Buletinul Ştiinţific al Universităţii "Politehnica" din Timişoara

Seria ELECTRONICĂ şi TELECOMUNICAŢII
TRANSACTIONS on ELECTRONICS and COMMUNICATIONS

Tom 49(63), Fascicola 2, 2004

Prepayment Gas Meter – A New Trends in Natural Gas Metering Technology

Monica Sabina Crainic[1]

Abstract

Natural gas is a non-regenerable energy source. For this motive she must be managed properly to protect it for future generation. Proper management of natural gas reserves requires submetering. Submetering of natural gas consumption and revenue collection is traditionally accomplished using diaphragm gas meter. To resolve some problem of revenue collection new technologies liken prepayment metering is implemented. In this context we at AEM Luxten Lighting Co produce prepayment gas meter

Keywords: flowmeters, diaphragm gas meter, natural gas submetering, prepayment device

I INTRODUCTION

Revenue collection is one of the core activities of any utility inclusive natural gas distribution company. This has traditionally been accomplished using conventional credit meters like diaphragm gas meter, with regular meter reading, extension of credit to customers and normal credit collection mechanisms.

This process is costly, with numerous inherent problems for both utility and customers. To solve some of these problems new technologies like prepayment metering is implemented which offer benefits to both parties.

Prepayment metering in its simplest form refers to the payment of utilities prior to the use of the utility until such time as the credit has expired.

The concept of prepayment metering is not a novel concept having first been introduced in the form of coin gas meters in the United Kingdom [1-2]. This concept was refined in the 1980's through the use of electronic or numeric transfer of the credit and other information.

II THE LEVELS OF PREPAYMENT METERING SYSTEM

Electronic prepayment metering system operates on three level. At the lowest level, are the gas meters, which are installed at the consumer's home. The next level is the credit sales point which are placed at the utility's office or appointed agents. The consumers who need credits (who need natural gas) come to credit sales point.

Upon his request and need certain amount of credit that is

Upon his request and need certain amount of credit that is equal to certain amount of natural gas is loaded in his card and the billing is made by the officer against the cash moncy. In this respect, the processes like meter reading, billing after consumption and difficulties in collecting natural gas costs will be removed. The smart card has a security passworth inside and each smart card has its own passworth which means each card is different from each other. When consumer comes to the credit sales point with his smart card to purchase credit, the card is checked in PC. In this check, it is controlled which municipality, consumer and meter the card belongs to. According, to the data obtained from the card and user, the card is accepted or refused and the billing is made with reference to the name of the consumer. If the data obtained from the check of the card doesn't comply with that obtained from the consumer, the card will not be loaded. At the top level is the credit selling points control center (central PC) which is necessary to ensure a common data base for reporting as well as to provide for total management, administration, financial and engineering control.

[1] AEM – Luxten Lighting Company SA, Gas and Water Meter Research Department, 26 Calea Buziasului 300693 Timisoara, Romania, Tel: 4-0256-222200, Fax 4-0256-490928, e-mail sales@aem.ro

III GAS METER WITH SMART CARD

The gas meter with smart card comprises mechanical gas meter with pulse output, valve group, electronic hardware, battery group electronic software and smart card.

3.1 MECHANICAL GAS METER WITH PULSE OUTPUT

These are volumetric dry, diaphragms gas meters [3-4] meant for measuring domestic natural gases consumption. They comply with OIML R6, R31 and to SR 6681-98 provisions. Some technical characteristics are presented in Table 1

Their cases are cupped steel bodies with electrostatic spray paint with epoxipolyesteric powder. The rotation of gear is transferred via a magnetic coupling.

The gas meter with pulse output converts the data obtained from mechanical meter into an electrical signal by means of a reed switch group that is activated by a permanent magnet. It makes a sensitive reading and gives 2 pulses per one liter.

3.2 VALVE GROUP

The valve used in system is a gas valve actuator bistable action [6] which can be customized to meet various flow control applications.

Table 1

	G 1,6	G 2,5	G 4
Cyclic volume V (dm^3)	1,2	1,2	1,2
Maximum flow Q_{max} (m^3/h)	2,5	4	6
Minimum flow Q_{min} (m^3/h)	0,016	0,025	0,040
Maximum pressure P_m (bar)	0,5		
Environmental and gas temperature range	- 20 ... +50 ° C		
One pulse value (on request)	0,002 m^3		
Counter range	99999,999		
Connections	G1 or G1 ¼"		
Maximum admissible errors	± 3% for $Q_{min} \leq Q < Q_{max}$ ± 1,5% for $0,1Q_{min} \leq Q \leq Q_{max}$		
Weight (kg)	2,5		
Overall dimensions (mm)	243 × 228 × 172		

The operating voltage of the valve is 1,9 V minimum ambient temperature of 20 °C (relay drive circuit). The power consumption of the valve is of the lowest ones to ensures the longest life of the battery. The valve is actuated within 20 ms either in operating and closing. Once the valve is closed or opened it keeps its position until it is activated again without consuming energy. So that it saves the energy in the battery. The valve is able to evaluate the opening/closing data sent from the electronic hardware. Other performance of the pressure pulse valve are presented in table 2.

3.3 ELECTRONIC HARDWARE

This unit controls the mechanical meter and the valve and establishes the communication of the system with the gas administration or distribution company by means of smart card. The electronic hardware is a very unique one and all components are gathered in one PBC. The socket switch locks on them are used in the circuit to ensure the rigidity of the system and facilitating the assembly process. The electronic components used are chosen with a great care and of the best quality.

3.4 DISPLAY

Thanks to the Alphanumeric LCD used, the characters can be read easily. Without any difficulty and hindering the eye look. When the display is active, its power consumption is so lowly by the help of display driver.

3.5 BATTERY GROUP

Battery group supply energy to the electronic hardware and to the valve. The life of the battery C Lithium size is 10 years. Battery which as a voltage of 3,6 V is kept in their own battery protections. The battery connected with the locked sockets belonging to PBC provide a speedy and an easy replacement with the new ones. The battery is located in the meter apart from the meter and the valve group such that it is possible for the gas administration officers to replace the battery without dismantling the seal of gas distribution company. The charge of the battery is checked by the electronic hardware continuously. I(f it is detected that voltage of battery is lower than the working voltage or the battery is out of service because of any reason, the electronic hardware record all the data and shuts down the valve.

3.6 ELECTRONIC SOFTWARE

Thanks to the special software developed, the continous and secure data communication between the meter and the valve group and the synchronization of the smart card with the central PC has been established.

The data's that carried by smart card are as follows:

- the name of the natural gas administration,

Table 2 [6]

PERFORMANCE		
ELECTRICAL	Shrouded coil	Intrinsically safe potted construction and dual zener circuit
	Operating pulse (flat top)*	Coil winding resistance 7,0 Ω ± 5% at 20 °C (with actuator seat mounted uppermost) 100 ms minimum duration or capacitor discharge pulse 2,5 V-peak Energy typically 60m Joule
MECHANICAL	Diaphragm /spindle stroke	7,0 mm nominal. Shut off against flow pressure
	Overtravel (shut-off)**	1,5 mm maximum/ 500 gF minimum to seal gas at 30 mBar maximum pressure
	Flow rate**	0 to 6 m^3/h
	Leakage	2,0 l/h maximum (when shut-off)
	Minimum life**	20 years/ 7500 operations
	Weight	300 g
ENVIRONMENTAL	Ambient temperature range	- 25 °C to + 55 °C
	Gas humidity	3 % RH from – 20 °C to + 10 °C 60 % RH from + 10 °C to + 50 °C
CONSTRUCTION	Diaphragm/Seat	Moulded in gas approved nitrile
	Spindle connection	Seat to suit orifice inlet port of meter; 24 –42 mm diameter range Spindle to diaphragm spring; ball joint or clipped
	Switch	Indication for end of stroke closure; no volt's reed switch circuit
	Materials	Compatible with natural and manufactured gas

* Typical value. Other combinations are possible to suit various and applications

** Typical values. Other flow rates and working pressure possible up to 10 psi

- the type of consumer,
- the number of consumer,
- the number of meter,
- the information about the credits,
- the information about the spare credits, that will be determined by the administration,
- the charge condition of the battery,
- the last data at which the credits has been loaded to the meter,
- the information about the valve malfunctioning,
- the information about the meter malfunctioning

and

- the information about the consumption.

The data's and messages that maintain the system to be controled are: the alarm messages about valve and meter malfunctioning, electronic hardware and valve battery charge information and a message about meter out of credit.

The main control unit checks if there is warns the consumer by displaying the message on its display. The electronic controls the amount of natural gas that passes through the meter to and decreases the number of credits as a function of the consumption. In case the meter is out of credit and the valve is closed, the consumer inserts his card into the meter to open the valve and run the spare credit. The consumer can also observe on meter's display the necessary information that he is consuming the spare credit. In a certain period of time, if a certain amount of consumption is exceeded by the consumer that belong to the first tariff, the meter switches to the second tariff automatically. When this period of time passes, the meter switches it self to the first tariff again. The information about the tariff and level of consumption can be loaded in the card with three different levels. In case of inquiry from the consumer, the meter can make itself out of service for certain period of time (in case of holidays or absence of the family for a long period of time). If no gas flow is detected by the meter in 10 days for example, the valve closes itself automatically for the safety reasons. The valve can be opened and meter can be put in service again by using a card. This card is used by administration officer. The duration 10 days can be adjusted up to request.

Checking the level of battery is made by the electronic hardware continuously. In case the battery level is lower than the level it should be, all the data's are stored in the EEPROM memory. By means of the smart card the information about the battery levels are carried to the Credit Sales Point letting the administration be informed too. In case of malfunctioning of the valve a message is displayed. The meters goes on metering the consumption and recording the consumption higher than the amount of

credit as the consumer's debt. In the case of the meter box is opened by the unauthorized people or interfered deliberately, the electronic control unit terminates the gas flow by shutting off the valve and records the date in smart card. After the maintenance is performed by the administration, the system is update by the authorization card

The time and the data adjustment of the meter is made by means of a card. The real time clock placed in the electronic hardware can be programmed to detect the working hours, working days the month and even the number of days in February adding one day to the year every 4 years.

If the consumer uses the spare credit and if the meter goes out of credit not in the working hours, valve will not close itself until the new working days starts letting the gas being consumed by lending credit. When the consumer goes to Credit Sales Point to purchase credit, the landed credits will be decreased from the number of new credits loaded.

3.7 SMART CARD

The cards used in control system conforms with the ISO7816-2 and they have secure memory. If a wrong card is inserted into the meter, the main control unit identifies that card and warns the consumer displaying a message. The names of the cards used in the system are:

- The consumer card by which the data transfer data displaying and credit purchasing processes can be executed.
- The authorization card which executes all the operations that the consumer card does with the exception of the credit loading. In necessary, one can change all the data's and reload them with this card.
- Redundant Credit Card by which in case the consumer inquires his redundant credits he makes back loading by using this card taking finished credit loaded in the meter. After having finished this operation, he delivers this card to the Credit sales Point and can take his money back.
- Switching off Card which is used by gas administration and executes the meter switching off process by shutting off the valve.
- Reset Card which is used to reset the data's of the microprocessor in the electronic control unit.
- Time Card which adjusts the data and the time in the electronic control unit.

IV CONCLUSIONS

Pre-payment metering is not merely a choice of a different brand of meters. Pre-payment metering replaces not only the classical gas meter but also the billing system, the reading of meters and the administration of the revenue collection. Pre-payment benefits both utilities and consumers. Utilities benefit because payment is received on average 45 days early than with a conventional billing system. This is not, however the only advantage. Pre-payment metering offers improved customer service, no meter readers required, eliminate of bad debts, disconnection and reconnection fees, ensure a hand control and eliminate inaccurate meter reading.

The typical user of pre-payment gas metering system is a member of lower income groups in the population [7-8]. He will appreciate the fact that he now has direct control over his budget and often his acceptance of pre-payment is much higher, because there is a direct link between the money, he spends and the value he gets. Also pre-payment metering system require no cost for disconnection/reconnection and no waiting reconnection and offer ability to payback debts. To implement a pre-payment metering system, means a change of mind set, a change in the way to revenue collection is managed, a change in IT procedures, a change in customer service, a change in metering and a change consumer behavior. Because pre-payment gas meter is much more expensive than a conventional meter to be able to reap the benefits as expressed above, all parties need to be into the system and appreciate the benefits they themselves will receive.

REFERENCES

[1] *** "Improvements in or relating to coin-feed meters" GB Patent no 191505193 from 30 March 1916

[2] *** "Improvements in prepayment gas meters" GB Patent no 191403216 from 8 July 1915

[3] *** Omega Transactions Technical Reference Series vol 4 Flow & Level Measurement 2001

[4] Dane Enrich "A guide to metering technologies" ASHRAE Journal October 2001 p.33

[5] *** Catalogue AEM Luxten Lighting Company SA

[6] *** "Pressure pulse valve actuator" BLP Components Ltd Catalogue http://www.blpcomp.com

[7] *** "Fuel Pouerty: Low Income, Prepayment Meters and Social Obligations" Center for Management under Regulation University of Warwick and Center for Competition and Regulation University of East England March 2001

[8] Roger D Colton "Prepayment meters and the Low-Income Utility Consumer" Fischer, Sheehan & Colton Public Finance and General Economics October 1998