Part 3

ASH AND SLAG HANDLING

3.2. Ash and slag handling systems at TPPs

3.2.2. Ash removal

3.2.2.4. Contact free measuring of the level in liquids and bulk mediums in industrial tanks using short range radar methods

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ABSTRACT

Advantages of radar methods for monitoring the filling level in technological tank, especially in case of aggressive environment are marked. Technical characteristics of the introduced level gage of 8-mm wave range, applied in systems with a number of tanks, are resulted. In the paper introduction of radar level gages at several power plants is mentioned. Perspective modifications of level gages with essentially lowered price and application of new programs for microprocessors of digital signal processing are discussed.

INTRODUCTION

As follows from the set technical requirements for measurement and level control systems in technological tanks of power plants and the comparative analysis of the known systems [1], a choice of the optimum continuous control system is made in favor of a radar principle of measurement with use of linear frequency modulation (LFM). Such radar instruments for measuring the distance to the object, reflecting the microwave radiation, are now applied to control the tank filling level at industrial plants. A similar specific target arises, in particular, at power generation plants (thermal power plants, state district power plants) to measure a level of liquid fuel (black oil) in storehouses, coal dust in boiler hoppers, dust collectors of flue gas cleaning systems, to measure a level of acids, alkalis, liquid ammonia in tanks of chemical water treating departments and in a number of other cases.

Advantages of radar methods in comparison with other level control methods consist in absence of direct contact of gages with medium, being often aggressive or leading to change of the gage characteristics, and sometimes to their failure state. In addition, using narrow-directed radio emissions as a probe, in comparison with ultrasonic locators, allows to exclude (or, at least, to lower) the impact of pressure, humidity, gas or steam structure over the controllable surface on accuracy of measurements.

Nowadays in our country and abroad the radar level gages of various modifications of different frequencies, microwave section design, type of aerials, methods of processing and display of the readings and, of course, the cost are developed and applied. Developments of the defense companies of Ryazan and Tula are well-known, for example. The most introduced is a radio range finder RRF-1 developed by Fryazinsky scientific and development production centre "ISTOK" working in 8-mm radio-wave range. The most popular foreign level gages are ones developed by the following firms: SAAB, SIEMENS, ENDRESS+HAUSER, KROHNE, VEGA, ENRAF, working, as a rule, in centimetric wave range. In MPEI the applied problems for short range radar-location systems were investigated in 50-ties, and directly for creation of level gages – from the beginning of 90-ties of the XX century.

The feature of all known types of radar level gages is use of electromagnetic waves of radio-frequency in them (of centimetric and millimetric ranges) that allows by means of antenna arrangements of the comprehensible sizes to receive rather narrow-directed radiation and eliminate the stirring reflections from collateral objects, in particular, from tank walls.

GENERAL PRINCIPLES OF OPERATION

A level gage represents the radar system operating in LFM mode. The gage includes a microwave sensor (S), set on the top mark of the controllable tank, and a secondary device (SD). The secondary device contains power, control, processing and alarm units placed on the taken out control panel.

The gage and the secondary device are connected by means of cable lines; the distance between them is to 150 m; gage overall dimensions are 215×215×295 mm.

In the level gage the following is provided: digital readout; control, correction and adjustment of the measurement channel; setting adjustment; alarm system and relay output at the bottom and top levels in controllable tanks; indication of the general working capacity of the measuring channel; standardized analog current output - 4 … 20 mA; RS-485 digital interface; a range of the measured distances - 0,5 … 20 m; inaccuracy of the level measurement without an external computer ±50 mm, with an external computer ±15mm; measurement error in the flow meter mode ±1 mm, maximum speed of the distance change - 30 mm/sec; working temperature range differs from –30°C to +40°C.

In case it's required to control a level in several tanks, at each tank there can be set the described level gage with an output of the measured signal to secondary devices and in the uniform data collecting system (DCS), including, in particular, the computer and the control panel. An example of such realization with four tanks is schematically shown in fig. 1, and a screen of the computer monitor in case of two tanks in operation – in fig. 2.

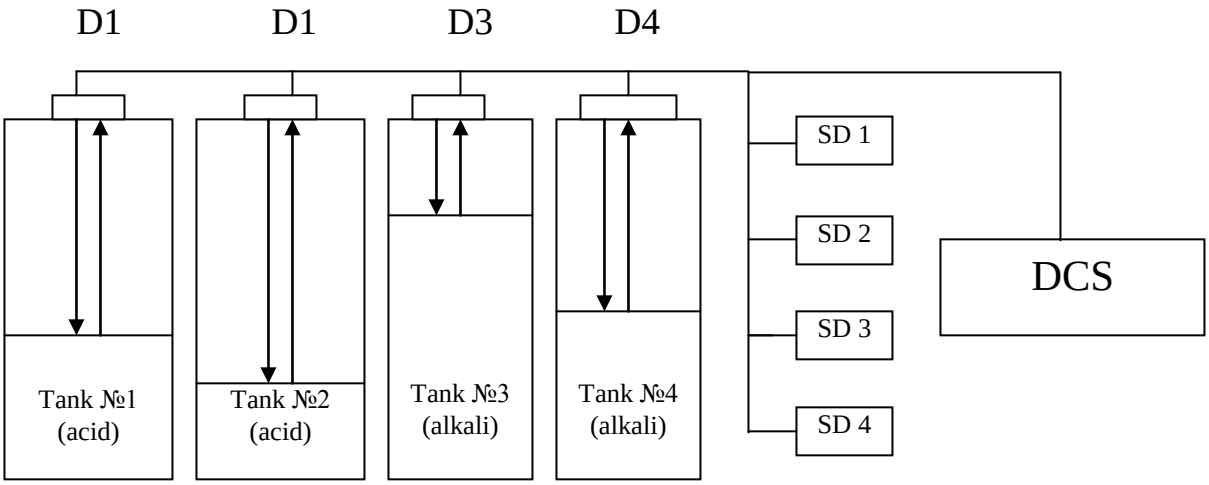

Fig. 1. Bloch-diagram of the level control system in four tanks of the chemical department of the SDPP

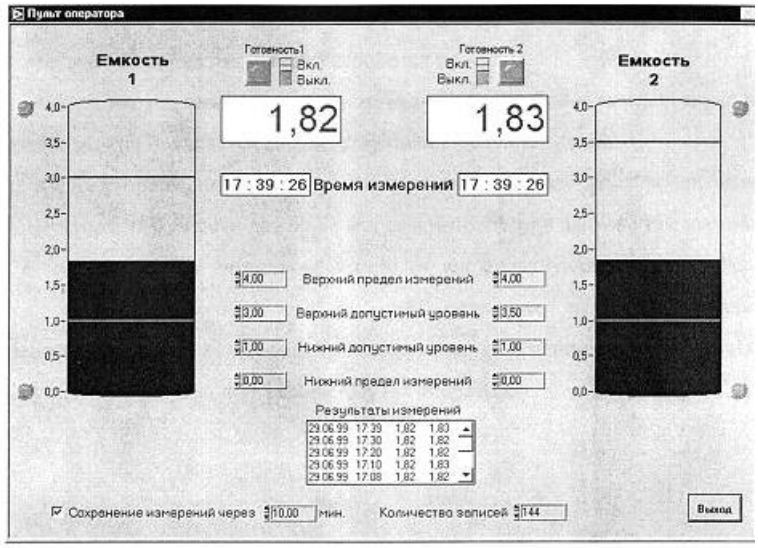

Fig. 2. Indicator of the level control system for two tanks

PERSPECTIVES

Nowadays works on level gage improvement are being conducted in different directions.

Direction №1. Price cutting. For that purpose a specially developed UHF part of the system, containing a frequency-operated generator on the field transistor, transistor amplifier of high frequency and a mixer, and also a small-sized ferrite circulator, manufactured by scientific and practical enterprise "Granite", is applied. Operating frequency (10 Ghz) and the components used allow to make a microwave unit in microstrip execution that is essentially more manufacturable and cheap than waiveguide designs.

Direction №2. Working out of new principles of digital signal processing. For that purpose the programs for microprocessor which is a part of the level gage are checked. The programs are intended to control the elements of UHF module, digitize and process the signal, output the data to the secondary device and communicate. The created signal processing programs (in particular, using a phase method) should expand a scope of radar level gages due to possibility of conducting the measurements in adverse conditions, being inadmissible for normal operation before. The created systems allow the operational personnel to automate the process of tank filling and discharging; provide continuous data occurrence; practically exclude an industrial traumatism and occupational diseases; lower probability of pollutants into environment.

The presented level gages are set and operated at Ryazanskaya, Permskaya and Kashirskaya SDPPs, TPP-12 (Moscow), and also approved in installations of dry ash collection and discharge at Ryazanskaya SDPP and in the pellet loading system at Oskolskiy metallurgical industrial complex.

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