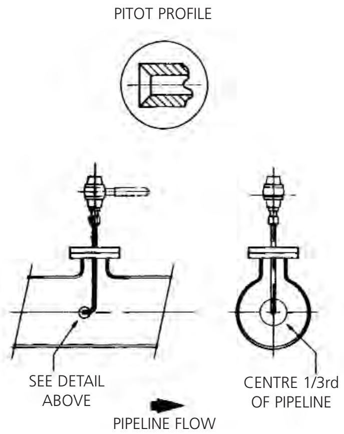

Figure 3

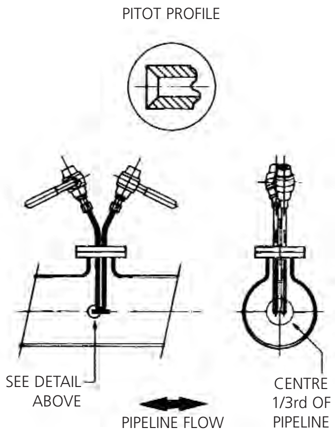

Figure 4

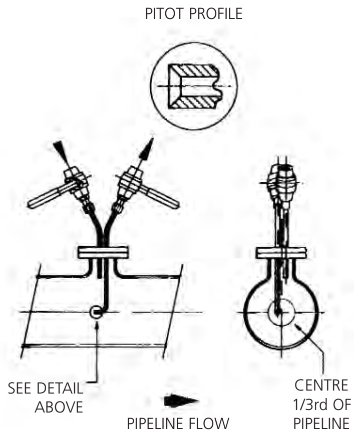

Figure 5

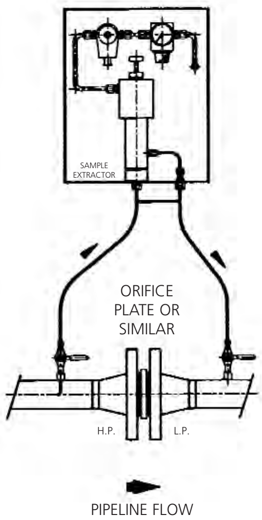

Figure 6

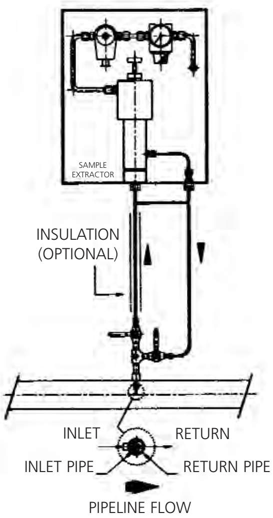

Figure7

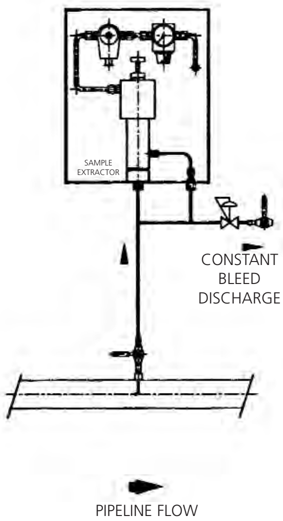

Figure 8

SAMPLING RATE IN MINUTES FOR VESSEL INDICATED													
		31 DAY SAMPLING PERIOD Vessel size in cc's						7 DAY SAMPLING PERIOD Vessel size in cc's					
Number of turns open on pump stroke screw	Sample pump displacement per stroke	1000	800	640	500	400	300	1000	800	640	500	400	300
1	0.042	1.9	2.3	2.9	3.7	4.7	6.2	0.4	0.5	0.7	0.8	1.1	1.4
2	0.085	3.7	4.7	5.8	7.4	9.3	12.4	0.8	1.1	1.3	1.7	2.1	2.8
3	0.125	5.6	7.0	8.7	11.2	14.0	18.6	1.3	1.6	2.0	2.5	3.2	4.2
4	0.167	7.4	9.3	11.6	14.9	18.6	24.8	1.7	2.1	2.6	3.4	4.2	5.6
5	0.208	9.3	11.6	14.5	18.6	23.3	31.0	2.1	2.6	3.3	4.2	5.3	7.0
6	0.250	11.2	14.0	17.4	22.3	27.9	37.2	2.5	3.2	3.9	5.0	6.3	8.4
7	0.292	13.0	16.3	20.3	26.0	32.6	43.4	2.9	3.7	4.6	5.9	7.4	9.8
8	0.333	14.9	18.6	23.3	29.8	37.2	49.6	3.4	4.2	5.3	6.7	8.4	11.2
9	0.375	16.7	20.9	26.2	33.5	41.9	55.8	3.8	4.7	5.9	7.6	9.5	12.6
10	0.417	18.6	23.3	29.1	37.2	46.5	62.0	4.2	5.3	6.6	8.4	10.5	14.0
11	0.458	20.5	25.6	32.0	40.9	51.2	68.2	4.6	5.8	7.2	9.2	11.6	15.4
12	0.500	22.3	27.9	34.9	44.6	55.8	74.4	5.0	6.3	7.9	10.1	12.6	16.8

Times indicated are in minutes and based on a line pressure of 70 barg.

Figure 9

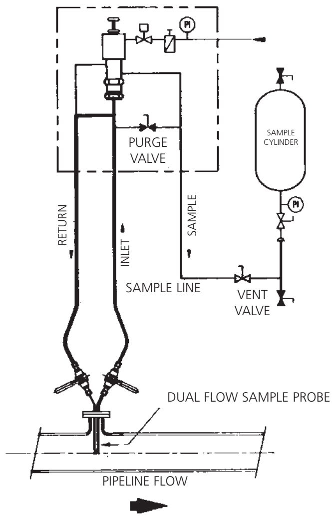

Figure 11

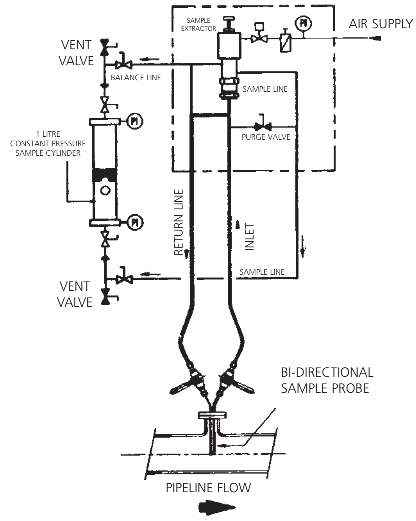

Figure 12

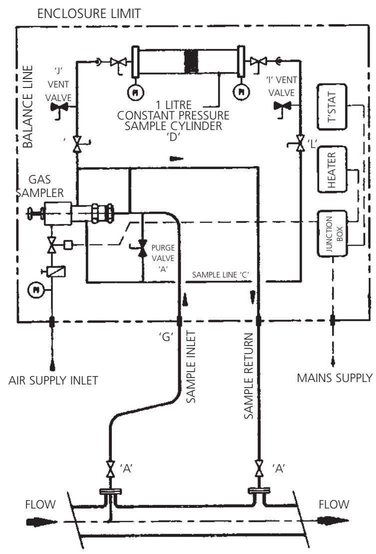

Figure 13

Sample receiver

The sample receiver is used to transfer the sample, upon completion of the batch or time interval, from the sample point to the laboratory for analysis.

There are two basic types of sample cylinder: The fixed volume and the piston balanced C.P. (constant pressure).

The selection is generally dependant upon the type of gas being sampled. Where there is a requirement to capture a sample of dry gas then a fixed volume receiver is utilised, as illustrated in *figure 11*. These do not produce repeatable results when used on wet gas.

However, when wet or dry gas in excess of 1025 BTU's is sampled a piston balanced (CP) receiver should be used as shown in *figure 12*.

By the use of a piston balanced receiver, the sample is maintained in equilibrium, under line conditions (temperature and pressure), thereby preventing any degradation of the sample prior to and during analysis which is caused by condensation of water, heavy products and contaminants.

In general, C.P. cylinders will yield more consistent results when run to a chromatograph for final analysis.

The sample receiver is considered to be an integral part of the gas sampling system and should be mounted as close as possible to the sample pump, generally these are mounted vertically. However, piston balanced (CP) receivers may be mounted horizontally.

Consideration should also be given to the operational requirements. The sample receivers must be designed for the correct working pressure and constructed of materials suitable for the application. Purge, cleaning and flushing valves are required to ensure the safe operation and correct handling of the sample receivers so as to minimise any potential contamination of the sample. These valves should be full bore valves with soft seats to ensure a tight shut off and minimise any leaks which will invalidate the sample.

The receivers should also comply with any transportation requirements (DOT or IATA) and are therefore often fitted with bursting discs and protective carrying cases.

The sample receiver enclosure, *Figure 13,* may require heating to keep the receiver at line pressure and temperature if the gas is wet. This will prevent condensation of the heavy products and liquids that may affect the sample validity.

System integration

Gas sampling is not just the purchase of the right components; it is the integration of them to form a complete system. To build such a system it is necessary to design, engineer and to integrate the components to provide a fully operational gas sampling system that will be capable of meeting the clients unique application. Consideration should also be given to the operational requirements, the materials of construction, ease of assembly, maintenance and service requirements, system operating pressure, and finally, how the sample will be analysed.

Jiskoot has an installed base of gas samplers throughout the world, each engineered to suit the end user's particular needs. High quality precision manufacture and attention to detail enable Jiskoot to produce reliable and accurate gas sampling systems. These systems, when installed correctly, are capable of providing a truly representative composite gas sample giving both the user and his client confidence.

MEASUREMENT SYSTEMS

DIVISION HEADQUARTERS
HOUSTON, TEXAS
+1 800 654 3760

JISKOOT QUALITY SYSTEMS
HEADQUARTERS
TUNBRIDGE WELLS, KENT, UK
+44 1892 518000
ms-jiskootinformation@c-a-m.com

JISKOOT QUALITY SYSTEMS
US TECH CENTER
HOUSTON, TEXAS
+1 281 582 9500
ms-jiskootsales@c-a-m.com

USA • CANADA • UK • CHINA • UAE • ALGERIA • MALAYSIA • INDIA • KENYA

www.c-a-m.com/jiskoot