THE IMPORTANCE OF DOMESTIC AND INDUSTRIAL GAS METER CALIBRATION: RELEVANCY TO MALAYSIA APPLICATION

Rahmat Mohsin, Zulkifli Abdul Majid, Zulkefli Yaacob and Liaw Kim Kiat
Gas Engineering Department
Faculty of Chemical and Natural Resources Engineering
Universiti Teknologi Malaysia
81310 UTM Skudai, Johor Darul Takzim, Malaysia
Tel. No.: 07-5576160 ext 5289, e-mail:rahmat@fkasli.utm.my

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ABSTRACT

Gas industry in Malaysia had grown rapidly due to its clean combustion characteristic and the economic factor compared to the other competitive fuels. The pricing of natural gas is highly regarded as a matter of supply and demand, while the determination of the accuracy of gas measuring device and its importance in the gas custody transfer is a matter of urgency and technology that will be discussed in this paper. In view of the current gas trend in Malaysia, focal attention will be given to the applicability of calibration to domestic and industrial gas meter. The aspect of calibration concept plays an important role in any gas metering facilities due to stringent measures applied by the gas supplier and customer. Indirectly this has a prominent effect to the industry involving a financial impact and control of natural gas trading and further providing firm assurance of the quantity of the gas flow passing the control boundary. This paper intend to highlight the importance in carrying out scheduled calibration to gas meter in order to provide firm guarantee of its accurateness and readiness to operate as per demand. Survey has been carried out to provide further information of type of gas meters and their quantity employed by Malaysia gas user.

INTRODUCTION

The demand of natural gas in Malaysia had increased after the completion of the second stage Peninsular Gas Utilization (PGU II) Project. Besides that, domestic and industrial sector intends to use natural gas due to its economic factor and its environmental friendly behaviour. The accuracy is one of the important factors to determine the efficiency of flow. Besides the initial costs of the instrument and an adequate installation, the maintenance of the required precision also cost money. The failure of flow meter to give correct measurement could cause a lot of loses either to the gas company or the gas customers. Therefore, the calibration system is important to determine the performance of the flow meter.

GAS FLOW MEASUREMENT TECHNIQUES

Generally, there are two categories of gas flow measurement being widely used in gas industries namely as positive displacement meter and inferential meter. The operation mode of any positive displacement meter is by direct volume measurement, measured periodically by filling and discharging one or several measuring chambers. The inferential gas meter measured indirectly the gas flow volume with measuring elements moved by fixed elements influenced periodically by the flow. The types of gas meter available in the category of positive displacement meters are namely as diaphragm type, rotary displacement and wet type. The inferential meters are such as turbine, anemometer, pressure differential types (orifice plate, venturi, nozzles, target, annubars, elbow, wedge and pitot tube), variable area (rotameter), ultrasonics type and vortex shedding type.

MEASUREMENT FIELD EQUIPMENT SELECTION

In order to measure gas accurately, several basic infrastructural facilities are required and related instruments are needed. The physical function of gas measurement that is performed in the field is of vital importance. The accounting of gas can be no better than the measurement of the raw gas at its source. There are several factors in selecting meters. The primary consideration is to obtain the optimum measuring accuracy at minimum cost. The users also had to consider the range of physical and chemical of the fluid to be handled, process conditions under which the flow meter will be operating, performance requirement and economic factor. There are other considerations that also need to be included such as end connections, size and weight of meter, material of construction and the update capability as technology advances. The survey data obtained from Gas Malaysia Sdn. Bhd. (GMSB) had indicated that in the domestic gas user are using positive displacement meter namely of a diaphragm type gas meter whilst the industrial factories uses inferential meters due to its high operating pressure and high flow rate capability such as rotary and turbine meters. The operating principle for these two meters is totally different. For the turbine meter the consumption of user will affect the meter using the term G-rating. Capacity (G-rating) – The European made turbine and rotary meters are usually standardized using G-rating for maximum capacity of each connection size meter. The relation between G-rating and maximum capacity (Q_{max}) is Q_{max} = 1.6 x G-rating.

DIAPHRAGM GAS METER AND THEIR OPERATING PRINCIPLE

The diaphragm meter (Figure 1) is a simple, inexpensive and reliable meter of moderate accuracy, widely used as a domestic gas meter. It can be regarded as a kind of four piston reciprocating meter, which two bellows (B and C of Figure 1) act as two of the cylinders and the annular spaces around these bellows (A and D) as the other two cylinders, with the operation being control by a double slide valve. A is empty while B is filling, whereas C has just finished emptying and D has just finished filling. In next position, C is filling and D is emptying, whilst A has just been emptied and B has just been filled. A mechanical linkage enables the number of cycles to be counted on the series of dials, which are to read in units of volume. If this type of meter is fully calibrated and reasonably well maintained an accuracy of ± 1% over s flow rate range of 20:1 is feasible. This type of meter is limited to pressure and temperature near to ambient.

TURBINE METERS AND THEIR OPERATING PRINCIPLE

A gas turbine meter is a velocity device for measuring flow volume, in which the direction of flow is parallel to the rotor axis of the meter and where the speed of rotation is proportional to the rate of flow. A typical turbine meter (Figure 2) consists of a body, an internal rotor mechanism with inlet and outlet diffuser, a magnetic drive and an index or instrument to provide totalisation. A major advantage of the turbine meter is in the flow-totalising field. The meter obtains its driving energy from the kinetic energy of the gas, which is caused to increase as the gas passes through the meter by reducing the cross-sectional area of the stream. This is done by diffusers, which direct the gas to the outer periphery of the meter body. This is to keep the total pressure drop as low as possible, the flow passages are contoured similarly to a venturi. Excellent linearity and repeatability between flow rate and turbine rotation speed are obtained with constant operating conditions over a quite wide range in many of the recently developed units in Malaysia. These turbine meters have widely used in most of the industrial sector and being used increasingly in commercial flow measurement. Turbine meter accuracy is quoted as better than ±1% and very much dependent upon an established velocity profile being achieved at the meter inlet, tip clearance, friction across the blades, bearing friction and other retarding torques. The meter creates no problems with security of gas supply. It also offers the advantages of being able to measure high flow rates at high pressures over a wide range of temperature.

ROTARY DISPLACEMENT METERS AND THEIR OPERATING PRINCIPLE

A rotary displacement meters is defined as a ‘positive displacement meter in which the measuring compartment is formed between the walls of a stationary chamber and a rotating element or elements making substantially gas-tight contact the walls’. There are a few type of rotary displacement meters, the most popular for gas application is of the roots type (Figure 3). The two impellers are geared together by timing gears which ensure that they contra-rotate at the same speed. The impellers intermesh closely at all the times which that gas can only pass forward from the inlet to the outlet through the measuring chambers which are formed between the sides of the impellers and the walls of the casing. The clearances between the various parts are very small (e.g. < 0.05mm). The following gas drives the impellers round because of the unbalanced load on one or other impeller, when pressure is applied at the inlet.

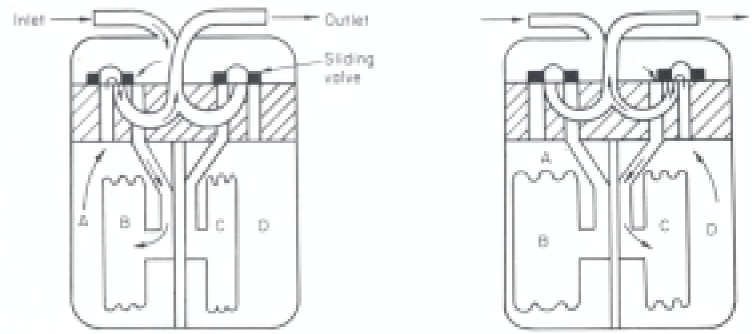
FIELD METER

From the survey conducted and data obtained from Gas Malaysia Sdn. Bhd. (GMSB) most of the currently operational industrial gas meters found in the Malaysian environment are of European meters. The manufacturers of those meters are such as Elster, Instromet, Schumberger, JB Rombach and Dresser. Those meters are manufactured from Belgium, France and Netherlands. Europe manufacturers follow European Union Standard in which the dimension is constant irrespective of brand. Therefore, those turbine and rotary gas meter have identical face-to-face dimension in accordance with their connection size. Table 1 shows the combination of meter connection sizes and their G-rating or flow rate maximum, Q_{max}.

MASTER METER

The simplest and cheapest ways of calibrating a flow meter is to put it in series with another flowmeter of higher accuracy and to compare their readings.

Calibrated master meter may be used to measure the flow in a pipe and to calibrate other meter. Positive displacement meters are commonly used but turbine and other meter also have been used. For domestic gas meter, the wet type gas meter is recommended and for industrial meter, turbine meter is used. To achieve a check on the performance of a master meter they are often used in pair,



either in series, so that the consistency of their readings in continually, checked, or in parallel when one is used most of the time and the second is kept as a particularly high precision meter for occasional checks.

FIGURE 1 Diaphragm Gas Meter at two stages in its operating cycle

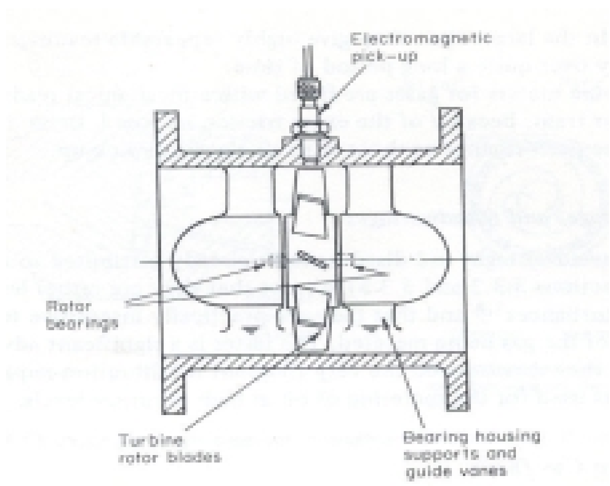


FIGURE 2 Gas Turbine Meter

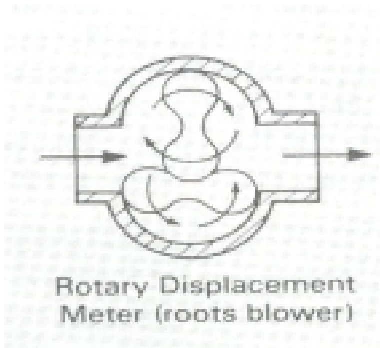


FIGURE 3 Rotary Meter

TABLE 1 Combinations of meter connection size and its G-rating
(European meter)

	Number of meter used										
G-rating (Qmax, m3/h = 1.6 x G-rating)	15	16	40	65	100	160	250	400	650	1000	Total
Type and connection size, (inch)											
Rotary											
2	2	3	23	1	2						*31*
3				1	17	22					*40*
4							2				*2*
6									1		*1*
Total Number											*74*
Turbine											
2				7		1		2			*10*
3					2	18	7				*27*
4						1	5	22			*28*
6								1	9	11	*21*
8										4	*4*
Total Number											*90*

STANDARD INSTALLATION TURBINE METER

Turbine meters are widely used for natural gas measurement and provide high accuracy over large ranges of operation. Therefore, the design of the turbine meter and the installation piping practice are important to ensure high accuracy measurement. American Gas Association (AGA) Report 7, “Measurement of Gas by Turbine Meters” and International Standard ISO 9951, “Measurement of Gas Flow in Closed Conduits – Turbine Meters” were published to give a guideline for the installation of the turbine meter. AGA 7 recommends installation of an in-line gas turbine meter at least 10 nominal pipe diameters from the inlet.

CONCEPTUAL DESIGN OF CALIBRATION SYSTEM FOR GAS METER

In order to calibrate those domestic and industrial gas meter, air, nitrogen and natural gas could be used. Those gases are has be assured to acquire constant pressure and be stabilized by passing through series of pressure regulator, cooler, dryer and filter. After selecting the test item, inspection is started and then valves in a calibration system are opened and closed by controller. The system is stabilized after some running time and then start to measure temperature and pressure. After accumulated flow amount of standard flow rates, test results are calculated by comparing the reading of master meter and meter on test. Therefore, the performance of each meter could be determined

CONCLUSION

Calibration of gas volume meter is a costly operation, it should therefore be realized in advance whether a calibration is necessary. Although in Malaysia, there are no rules specifically requires for gas meter calibration, the gas customers should realized and exercised their right to check for the accuracy of their gas meter. As a result, it is suggested that domestic, industrial and commercial sectors should implement the periodical gas meter calibration.

REFERENCES

Baker, R.C. 1992 *An Introduction Guide to Flow Measurement.* London : Mechanical Engineering Publication Limited.

Alan, A.T. and Hayward, J. 1979. *Flowmeters A Basic Guide And Source-book For Users*. London : The Macmillan Press LTD.

Matschke, R., Schlieter, H. and Aschenbrenner, A.. 1982. *PTB Testing Instruction*, Vol. 4 of Gas Volume Meters, Braunschweig and Berlin : Physikalisch-Technische Bundesanstalt.

Nicholas P. Cheremisinoff. 1979. *Applied Fluid Flow Measurement Fundamentals and Technology*. USA. Marcel Dekker, Inc. New York and Basel.

Miller, R.W. 1983 *Flow Measurement Engineering Handbook.* Third Edition, New York: McGraw-Hill.

Anon. 1986. *Gasunie Information – From Paris to Westerbook*,. N.V. Nederlandse Gasunie : The Gas Department of The Nertherlands Metrology Service.

Heeres, J. 1985. Test Installation For Gas Meters with a Maximum Capacity of 12,000m^3/h. *Bulletin OIML*, Mars, pg.20-28.

Peace, D.W. 1995. Proper Installation Ensures Turbine Meter Accuracy, *Pipeline & Gas Journal*, 136th July : 30-32.