1.11.9. COMMUNICATIONS SYSTEM FOR REMOTE DIAGNOSTICS AND CONTROL OF CORROSION OF THE STATE AND LEAKPROOFNESS OF PIPELINE

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Pipeline transportation systems for various purposes are the basis of the fuel and energy complex. The problem of improving the operational reliability of pipelines is a critical factor for the functioning of many industries.

One of the solutions to this problem is to establish effective methods and tools for diagnosis and monitoring of communications equipment and pipe.

This paper observes the developed version of the telecommunications system of diagnosis and control of the state of corrosion and leakage of pipelines. Created experimental system consists of a number of acoustic sensors, the two pulse generators, a number (number of sensors) of the signal amplifiers, communication unit and a laptop computer ("notebook").

The topology of the network is not essential: it could be as «Bus», and «star». Blocks of Electronics (BE) must manage the acoustic sensors and process signals received from them. Block of network switching (S) should receive messages from all BE and forward them to your PC, and send to any of BE commands received from PC. When choosing interface, we must take into account the requirement for speed.

Information from each sensor is processed by appropriate BE and comes in digital form on a laptop PC (personal computer) via a digital serial channel switch (S). On the PC, this information is processed by software and is issued for display, is stored on the hard disk and can be further printed in a report.

The principle of the system is as follows. In the pilot station sensors are installed directly on the tube body, bypassing the outer layers (thermal insulation, optoisolation, etc.) in locations shown in the diagram of experiment (fig. 2).

When starting, the system is transferred to the passive mode, in which the expected appearance of the acoustic signal frequency and sufficient power, which corresponds to the appearance of cracks or breaks in the pipeline. In addition, there is a constant acoustic signal noise caused by the moving fluid (water, oil, etc.) in the pipeline, as well as a contribution to the signal making noises arising from corrosion defects.

Corrosive defect in the form of pipe wall thinning is considered as a membrane, which, in accordance with the basic decision theory of acoustics, has its own frequency of oscillations f. According to the band for the defects with linear sizes larger than 20 mm ranging from 500 to 5,000 Hz (acoustic band).

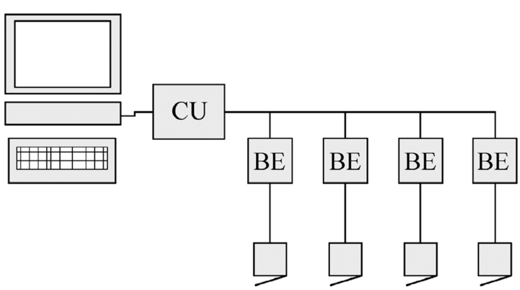

Fig. 1. A simplified structure of the pilot system

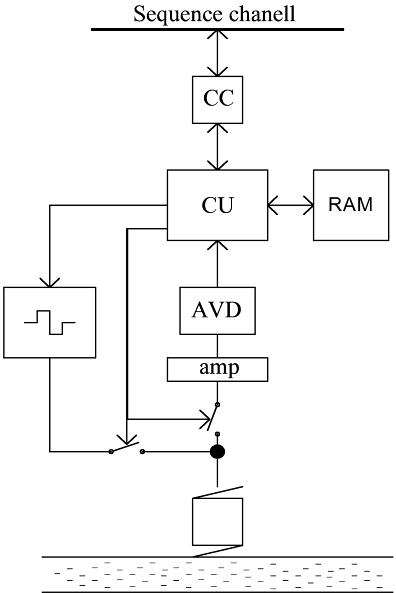

Fig. 2. Scheme of experiment

Power factor, initiating a forced oscillation of the element is the pulse pressure in the water at the expense of the pumps, water currents, etc. These pulsations are presented as a set of pulses of different frequencies (f_k). When the pulse frequency is close or coincides with its own frequency of the defect ($f_k \sim f_o$), there are resonant oscillations of defect with different wave radiation (emission), which are subjected to metal pipes and water.

By type of excitation, this method refers to passive, that is not used, no additional devices for the excitation of oscillations corrosive defects.

It is also proposed as a method of active control when one of the acoustic sensors initiates probing signal, which is distributed by pipeline to the distance to the receiver transducer.

These signals are recorded by all sensors in the passage of an acoustic wave front. The output of the sensor signal before is represented with the voltage fluctuations from 0.1 to 10 V (“useful” signal, in contrast to the background noise), it comes through the protective circuit and the amplifier for high-speed ADC, which converts it into an information pack voltage at fixed time quanta. Through the serial channel controller (K) on a PC is reported to receive a signal of acoustic emission sensor and the sensor, that accepted this signal. Such data are received on a PC with each sensor in the manner of their passing the front of acoustic waves. Time intervals between messages are measured, arrived from the sensors and, in view of their order, and the coordinate source of acoustic emission is defined.

In the active mode of operation in each time only one sensor is involved. At the same time it connects to a high frequency pulse generator (20, 30, 50 or 100 kHz) for 10 ms, resulting in a pipeline brought fading acoustic signal lasting about 250 ms. When connecting the sensor to the generator the countdown is started. After 250 mcs from the moment of connecting the sensor to a pulse generator, it is included in the input of amplifier. Switching of piezosensor, timing and all other operations are managed by programmable microchip, also processing commands from the PC. Reflected from an obstacle acoustic wave comes back to the sensor, which represents its shape in the form of voltage fluctuations. These vibrations are converted with fast ADC in the information packet that is placed in the operative memory (RAM) together with the value of time that has elapsed since the initiation of the sensor before the arrival of the reflected wave front (timing is stopped). Further, whole package is sent to a PC on the serial channel. On the PC adopted package is processed accordingly and displayed as oscillogram of the received signal, and the distance from the sensor to the point of reflection of waves is calculated. The error does not exceed the calculated value of 0.7 m. The whole cycle is repeated through the 2 – 25 s.

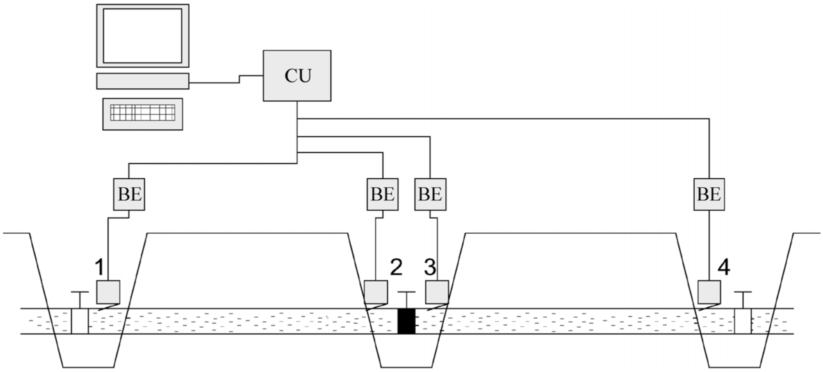

Fig. 3. Scheme of terrain distribution of system

Scheme of terrain distribution of a system consisting of four sensors, is shown in fig. 3.

The distance between the wells does not exceed 120 meters, but is exactly set when you configure the system at the site before the experiment. In the active mode, the system only works with sensors 1 or 3. The sensor (eg, 1) emits acoustic signal which propagates across the surface of the pipe at the target site (1–2). Having reached the obstacles (fracture gap) or valve jumper in the next well, the signal is reflected, and after a time t is returned to the sensor 1. At a known rate of propagation of the signal (6 km/s) it is possible to calculate the distance to obstacles, and if it proves less than the distance between the wells to draw a conclusion about the existence of damage to the pipeline at the site 1–2. Similarly, the integrity of the 3–4 is checked.

In the passive mode all four sensors work simultaneously. If there is a signal of acoustic emission, it is recorded by all sensors in the manner of their passing the front of acoustic waves. The fact of registration is reported to the PC, where after the first of such messages (a total of 4 must be the number of sensors) the counting is started to count the time t until the moment of receiving the second message. Upon completion of the reception of messages, the order of their arrival is considered (ie the order of passage the sensors by the wave front) and concludes on the location of the source of acoustic emission (sites: to the left of the sensor 1, 1–2, 2–3, 3–4, to the right from the sensor 4). Then, depending on the order, distance from the source to the first sensor, accepted the signal, is calculated. The results are shown on PCs are stored in a special log file, and later it can be printed on your printer.