Continuous monitoring during operation

Of INSULATED PRESSURE VESSELS

By Acoustic Emission method

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Industrial production associated with poisonous, flammable, explosive and radioactive substances, high and ultra-high pressures and temperatures is potentially dangerous to humans and the environment. In the case of deterioration of equipment associated with the natural aging of the fixed assets, with a long, critical service life at elevated or close to the limit loads danger increases manifold.

Fortunately, the disaster of global scale with the irreparable loss of human life and material damage, like the explosion at the Chernobyl nuclear power plant in Ukraine, occur rarely. But any accident at the nuclear power plants and chemical industry dangerous for the environment. And the destruction of any equipment, which plays a key role in the process, for the affected enterprise is associated with a loss of wealth, costly restoration work, fines and other sanctions, in violation of terms of delivery, loss of market position.

Ensuring a stable and trouble-free operation of industrial equipment, as a rule, put into the process of designing and manufacturing, and continued in the framework of the pre-operational, periodic and extraordinary inspections and repairs. Various methods of non-destructive testing - before the start of operation of the process, when a temporary halt for the purpose of current or extraordinary maintenance or inspection - accumulate information on the status of the equipment under test. conclusions formed on the basis of the information about the quality parameters and the expected life of the equipment, its share.

Equally important it would be, however, to update the predetermined evaluation - in the course of operation. This would allow, depending on the actual current state of the equipment, specify or revise the conclusions concerning the life of equipment, or the timing of the next Extraordinary control, and most importantly, time to take the necessary measures in the event of a sudden destructive process.

Unfortunately, a small amount of known diagnostic techniques, which can reflect the actual state of the equipment, not only during the test, but also during operation. Acoustic emission (AE) - one of the few universal methods of non-destructive testing and technical diagnostics.

Method AE distinguishing feature is the ability not only to study vneekspluatatsionnyh during testing, but also monitoring: continuous monitoring of industrial equipment is in operation without interruption during the manufacturing processes, in an actual working load.

With the help of the required number of sensors located on the surface of the object AE devices allow you to check the material condition of the equipment functioning in full.

With proper selection and configuration of instrumentation, its careful installation and in the presence of professionally trained staff of acoustic emission monitoring makes it possible to detect the early stages of a destructive process in a timely manner to take the necessary preventive measures.

CHEMICAL PLANT STORAGE AND AMMONIA

Odessa Portside Plant (IPF), founded in 1976,

and is so far the largest chemical enterprise for the production of ammonia and urea, for a number of years apply AE monitoring for continuous monitoring of its four unique reservoirs that serve for storage of liquid ammonia.

Ammonia is produced partially in place, partly supplied via pipelines from other Ukrainian plants. A smaller part of the product used for the production of urea, a lot of bulk, after temporary storage, is transferred into tankers and by sea for export.

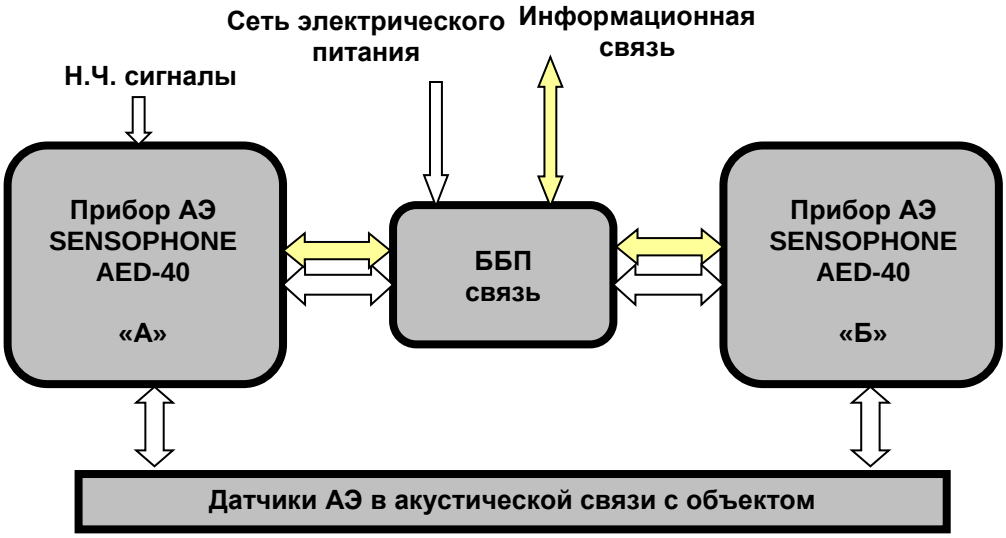
Storage tanks for temporary storage of ammonia - a four identical steel cylindrical container volume at 40,000 cubic meters each. . Perimeter vessels 160 m, height 20 m insulated vessels, liquid ammonia is contained in them at a temperature of -33ºC. The amount of product in the tanks are constantly changing, which means an additional cyclic load at the factory and seeks to equally use all four of the tank. Over 25 years of operation, insulation of tanks thoroughly "worn out", has matured the need for its updating and the accompanying examination of the technical condition of the vessels. Consistently produced current repair and replacement of insulation of all 4 vessels used the complex to install EMA-3S continuous monitoring, based on the method of acoustic emission.

ammonia tanks

MEASURING SYSTEM OF ACOUSTIC EMISSION

Measuring complex on-3S is based on the AE unit «SENSOPHONE AED-40" Hungarian production (company «Gereb es Tarsa») and software and the AE sensors Electric Institute to them. Paton of the National Academy of Sciences of Ukraine. Paton Institute in the recommendations does not need. Hungarian instrument was chosen for its reliability and guarantees of timely quality service.

Complete measuring system ON-3S, offering all the ammonia storage, consists of 4 identical measurement systems (one for each tank). The systems include two SENSOPHONE AED-unit 40, which provides the desired number of channels (up to 64 per system).



Driving instrument parts EMA-3S measuring system

Measuring tank system ST3

Each tank was set to 56 sensors, three rows of sensors 16, plus 8 additional sensors in close proximity to the shell. The distance between sensors 10 m horizontally, vertically - 7. The signals received from the sensors via coaxial cable insulated with teflon LLA-programmable amplifier 102, and then to 40 SENSOPHONE AED-input devices. Devices with amplifiers and

power systems uninterruptible power supply installed in three explosion-proof sealed containers. The distances between the devices and sensors, and, accordingly, the length of coaxial cables - from 40 to 120 meters. Remote LLA-amplifiers 102, a part of the device SENSOPHONE AED-40 allows to double the maximum distance between the sensors and measuring equipment, but in this case the need for this has not been.

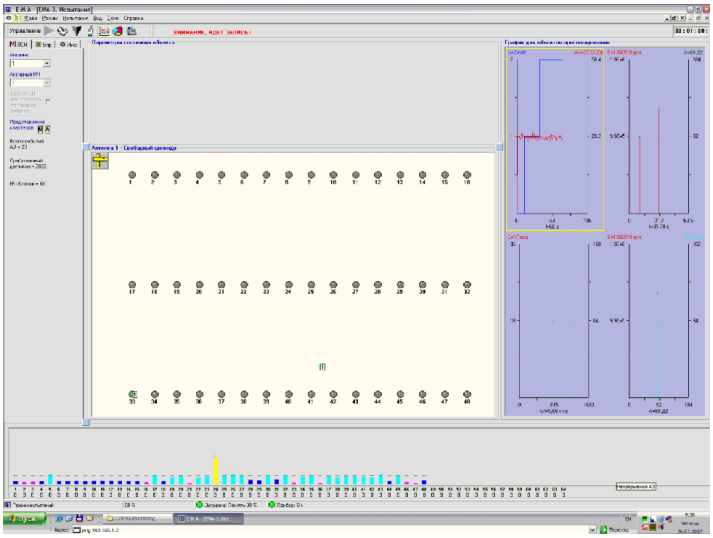
Used instrument modification receives power (12V DC) uninterruptible power supply, equipped with a battery and is connected to AC power plant. To provide the necessary operating temperatures in the winter (above dew point) is set inside the instrument containers with electric thermostat.

system devices continuously process the sensor signals, AE emit pulses, measure their parameters. The measurement results are collected in a file.

Systems connected to the information network of computers that control the process of measurement and process the files with the measurement results. Control computers located at a considerable distance from the AE devices. Initially, they were installed in the plant room, the CPU at about 300 meters from sámogo long reservoir. cable to the Ethernet repeaters several industrial performance has been applied to the implementation of information communication. Employees of the CPU, however, did not have the proper training for AE measurement technology. For this reason, control computers later moved to the factory NKiTD laboratory, where they are served by professionally trained specialists. The laboratory is located on the park tanks at a distance of over a kilometer. Therefore, the fiber optic link has been applied.

SOFTWARE MONITORING SYSTEM

As already mentioned, all 4 AE monitoring system, together with its control computers are connected to a common information network. Computer Monitor operation and the monitoring process as a whole AE: run continuously measuring cycles, receive, process and store measurement results files produced by the devices. Additionally, acquiring and storing data relating to the mode and operating conditions of tank internal pressure, temperature, level, flow and pumping ammonia, condition of valves. This data comes from the CPU into a digital form.



Operating monitoring window

During the measurement cycle, the program performs the usual real-time processing of AE signal: graphically displays the AE pulse parameters, the connection between them, the average level of the signal on the channel, the process of changing the load parameters. Performs calculations locating AE events, displays AE sources space on the expanded map of the vessel walls. Watch for possible excess of the limit values of controlled parameters. In case of excess gives warning signals.

At the end of each measurement cycle summarizes the results of this measurement, connects these results to the results of previous measurements. Extracts information about AE events that deserve special attention, that is, those on which we can draw conclusions about the state of the vessel. On the course of the measuring cycle, the operator actions, any interference in the measurement process of the automatic entry in the "diary" file warning signals is carried out.

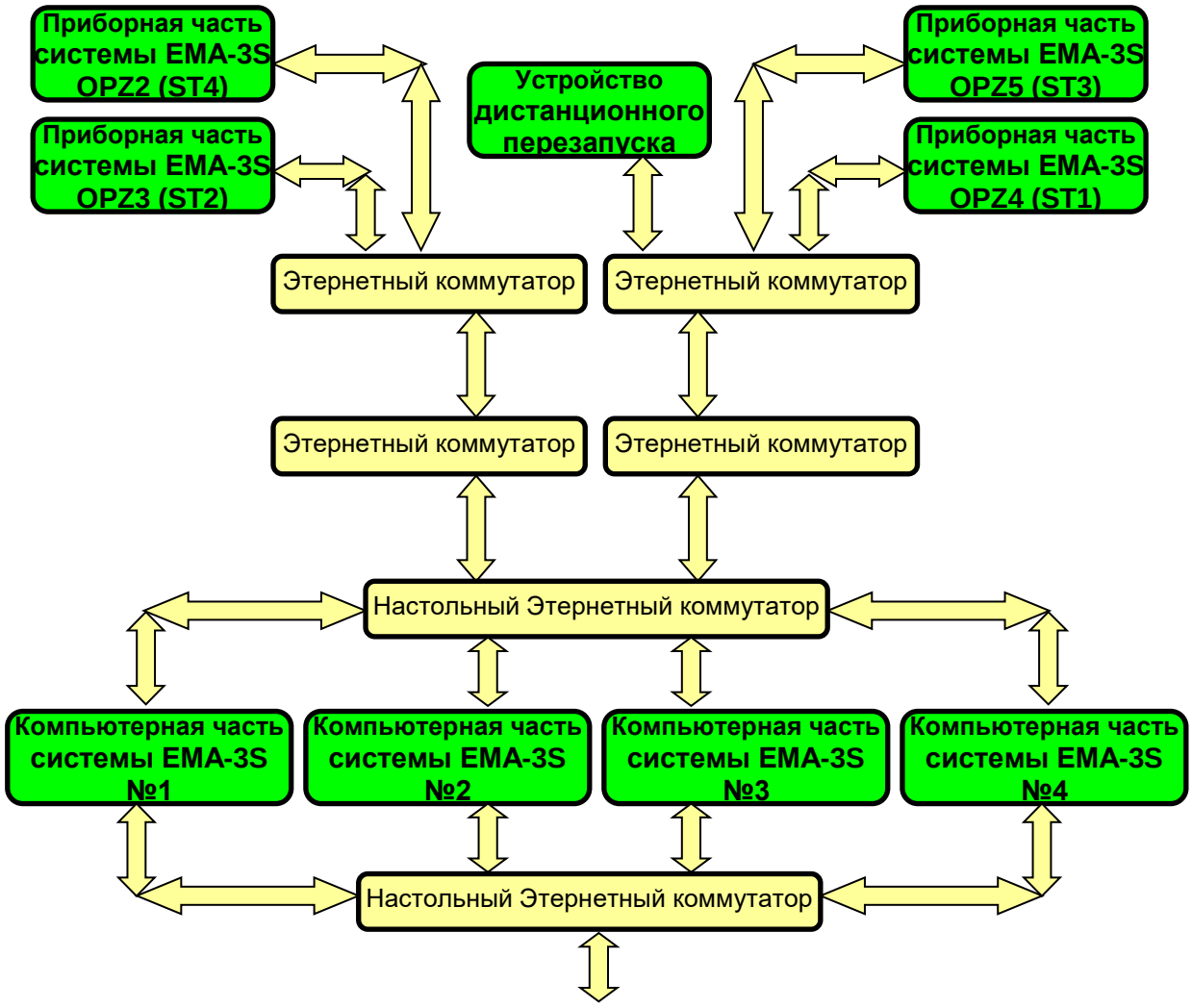
Operator service system should respond to possible warning signals, track records in the "diary" file. From time to time he archives the files of measurement results and print reports. If necessary, it can change the content and form of real-time processing, to carry out tests, re-process the results of previous measuring cycles.

Block diagram of the EMA-3S full measuring complex

Local network monitoring complex is connected to the in-plant network, and through it - to the Internet. Because of this it can connect other computers. In an emergency, any computer with a respective tolerance may follow the course of monitoring. Such authorization has, for example, the chief of the laboratory plant NKiTD and software development company located in Kiev.

FIRST EXPERIENCE OPERATING SYSTEM MONITORING

During repairs, multilateral examination of tanks different NDT methods were carried out after removal of the old insulation. These surveys have shown that the blood vessels are in good condition. Поэтому после установки АЕ мониторинговой системы (2002 – 2005 год) мало



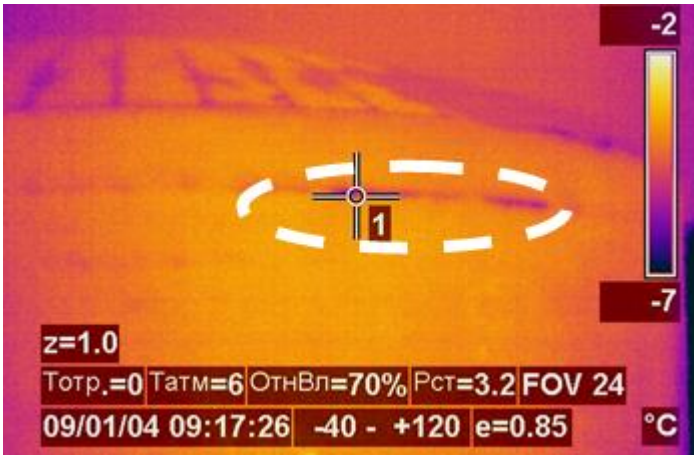
likely to be expected in the next few years the development of dangerous cracks or other defects in the welds, the walls and bottom of the vessel material. Indeed, AE signals indicative of crack growth, "interesting" in terms of "scientific curiosity", fortunately, have not been registered. However, the creators and users of AE monitoring of the complex, it was important to make sure that the system is sensitive enough and, in the event of a defect, can register related to this defect AE signals.

In the first place, of course, built in test equipment features have been used as sensors in turn act as a source of AE pulses. Tests have shown that the sensors mounted on the vessel, "hear" each other, and the location is carried out with sufficient precision.

In addition to the tests were obtained and other demonstration measurements, confirming the effectiveness of monitoring.

When filling the vessel with ammonia AE devices consistently recorded growth acoustic background - the average level in the AE signal channels. It - is normal, and it can be compared with the data obtained from the reservoir of the CPU operation. Signal analysis revealed that the sound sources to the greatest extent are the site of attachment of the filler pipe brackets. It rises to the center of the tank roof and vibrates in the feed liquid ammonia.

During the original, after the installation of insulation, filling one of the vessels, the monitoring system has become unexpectedly detect the acoustic activity of a different nature. Locating map pointed to two adjacent vague spots on the vessel wall. When viewed from the vessel through a "thermal imager", which allows to determine with great accuracy the temperature at the surface of the object have been recorded in these areas are dark spots with little difference in temperature (1º - 2º C). Inspection of these sites revealed a slight defect in the insulation. Representatives of the firm, which established the insulation, fix bugs, and at the same time were very surprised how it was possible to detect such a defect unobtrusive.



Hot Photo walls ST1 storage

Complete monitoring system is a complicated technological complex. Naturally, its installation and start of operation could not go completely smoothly, without those or other difficulties. But the question is able to quickly and efficiently solve. This was facilitated by the fruitful cooperation of the three involved in the creation of complex sides: the supplier of instruments (firm «Gereb es Tarsa», Hungary), a supplier of sensors and software (Institute of Electric Paton Electric Welding Institute of the National Academy of Sciences of Ukraine.) And the customer - the Odessa Portside Plant. They have been improved and expanded, taking into account comments and suggestions HMO professionals program "low-level" managers directly measuring devices, and the "top" of the program, performing measurement control and data processing. Systematically carried out study staff and technical advice. Hardware failure was virtually no after a short break-in period. Mounted on four tanks at a total of 224 sensors except one, constantly perform their control functions.

HMO Guide did not expect the introduction of AE monitoring of immediate economic benefit. It considers the installation of AE systems necessary investment with a view to improving the technical safety of production. This does not preclude obtaining certain economic benefits. Depending on the results of the aggregate AE measurement for a sufficiently long period of time, it will be possible to obtain more accurate picture of the reality of the corresponding vessels resource. This will take a decision, for example, to raise the maximum level of the stored liquid ammonia, an increase in service life to the next test (requiring stopping the process), which can significantly improve the efficiency of operation of reservoirs.

A large chemical plant, working on the Black Sea coast near the biggest city in the resort area of national importance is constantly under the eye of numerous environmental organizations. Factory introduction of AE monitoring systems showed that the increase in technical safety in addition to economic and technical considerations, aims to the highest possible protection of the environment, that environmental issues play a major role for him. To meet these challenges, the plant uses the most modern methods of technical control, is investing considerable material means.

Odessa Portside Plant