Development of flow meters and assistive devices for the technological air and carbon dioxide accounting

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Abstract – Result of development and implementation of gas flow rate measurement system for rapidly varying flows are considered in this paper. The flow rate meters in this system are based on pressure differential devices with fast processing of flow rate calculation algorithm by PLC`s united into a network and integrated in SCADA.

Key words: measurement of pulsating flow, flow meter, differential pressure flow meters, compressed air, carbon dioxide .

I. Introduction

Continuous monitoring of material and energy flows in production is a prerequisite for their economical use. Usual is a continuous recording of consumption historycal trends by production units of electricity, water, heat or refrigerant and their analysis in order to attribute the costs of these resources per unit of output.

For many food technologies, it is important and cost-effective to record the flow of compressed air and carbon dioxide. The accounting of the flow of compressed air is important in the food industry, which has a large number of pneumatic drives in the technological lines, and in air compression, where are used multiple compressors of high power. In the brewing industry are used many pneumatic drives for the relatively small production (PJSC "Carlsberg Ukraine", Lviv city) where the electric power of the multiple compressors reaches 250 kW. The compressor units control is carried out by the central programmable logic controller, which allows distributing the load to the compressors to make energy consumption maximum effective, taking into account the peculiarities of the compressors auxiliary equipment (lubrication systems, etc.) [1]. In addition, in the brewing industry is released and consumed carbon dioxide, which is a valuable raw material and its excess is sold to other industries, for example, for gassing soft drinks. For these technologies are needed high-speed flow meters of pulsed fluxes of compressible fluid , which can measure rapid changes in the flow rate within the range of 0.2-1 [2] from the measurement range within 1-5 seconds.

II. Terms of equipment selection

Measurement of the flow of compressed air solves two problems: the first is accounting; the second one is taking the flow signal for the multiple compressors automation. In automation system of multiple air compressors can be offered new algorithms to control them, which will significantly save energy, unlike the cascade of pumps for water pumping, where are used non-compressible fluid with a high speed change of pressure in it. To implement such a control system is required a flow meter with high speed facility and low pressure loss on it.

Measuring the flow of carbon dioxide consuming, which is used to create a carbon dioxide atmosphere, in technological devices (buffer capacities) and saturation of beer, it is not critical the pressure loss on the flow meter. However, it is important high-speed measurements and the flow's value limits, which does not exceed the maximum value of the measuring range of the instrument, in the supply line. It is critical to choose the upper limit of measuring the flow meter at the level of 2-2,5 values from the calculated average consumption and prevent the excess value of the flow of the technological bottling line beyond this value, because observational error will be significant when it integrate the flow to calculate large carbon dioxide capacity. The limit of the flow value was achieved in two ways: 1) the installation of an additional diaphragm in the flange of the flow meter after the control area; 2) the installation of a specially designed of the flow restrictor of direct action, after the flow meter.

The special restrictor installation is the best solution to the problem, despite the greater implementation complexity. This device is a local constriction, with a bellows or membrane actuating mechanism and a valve, which must have a static characteristic, shown in Fig.1

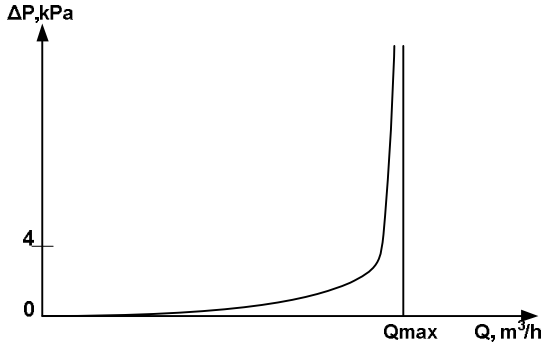

Fig.1 The flow limiter static characteristic (ΔP – pressure drop across the flow limiter, kPa, Qmax – maximum measuring range of the flow meter, m3 / h)

To construct flow meters of pulsed fluxes of compressible fluid, the differential pressure method was chosen on the basis of non-standard tapering devices. The pressure difference on the narrowing device was measured by a serial differential pressure meter, and two other measurements – the absolute gas pressure and temperature required to calculate the gas density under working conditions [3]. Rapid processing of information is implemented on a separate controller type S7-1200, which is easy to integrate into the industrial information network. In project was used Siemens concern equipment, which representation in Ukraine contributed most to the implementation of this development.

The peculiarity of the constructive implementation of flow meters is that they are made as a single-walled design with control areas and a minimum number of seals. The critical dimensions of the constituent of the

tapering device become hard to produce with an allowance less than 10 μm for pipelines with diameters of up to 50 mm, . Therefore, the calculated static characteristic of the flow meter was recalculated according to the actual dimensions of the finished parts.[4]

III. Developed flow meters

In fig. 2 shows the appearance of a batch of carbon dioxide flow meters manufactured for PJSC "Carlsberg Ukraine", Kyiv.

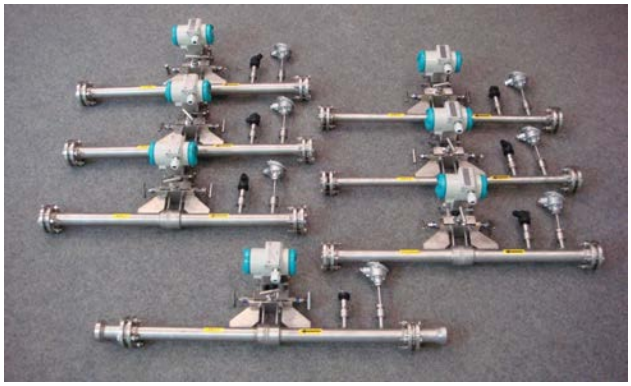

Fig. 2. General view of measuring units of flow meters of pulsed fluxes, executed as a single-welded structure.

In fig. 3 shows the flow-measuring unit for measuring pulsed compressed air flows, manufactured as a complete weldless design without control points of the pipeline, which is involved in the automation system of multiple compressors at PJSC "Carlsberg Ukraine", Lviv, one of which is driven by a frequency drive.

Fig. 3. General view of the measuring unit of the flowmeter of the pulsed compressed air flows, which is executed as a single-welded structure.

In fig. 3 shows a computing device for pulsed streams flowmeters of compression fluid data processing using the programmable logic controller S7-1200. This makes it easy to integrate the device into a multiple compressor control system.

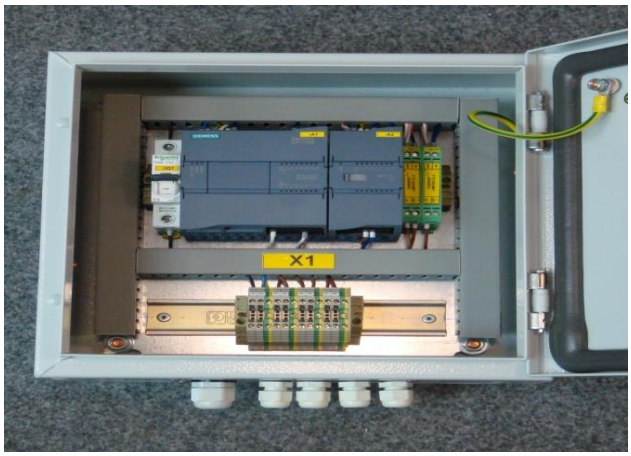

Fig. 4. General view of the computed device of the pulsed streams flow meter of ccompressed fluid using the programmable logic controller S7-1200.

Conclusion

The development results of flow meters of pulsed fluxes of carbon dioxide, liquid carbon dioxide, compressed air were introduced at the enterprises of PJSC "Carlsberg Ukraine", Lviv, Kyiv, JSC "Radomyshl Beer and Non-alcoholic Combine", Radomyshl, Zhytomyr region.

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