METHOD FOR LEVEL MEASUREMENT IN HYDROENERGETIC ACCUMULATIONS

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Abstract. *The described measurement system is recommended for the measurement of the water level in hydroenergetical accumulations because permits the measurement of the water level in large limits with the error ε desirable by user, eliminates the possible measurement errors due to the zones which could appear in the cold season between the water level and the appeared ice bridges and due to the fact that are used two distanced contacts systems are eliminated the situations appeared when the sensors register erroneously by reason of some objects (trashes, branches, etc.) appeared in the sensors placed above the water level. In this case the displayed value of the level is with ε much more than the real level.*

Keywords: *level measurement, hydroenergetical accumulations, microsistem.*

Level measurement in big open vessel

The used methods for the level measurement in a reservoir are:

• Electric conductivity method

The level of a conductive liquid can be determined measuring electroconductibility between two electrodes inserted in the vessel which must be supervised. The method is simple and cheap. The electroconductibility *K* is the inverse of the electric resistance *R*:

$$K=1/R= S/(r \cdot l) = H \cdot L/(r \cdot l) \qquad (1)$$

$$[K]_{SI} = W^{-1} = Siemens$$

where:

r – the electrical resistivity of the liquid [W ·m]

l – the distance between electrodes,

S = H·L – the aria of the electrodes covered by liquid

L – the width of electrodes,

H – the level of the liquid.

• Ultrasonic and sonic method

Is emitted a short acoustic impulse to the liquid surface and the time whereafter comes back the sound (the echo) indicates the level of the liquid from reservoir. More precise, the distance *D* between the acoustic source and the liquid surface from reservoir determines the time:

$$t = D/v = \text{distance / sound speed}$$

The domain of the used frequencies is ultrasonic ~ 20 – 200kHz or audible ~10kHz.

The piezoelectric materials are used for electric-signals to sonic-waves conversion and to notice the acoustic waves. In applications must to know that:

- The sound aerially speed varies with temperature. A temperature sensor must to compensate this variation which influences the calculated distance and the level measurement.
- The materials from the liquid surface acts as sound absorber. In certain cases this phenomena excludes the using of the ultrasound.
- The big turbulence of the liquid can cause fluctuations of the device indications. The signal mediation helps to decrease this problem similar with the utilization of a waveguide.

• Electric capacitance method

The method uses the electric capacitance modification to measure the level from a vessel. It is useful for liquids, grazes or dielectric granules. The used frequencies are from 30 kHz up to 1 MHz.

Two plane conductors separated by distance "*d*" have the capacitance:

$$C = e_o \cdot e_r \cdot A/d \qquad (2)$$

where:

e_0 = vacuum permittivity

e_r – relative permittivity of dielectric material

A – the aria of the common surface of the conductors

• Hydrostatical pressure method

An old and many used method to determinate the level of a liquid uses the measurement of hydrostatical pressure practiced by liquid column about the vessel. The basic relation is:

$$P = d \cdot g \cdot H \text{ sau } H = P/(d \cdot g) \quad (3)$$

where:

P – pressure

g – gravitational acceleration

H – the high of the liquid column

D – the liquid density

The liquid density varies with temperature. For high precision measurements is required to compensate the variation of the density with temperature, as in the case of hydrostatical gauges.

The instruments for differential pressures measurement (the DP cells), used initially to measure the decreasing of pressure on an orifice (diaphragm) from a pipeline for flow supervising, can be easy adapted for level measurement. For the open reservoirs the big pressure pipeline is connected to the bottom of the vessel, and the other to the atmosphere.

• Microwaves method

The method usually uses microwave from the band X (10 Ghz). From the top of the reservoir is sent a microwave fascicle to the surface of the content from reservoir. The reflected fascicle is received after a certain time. This time is used-up for the determination of the level.

Five informations define type of the technology of measure the level:

- the material to measure;
- the material features: consistence (liquid, paste, solid, granules, dust), the interface, inductivity, the electric conductivity (S/m), the centipoises viscosity (Cp) and the density (kg/m^3);
- the technological process: what minimum and maximum values of temperature are, the present of the turbulence, the material from which is achieved the reservoir, the anti-explosive protective degree and the corrosiveness;
- the function of the reservoir: reactor, store, separate and a scheme of the vessel with the specification of the level 0% and 100%, the presence of an agitator and of other obstructions.

A new liquid level determination method in high dimension vessel

The suggested system has on base a micro-system with controller which permits the interaction with exterior using digital ports, the simple computing and the display of the results (the liquid level).

The sensor has on base two distinct systems which measure individually the liquid level, placed at distance *L* between they. Each from these systems is constituted from a number *n* of contacts pairs placed vertically at distance *h* between they and which cover wholly the maximum height H_{max} of the liquid from vessel (figure 1).

The successively command of the contacts from one level is achieved through a decoder commanded by the digital ports of the micro-system. Thus, due to water conductibility whose level is measured, to the command of one contact is obtained the logical value 1 on the reaction lines a_i. If the commanded contact is placed above the water level (aerially) on the reaction line is shall registered the logical level 0, this signal commanding the breaking of decoder command, and commanding the recording of rank of the contact placed above the measured level.

The measurement begins thus to the inferior level, according to contacts pairs k_{i1} and continue till the micro-system notice (through the reaction signals a_i) a contact pair placed aerially. The successively command of the contacts is achieved through the incrementing of one register of microcontroller.

In the moment in which is noticed a command on one from the reaction circuits, the microprocessor register whose digital value is transmitted to the signals $b_1 - b_k$ applied to the decodifier transfers his value *m* in memory and resets. The water level *H* in vessel is computed with the relation:

$$H = m \cdot h + i \cdot h/2 \qquad (4)$$

where

H – is the water measured level,

m – the number from the microcontroller in the moment in which is received a signal on the reaction i,

i – the rank of the reaction circuit on which is registered the command (0 or 1),

$h/2$ – the vertical displacement between the sensors with the same rank on that two contact systems.

The number k of signals on the output port of the micro-system (the binary rank of maximum number which shall be registered in the incrementing register) is computed with the relation:

$$k = \left[1 + \log_2 \frac{H_{\max}}{2 \cdot \varepsilon} \right] \qquad (5)$$

where ε is the maximum error desirable to register with this measurement equipment (h/2), the parentheses having the signification of computing of integer part of inland digital value. For example, in order to measure a maximum level H_{max} = 100 m with a maximum error ε = $h/2$ = 20 cm, the micro-system will command the decodifier on 8 signal lines (k = 8).

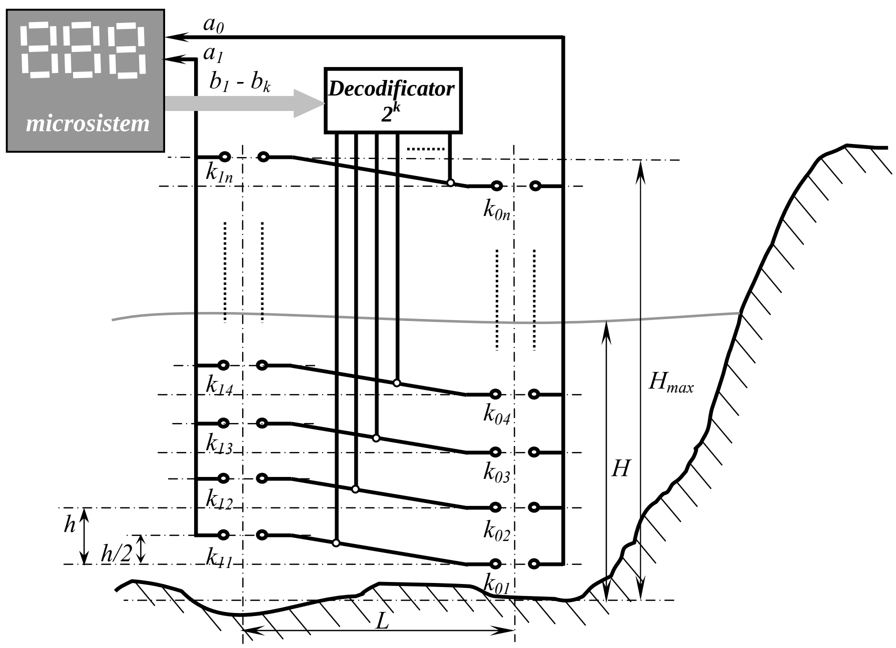

Figure 1.

Conclusions

The described measurement system is recommended for the measurement of the water level in hydroenergetical accumulations due to the following advantages:

- permits the measurement of the water level in large limits with the error ε desirable by user;
- eliminates the possible measurement errors due to the zones which could appear in the cold season between the water level and the appeared ice bridges;
- due to the fact that are used two distanced contacts systems are eliminated the situations appeared when the sensors register erroneously by reason of some objects (trashes, branches, etc.) appeared in the sensors placed above the water level. In this case the displayed value of the level is with ε much more than the real level;
- the equipment is digital, easy to debug and with minimum errors to the remote transmission of the information.

Being a digital device, the number of the line for information transfer is high. To realize an easy debug concomitantly with the achievement of a rigid structure for sustaining of the sensors system, it is recommended to use a tube. This constructive variant (figure 2) can be provided with an electrical heating system in the cold season in order to melt the ice bridges which tends to appear in contact zones. Therewith this structure permits the easy clearance of the sensors.

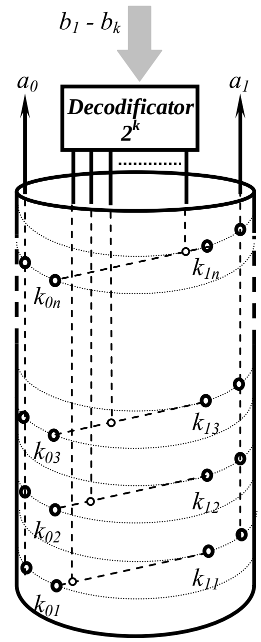

Figure 2.

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