Buletinul Ştiinţific al Universităţii "Politehnica" din Timişoara

Seria ELECTRONICĂ şi TELECOMUNICAŢII
TRANSACTIONS on ELECTRONICS and COMMUNICATIONS

Tom 53 (67), Fascicola 1, 2008

LUXTERM α – A HEAT ENERGY METER FOR AMR

Mihai Cadariu[1], Monica Sabina Crainic[1], Gheorghe Popa[1]

Abstract

Fluid media (clean hot water or steam) mainly distributes thermal energy to the points of consumption. The energy manager is not only interested in the total energy required but also in the consumption of the individual heat consumers and the flow of energy in the plant in general. As a result in this paper we describe an ultrasonic heat energy meter and an AMR system for this heat energy meter

Keywords: heat meters, energy measurement, district heating, automatic meter reading

1 INTRODUCTION

District heating system is an approach to supplying thermal energy through a distribution system of pipe from a central plant to individual users. Users then extract the energy the energy from the distribution system for their individual heating process requirement. The energy manager is not only interested in the total energy required, but also in consumption of individual heat consumers and the flow of energy in the plant in general. Because ultrasonic flowmeters are non-intrusive, have non moving parts subject to wear, have non pressure loss like turbine meters and are very accurate [1], in transmission systems in Romania ultrasonic heat energy meters are the principal type in use.

Revenue collection is one of the core activities of any utility inclusive heat energy distribution company This has traditionally been accomplished using ultrasonic heat energy 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 automatic meter reading (AMR) [2-3] is implemented which offer benefits to both parties.

In this situation we presented in this paper an ultrasonic heat meters manufactured in Romania [4-5] which has been developed to compliment permanently installed devices and a remote reading system for LUXTERM heat meters [6].

2 PRINCIPLES OF HEAT ENERGY MEASUREMENT

The differential method is the basis for the precise measurement of heat quantity. Assuming constant conditions, the heat flow can be calculated with the following formula:

$$Q = k_i(\theta_1 - \theta_0)V \qquad (1)$$

where V is the volumetric flow rate, θ_1 – inflow temperature, θ_0 – outflow temperature, k_i heat coefficient for the medium (water or air)

3 ULTRASONIC HEAT ENERGY METER

Energy heat meter is a combined instrument, which has separable sub-assemblies namely [7-9]: the flow sensor, the temperature sensor pair and the calculator. (see fig 1 a)

3.1. ULTRASONIC FLOWMETER

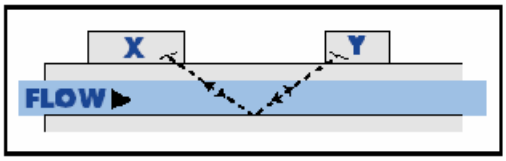
3.1.1. ULTRASONIC FLOW SENSOR

When ultrasound is transmitted between the two transducers X and Y, (see fig. 1b) the speed at which the sound travels through the liquid is accelerated slightly by the velocity of the liquid in the pipe. When ultrasound is transmitted in the opposite direction the flow of the liquid causes the transmitted sound to decelerate.

The subsequent time difference is directly proportional to the flow velocity in the pipe. Having measured the flow velocity and knowing the pipe cross-sectional area, the volumetric flow can easily be calculated [10].

[1] AEM – Luxten Lighting Company SA, Research Department, 26 Calea Buziasului 300693 Timisoara, Romania,
Tel: +40-256-222200, Fax +40-256-490928, e-mail sales@aem.ro
Corresponding author e-mai adresse crainicmonicasabina@yahoo.com

(a)



(b)

Fig. 1 Ultrasonic heat energy meter (a) the components of an heat ultrasonic heat energy meter (b) work principle

All transducers are clamped to the outside of the pipe wall with the rugged mounting hardware provided. Transducers are available to operate on pipeline from 15mm up to 200mm and at water temperature between 5°C and 130°C.

The flow range of the meter is dependent on the pipe size and the fluid velocity, which determines the selection of transducers that are supplied with each instrument. The instrument can be reprogrammed to use different transducers in other different modes in order to overcome signal strength difficulties, ease installation problems or to re-adjust the flow range of the instrument, should it be required.

In table 1 are presented some other technical characteristics of ultrasonic flow sensor.

3.1.2. RESISTANCE TEMPERATURE DETECTOR

The ultrasonic flow sensor made for heat energy meter features two input channel for platinum resistance temperature sensors Pt 500 (see fig. 1a) in 2, 3 or4 wire circuits [11-12]. This sensor type has been chosen because of its popularity in industrial application and ready in a variety of versions.

Some technical characteristics of resistance temperature detectors are presented in table 2.

Advantages of resistance temperature detectors: are: high accuracy, excellent long-term stability, and high signal output level that allows transmission over long distances without ancillary equipment.

Table 1 Some technical characteristics of ultrasonic flow sensor [5]

environmental class	A or C, as per NML 04-06-01, EN 1434, OIML R75
metrological class	2 or 3 as per NML 04-06-01, EN 1434, OIML R75
pressure	16 bar
ambient temperature	+ 5…+ 55 °C
connection	with thread with flange

Table 2 Some technical characteristics of resistance temperature detector [12]

accuracy class	A or B, as per NML 04-06-01,
measuring range temperature	0 °C…+ 180 °C
rated pressure:	16 bar

3.1.3. CALCULATOR

Calculator (see fig. 1a) is a sub-assembly, which receives signals from the flow sensor, and the temperature sensors and calculate and indicates the quantity of heat exchanged.

Heat energy meter displays various quantities required by the users (energy, power, volume flow and temperatures) enables remote data reading.

A heat meter can have either no interfaces or a number of interfaces to communicate with the outside world. Luxterm α heat energy meters have for example a RF radio interface module. The communication protocol employed is, according toEN60870-5. RF interface is connected to a radio module. The radio module is mounted in the lower case of the heat energy calculator. The radio module transmits the current records when it is appealed by a portable radio station from the neighborhood. The radio module is supplied from the calculator batteries. Some technical characteristics of heat energy calculator and radio module are presented in table 3 and 4. In table 5 are presented some climatic characteristics of heat energy meter.

The quantity of heat shall be indicated in Joule (J), watt-hours (Wh) or in decimal multiples of those units (MJ, GJ, MWh).

Display is made with liquid crystal with 7 digits.

Smart heat meters can be interrogated and programmed remotely from a laptop, personal computer or handheld device.

4. REMOTE READING SYSTEM

Revenue collection is one of the core activities of any public utility company. This has traditionally been accomplished using conventional credit meters

with regular meter reading extension of credit to customers and normal credit collection mechanisms. But as utilities around the world are coming to grips with deregulation, these is an increasing need for them to review existing business processes so as to make them more cost effective. This process is costly, with numerous inherent problems for both utility and customers. To solve some of these problems new technology like automatic or remote meter reading based on communication systems is being implemented which offer benefits to both parties.

Table 3 Some technical characteristics of heat energy calculator [5]

Temperature		
Temperature range		+0,5 °C… + 165 °C
Temperature difference range		+2 °C… + 150 °C
Programmable reference temperature		1,00 – 30 °C
Flow		
Consumed current	in stand-by 60 μA	
	in function 230 μA	
Frequency	max 200 Hz	
Pulse length	min. 2 ms	
Supply voltage		
Battery	3,6 V; 1,8 Ah – 10 years	
Memory	EEPROM	

Table 4 Some technical characteristics of radio module [6]

Communication channel Frequency	868 MHz
Modulation	RF-FSK
Radial power	max 3 mW (5 dB)
Transmission mode	Bi-directional (on request)
Communication protocol	EN 60870-5
Communication distance in open field	up to 200m
Operating temperature	0 °C… + 60 °C
Standards	according R&TTE Directive

Table 5 Some climatic characteristics of heat energy meter [5]

Environmental class	C as per NML 04-06-01, EN 1434, OIML R75
Storage and transport temperature range	- 25… +55 °C
Relative humidity	max. 95% at 20 °c
Protection class	IP 65

Remote reading system [6] is intended for the remote information collection concerning the heat energy consumption registered by Luxterm α heat meter provided with radio module.

The system is made up of the following: Luxterm α heat meters provided with radio module for the meters remote reading; Psion Workabout hand-held terminal provided with radio interface; central computer with data base for the collection of the metered heat energy consumption

On site data collection concerning heat energy consumption is carried out by means of PSION hand-held terminal provided with radio communication interface, and the data storage is achieved on a PC.

These functions are carried out by means of software application, made up of two modules: Luxterm P, for hand-held terminals of PsionWorkabout type and Luxterm BD, for PCs.

The Luxterm P module program communicates with heat energy meter through RS232 serial interface or TTL interface of Psion Workabout hand-held terminal with Luxterm heat meter provided with radio module. An RS 232 cable makes the communication with the PC

The application user interface is represented by a menus and dialog boxes system. The application starts working only after entering the user password. After the password checking, the user can use a menu comprising the following: configuration operations in the communication mode, addresses list loading, operations of current data reading and operations of current data transfer on a PC.

The configuration operations in the communication mode consist of the following:

a) Communication mode,
b) The choice of the address list,
c) List deleting
d) Current data reading

The program allows current data reading through the radio module. By operating this control, the following dialog box is displayed:

****

Heat meter reading
Address: <-Manual->
All meters: <-No->
GIVE UP GO ON
ESC ENTER

****

After pressing "Tab" key, the options for the address selection will displayed:

****

Manual
Name 1 l Domicile 1 l Address 1 l
Name 2 l Domicile 2 l Address 2 l
.....

****

In case there is no current list, only “Manual” option is displayed.

The meter can be read in turn, by selecting an address from the list or by entering the address with the keyboard, if <manual> option is selected.

If "All meters" is set up on "Yes", there will be read all the previously loaded meters, or only the

meters that have not been read, as function of the chosen option.

****

Multiple readings

Select: <-All meters-> <-Unread meters->

GO ON

ENTER

****

The data thus read are grouped in a directory, and the file names are created on the basis of the serial information (identifier). The hand-held terminal will display the following data: identifier (address, date and time), total energy, total volume, hot water volume, maximum flow, flow momentary temperature, return momentary temperature, temperature momentary difference, operating time etc.

The program also enables the manual entering of the data mentioned above.

The Luxterm BD software module has been intended to run under Windows 2000, XP. The Luxterm BD software module carry out the following:

- the transfer of the current data stored in memory PSION hand-held terminal,
- the deleting of the records from the memory PSION hand-held terminal, by operating the controls from menu.

These functions are correlated with the similar functions of Luxterm P program on Psion Workabout hand-held calculator.

Data display in the view zone and their deleting by operating the controls of viewmenu:

Viewing certain information from the database by operating the controls of: data base menu:

The reading of the current data from the memory of the gas meter, by equipping the PC: computers with a radio interface and a GPS:

The users, passwords and consumers lists configuration by operating the controls of configuration menu:

The data base can also be used by other specific applications: analysis, forecasting, billing etc

Technical characteristics of remote reading system for heat meters are:

- the maximum number of consumers stored by the HHU (2M memory),
- 10,000 consumers;
- HHU autonomy: 24h.

Some radio interface characteristics are mentioned in the paragraph 3.1.3 and in [13]. The antenna is internally executed. Supply is made with a Li battery of 3.6V (25 000 readings). One meter reading time length: 5 seconds.

4. CONCLUSIONS

Luxterm α is used for heat and cooling measurement in all water based systems. The use of ultrasonic technology offers numerous benefits:

- the meter is immune to soiling and does not require a filter like traditional turbine heat meter;
- the absence of moving parts prevents wear in metering components,
- no straight lengths are required before or after the meter;
- the head loss is very low with high metering dynamics.

All these characteristics contribute to accuracy stability overtime.

Remote reading system replaces not only the classical meters but also:

- the billing system,
- the reading of the meters and
- the administration of revenue collection.

The remote reading system capability could subsequently be an added in an evolutionary manner, in order to offer advantages over and above the simple payment function like added

- value service,
- fraud control,
- tariffs incentives and
- unattended dwelling

REFERENCES

[1] Crainic M.S. “Electronic flowmeters for thermal energy measurement” Annales of West University of Timisoara Physics Series vol. 44, (2003), p.78,

[2] Tom P Tomarkin "Automatic meter reading" Public Power Magazine 50 (5) 1992

[3] *** "Automatic meter reading " Cognyst Consulting LLC Publications www.cognyst.com/amr/

[4] Crainic M. S. “Luxterm a Romanian heat energy meter” Annales of West University of Timisoara Physics Series vol. 44, (2003), P. 212

[5] *** “Heat energy meter Luxterm α/αm” (prospect) http://www.aem.ro

[6] *** ”Remote reading system for LUXTERM heat meters” http://www.aem.ro

[7]*** BS-EN 1434-1 1997 Heat meters. Part 1 General requirement

[8] *** BS-EN 1434/2 1997 Heat meters Part 2 Constructional requirement

[9] *** SF 91-2003 Luxflow ultrasonic flow transducers

[10] Crainic M.S. Contributions regarding the indirect flowmeters for liquids in closed pipes (flow transducers with magnetic liquids) Doctoral Dissertation West University of Timisoara Romania 1998

[11] *** BS-EN 60751 1995 Industrial platinum resistance thermometer

[12] *** “Pair of thermal resistances” (prospect) http://www.aem.ro

[13] *** Heat energy calculator Luxterm (prospect) http://www.aem.ro