

NORDINKRAFT NDT-GROUP

ULTRASONIC INSPECTION OF ELECTRIC - WELDED AND SEAMLESS TUBES



EMATEST[®]-TU



INTRODUCTION

Tubes and pipes make up the largest individual segment in the steel market and it is one of the fastest growing. Tubes and pipes find their application practically in every branch of modern industry: oil and gas production and processing, power engineering and machine building, space-rocket engineering and civil construction.

New carbohydrates transportation technologies require principally new approaches to environmental and industrial safety. Therefore new pipe quality control solutions have to be found. Advanced development of methods and means of non-destructive inspection of tubes and pipes is an obvious priority of modern applied science and technology.

From the middle of the nineties of last century NORDINKRAFT has been successfully developing technologies of automated and automatic ultrasonic testing of pipes and tubes. In the meantime we have developed, manufactured and implemented more than 10 non-destructive pipe inspection stations. Equipment for ultrasonic inspection of electric-welded tubes and pipes from 8 mm to 500 - 600 mm in diameter is known under the name of «EMATEST-TU».

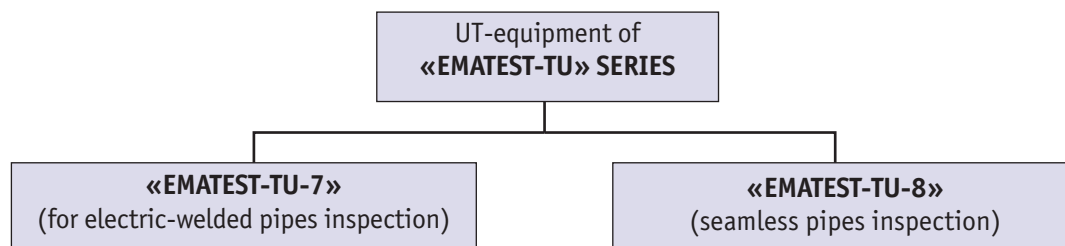
Along with development of ultrasonic inspection equipment NORDINKRAFT designs, manufactures and delivers transport lines, technological equipment, special-purpose machinery and renders engineering and other services.

EQUIPMENT FOR AUTOMATED ULTRASONIC TESTING OF ELECTRIC-WELDED AND SEAMLESS PIPES «EMATEST-TU» SERIES

«EMATEST-TU» series is modern fully automated multi-channel inspection equipment that provides reliable and high-efficiency ultrasonic testing of seamless and electric-welded pipes up to 500 mm in diameter.

«EMATEST-TU» systems can be divided into 2 groups (series) depending on their application:

- «EMATEST-TU-7» - for automatic ultrasonic testing of electric-welded pipes;
- «EMATEST-TU-8» - for automatic ultrasonic testing of seamless pipes.



«EMATEST-TU-7»

is intended for ultrasonic testing of weld seams, heat-affected zone and body of longitudinal welded pipes. As a rule such systems are integrated in a tube-welding mill.

This type of equipment allows one to detect various defects in a welded seam such as lack of fusion, cracks, nonmetallic inclusions, and inspect the pipe body and the heat-affected zone for cracks, laminations etc.

«EMATEST-TU» systems can be equipped with ultrasonic transducers of different types.

Non-contact electromagnetic acoustic transducers (EMAT) are the right choice for this application. Depending on their design, they allow one to generate and receive bulk transversal waves as well as normal ultrasonic waves of SV- and SH-polarization.

A very important advantage of SH-waves is no interaction with a liquid technological couplant flowing inside a tube during the production process (and therefore any restrictions connected with it).

High-frequency elastic vibrations are capable to spread over considerable distances, repeatedly run along the pipe perimeter without attenuating.

These waves are very sensitive to smallest discontinuities of different origin.

«Emascan-TU-7» certified by GOSSTANDARD of the Russian Federation uses pulse-echo, through-echo, shadow and multiple-shadow methods of ultrasonic inspection.





SYSTEM CONFIGURATION

Typical configuration of a «EMATEST-TU-7» system is given below:

- Test head with a set of ultrasonic transducers;
- Test electronics;
- Control computing system;
- Automatic system and power supply;
- Sensitivity adjustment and calibration station;
- Defect marker.

The CCS unites, coordinates and synchronizes work of all subsystems. It controls information flows, organizes the testing process, collects, processes, presents and stores data. The CCS organizes testing according to the specified standards and norms selected by the operator.

The pipes marked as defective are sent to a corresponding cradle by a sorting system, which is also controlled by the CCS. Each lot of pipes has its own test report.

A useful auxiliary CCS function is monitoring of main technological parameters of the mill and the welding machine such as speed, welding current, pipe geometry etc. Any influence on the welding process made by the personnel is controlled as well.

MAIN CHARACTERISTICS OF UTE «EMATEST-TU-7»

Description	Standard parameters	Potential
Type of test object	Electric-welded pipe	
Range of pipe diameters, mm	15 ... 500	Unlimited
Wall thickness, mm	1,0 ... 12	Unlimited
Speed of welded seam testing, m/s	Up to 1,0	Up to 2,0
Standards	DNV-OS-F101, API 5L, API – 5CT, ISO 10124, ASTM E 709-2001, Shell Spec, GOST 52079 and GOST 21105	
Temperature in testing zone, °C	- 40 ... + 300	Up to + 650

REFERENCES

NORDINKRAFT has implemented 4 systems for automatic ultrasonic testing of electric-welded pipes «EMATEST-TU-7». 3 systems successfully operate at pipe production mills at JSC «Severstal». 1 system is in operation at JSC «Uraltrubprom». Another 2 will be manufactured in 2008.



Fig.1. «EMATEST-TU-7» for ultrasonic testing of longitudinal welded tubes. Uraltrubprom, Pervouralsk (Russia).

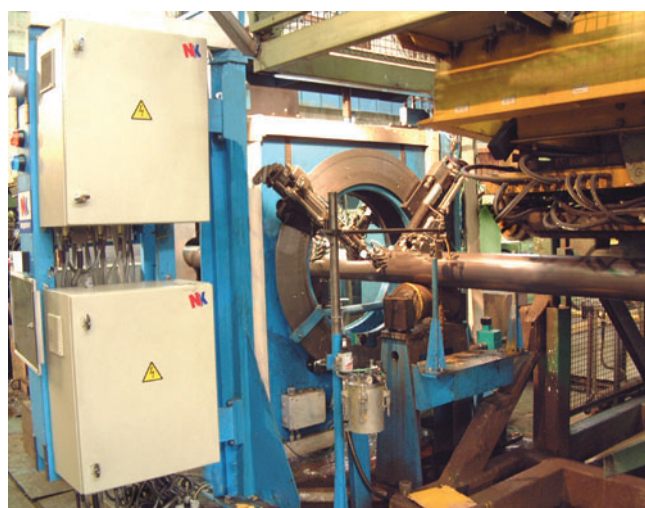


Fig.2. «EMATEST-TU-7» for ultrasonic testing of electric-welded tubes. Severstal, Cherepovets (Russia).





«EMATEST-TU-8» FOR ULTRASONIC TESTING OF SEAMLESS TUBES

Test equipment «EMATEST-TU-8» is intended for automated ultrasonic inspection of body and ends of seamless pipes. «EMATEST-TU-8» is able to detect longitudinal, transversal and oblique defects on both pipe surfaces and in pipe body such as cracks, laminations, rolling marks, nonmetallic inclusions, compression marks, scratches and other discontinuities as well as to conduct 100% measurement of pipe wall thickness.

«EMATEST-TU-8» uses discrete piezoelectric probes (PEP) and piezoelectric phased arrays (PPA) located under and above the pipe in a special local immersion tank. The transport unit of the system provides linear rotary or only rotary movement of the test object. If due to some technological reasons it is not desirable to use water as a couplant, we can successfully substitute PEP with EMAT and obtain perfect results. This «non-contact» variant allows one to transport pipes linearly without rotation. In this case EMAT blocks are located along the pipe perimeter.

A «EMATEST-TU-8» system consists of 3 conditionally independent testing units:

- longitudinal defects testing system (SL);
- transversal defects testing system (ST);
- wall thickness measurement and laminations testing system (SWL).

Ultrasonic transducers of SL- and ST-systems excite and receive transversal waves at an angle to the surface in the direction of perimeter and pipe geneatrix accordingly. Transducers of the SWL-system inspect the pipe body with bulk (longitudinal or transversal, it depends on the type of transducer) waves that spread perpendicular to its surface. «EMATEST-TU-8» systems realize a pulse-echo method of ultrasonic testing. Transducers of the SL- and ST- systems inspect the material in two opposite directions.

SYSTEM CONFIGURATION

Typical configuration of a «EMATEST-TU-8» system is given below:

- Test head with a set of ultrasonic transducers;
- Test electronics;
- Control computing system;
- Automatic system and power supply;
- Water treatment and supply system (for PEP and PPA);
- Transport system;
- Sensitivity adjustment and calibration station;
- Auxiliary equipment.

Upon Customer's requirement the transport system may include:

- Input roller conveyor with turning rollers;
- Output roller conveyor with turning rollers;
- Holding down devices with turning rollers;
- Sorting device;
- Cradles for tested materials.

MAIN CHARACTERISTICS OF UTE «EMATEST-TU-8»

Description	Standard parameters	Potential
Type of test object	Electric-welded pipe	
Range of pipe diameters, mm	50 ... 500	Unlimited
Wall thickness, mm	1,0 ... 12	Unlimited
Speed of welded seam testing, m/s	Up to 1,0	Up to 2,0
Standards	DNV-OS-F101, API 5L, API – 5CT, ISO 10124, ASTM E 709-2001, Shell Spec, GOST 52079, GOST 21105	
Temperature in testing zone, C	- 40 ... + 300	Up to + 650



TESTING SCHEMES

The «EMATEST-TU-8» equipment realizes a whole set of inspection methods and schemes specified by modern standards for ultrasonic inspection of seamless tubes made from carbon and alloyed steel. The system marks defect zones, defines deviation from specified wall thickness and sends tubes to the corresponding cradles depending on their test results.

«EMATEST-TU-8» systems are certified by GOSSTANDARD of the Russian Federation.

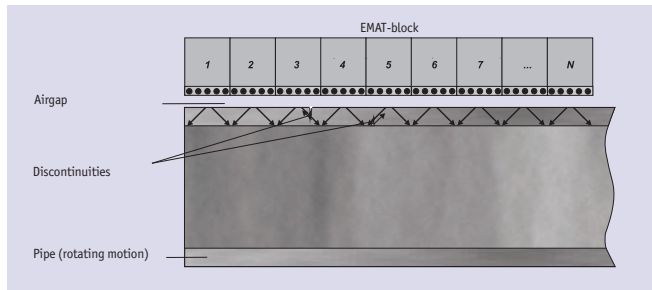


Fig.4. Detection of transversal defects using a multi-channel EMAT-block. Elastic vibrations are generated and received in turns in mutually opposite directions. The EMAT-block consists of $2N$ -active elements that provide a controlled inversion of directional diagram.

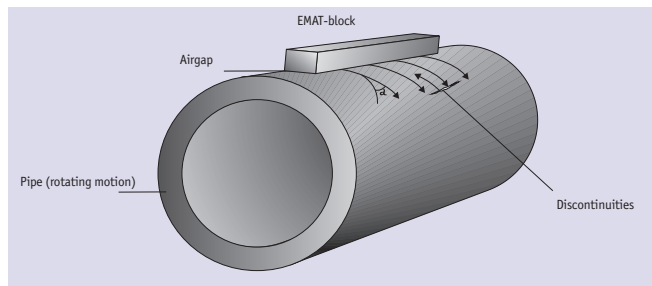


Fig.6. Detection of random oriented discontinuities using a multi-channel EMAT-block.

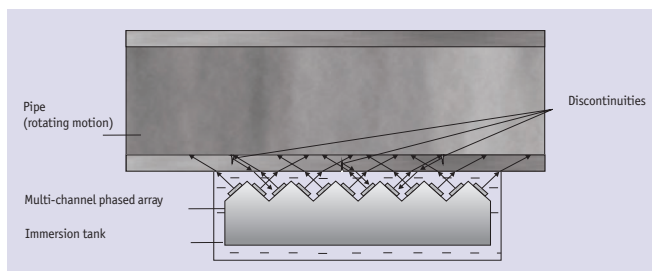


Fig.8. Ultrasonic inspection of pipes for the detection of transverse defects using piezoelectric phased arrays or (and) discrete elements.

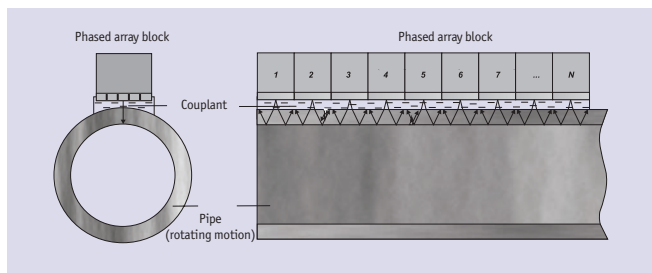


Fig.10. Ultrasonic inspection of seamless tubes for the detection of transverse defects using piezoelectric phased arrays or (and) discrete elements.

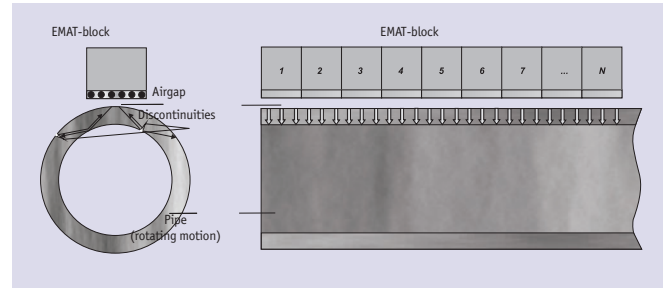


Fig.3. Detection of longitudinal defects using a multi-channel EMAT-block. Elastic vibrations are generated and received in turns in mutually opposite directions. The EMAT-block consists of $2N$ -active elements that provide a controlled inversion of directional diagram.

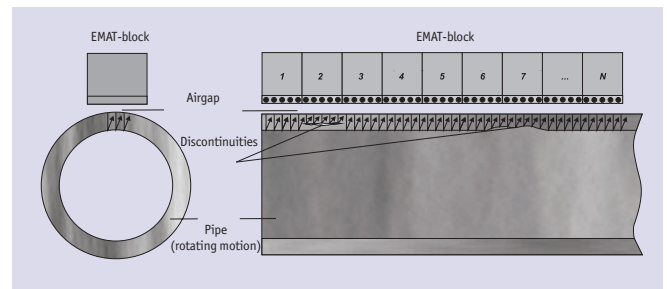


Fig.5. Detection of discontinuities and wall thickness measurement using a multi-channel EMAT-block.

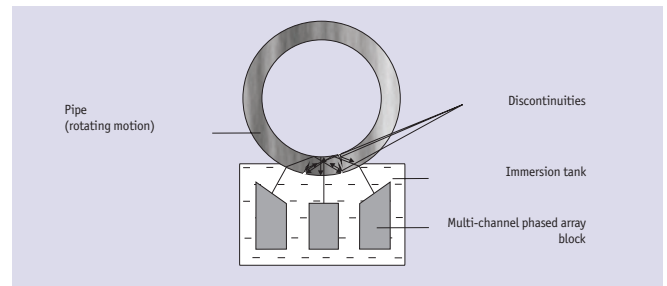


Fig.7. Wall thickness measurement and ultrasonic inspection of pipes for the detection of longitudinal defects using piezoelectric phased arrays or (and) discrete elements.

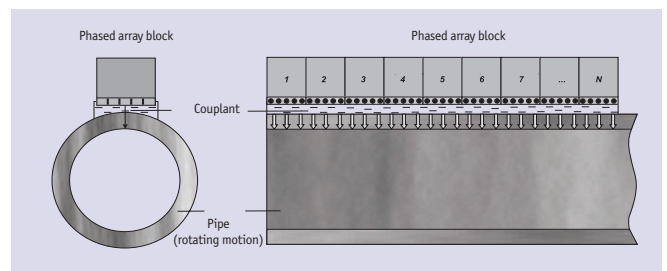


Fig.9. Detection of discontinuities and wall thickness measurement using piezoelectric phased arrays or (and) discrete elements.

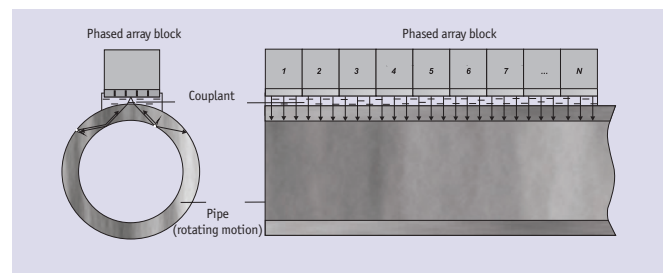
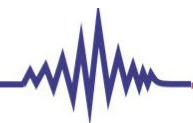


Fig.11. Ultrasonic inspection of seamless tubes for the detection of longitudinal defects using piezoelectric phased arrays or (and) discrete elements.



REFERENCES FOR ULTRASONIC TESTING EQUIPMENT «EMATEST-TU-8» SERIES

NORDINKRAFT has put into industrial operation 5 systems for automatic ultrasonic testing of seamless tubes «EMATEST-TU-8».

4 systems successfully operate in workshops №1, №2 and №3 at JSC «Volzhsky Pipe Plant».

Another system of «EMATEST-TU-8» series has worked at JSC «Synarsky Pipe Works» since 2003.



Fig.12. UTE «EMATEST-TU-8» for ultrasonic inspection of seamless tubes. Volzhsky Pipe Plant, Volzhsky (Russia).



Fig.13, 14. «EMATEST-TU-8» for ultrasonic inspection of seamless tubes. Synarsky Pipe Works, Kamensk-Uralsky (Russia).



Fig.15. «EMATEST-TU-8» for ultrasonic inspection of seamless tubes. Volzhsky Pipe Plant, Volzhsky (Russia).



Fig.16. «EMATEST-TU-8» for ultrasonic inspection of seamless tubes. Volzhsky Pipe Plant, Volzhsky (Russia).



FUNCTIONAL ELEMENTS AND UNITS OF THE «EMATEST-TU» SERIES EQUIPMENT

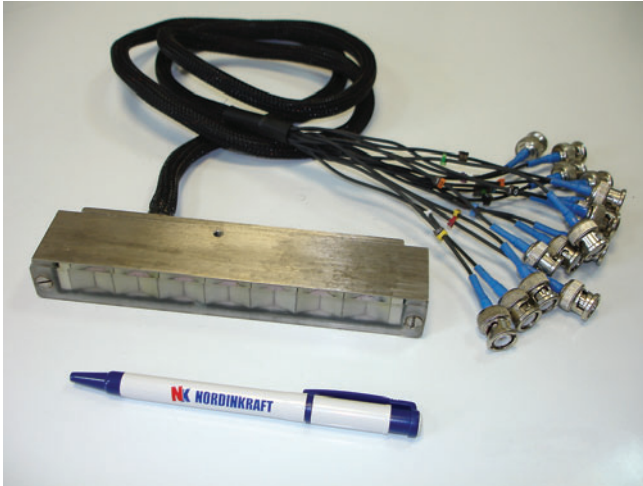


Fig.17. 16-channel PEP (detection of longitudinal defects).

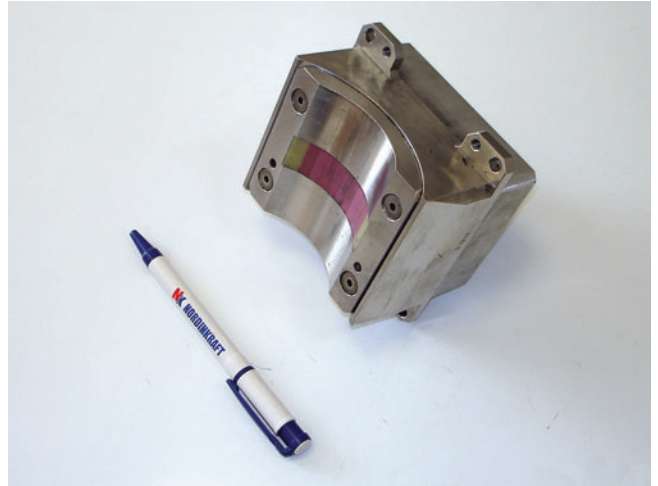


Fig.18. 6-channel EMAT (detection of laminations and wall thickness measurement).



Fig.19. Control station.

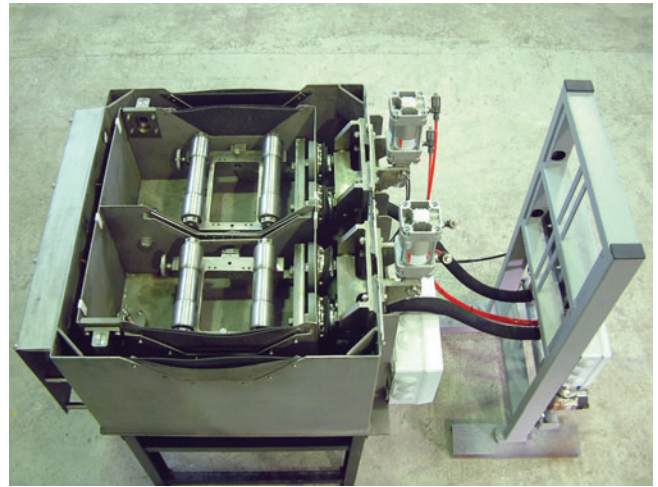


Fig.20. Immersion tank with carriages.



Fig.21. Roller conveyor with turning rollers.

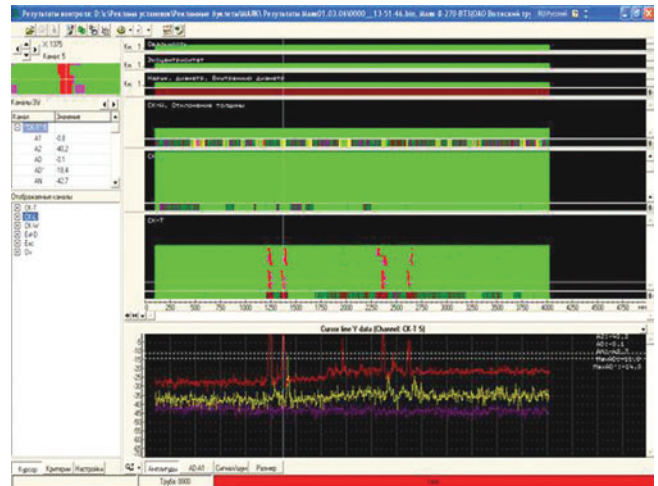


Fig.22. Test report (UTE «EMATEST-TU-8», Volzhsky Pipe Plant, Volzhsky) (Russia).

