European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ)	International Conference on Renewable Energies and Power Quality (ICREPQ'11) Las Palmas de Gran Canaria (Spain), 13th to 15th April, 2011

Real heating-value based cost-accounting method with networking capabilities in natural gas distribution systems

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Abstract. Nowadays customer-side natural gas measurements are only focused on gas volume, while prices are increasing and the market becomes more open. Because of the efficient cost accounting, large customers get interested in measurements corrected by real calorific value. For determining the real energy flow, continuous measurement of gas consistency needed. But online gas chromatography is too expensive for even large consumers. However the information exists at provider-side databases and can be used for calorific value and energy flow computing at different customer-side locations. The aim of the research and development project was to give a cost-effective solution to these requirements. At the first we give a short theoretical overview of gas-flow measurements in cost-accounting and show the related standards. After that we define a realizable computing method, and deal with the structure and operation of the new measurement system.

Key words

data acquisition, cost accounting, natural gas measurement

1. Introduction

When dealing with gas flow measurements, especially in cost-accounting systems, we get strong accuracy criteria, which can only be met by real-time correction computations. For these we need not only physical parameters, but the actual consistency of the flowing media too.

If we assume that gas consistency does not change while travelling in pipes, the already realized provider-side consistency measurements can be used for calorific value and energy flow computing at cost accounting measurements on customer-side.

The new measurement system introduces a new communication and database structure in cost-accounting. For realizing it, we need to create special hardware and software components, which are specified by the requirements described in the next sections.

2. Background of corrected flow measurements

The only fully standardized measuring principle for flow measurement is the differential pressure based method with orifice plates. The measurement can be easily reproduced because of its indirect principle. If the measuring system is constructed according to the standards, only the basic temperature and pressure sensors need to be calibrated, and the accuracy of the whole system can be determined theoretically.

The correlation between volume flow and the Δp differential pressure measured between the two sides of the orifice plate (1) can be deduced from Bernoulli equation and the continuity equation. These are the two basic laws of flow theory.

$$q_V = \alpha \cdot \varepsilon \cdot A_0 \cdot \sqrt{\frac{2}{\rho} \cdot \Delta p} \qquad (1)$$

The flow coefficient (α) represents the geometry of the pipe and the orifice plate. In real cases it depends on the speed of the gas-flow, especially on the Reynolds number too. The expansion coefficient (ε) is used to consider the change of speed, volume and density while the gas flows through the orifice. It depends also on the $\Delta p/p_1$ rate, where p_1 is the pressure before orifice. In technological control these coefficients can be defined as constants. But in cost-accounting systems they should be recalculated continuously, because of higher accuracy criteria.

Media density (ρ) is also needed for calculating volume flow (q_V). Direct measurement is rarely applied, but we have different ways to determine it. If density is known, mass flow (q_M) can easily be calculated (2).