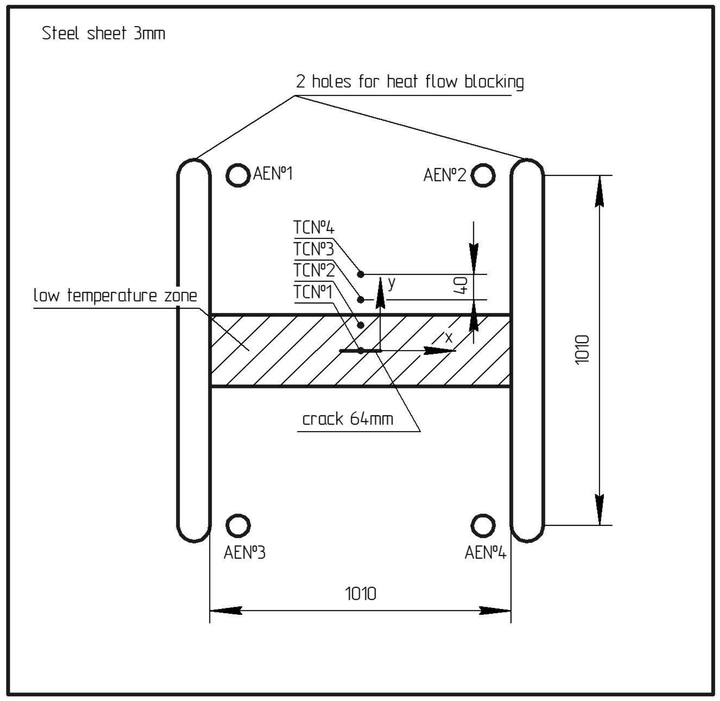
Determination of the dependence of a steel "St.3" flat specimen acoustic emission from the stress intensity factor at local low-temperature loading

The investigation offered to study and develop the method of local low-temperature thermal loading for acoustic-emission(AE) control in the industry to detect defects and predict defect behaviour



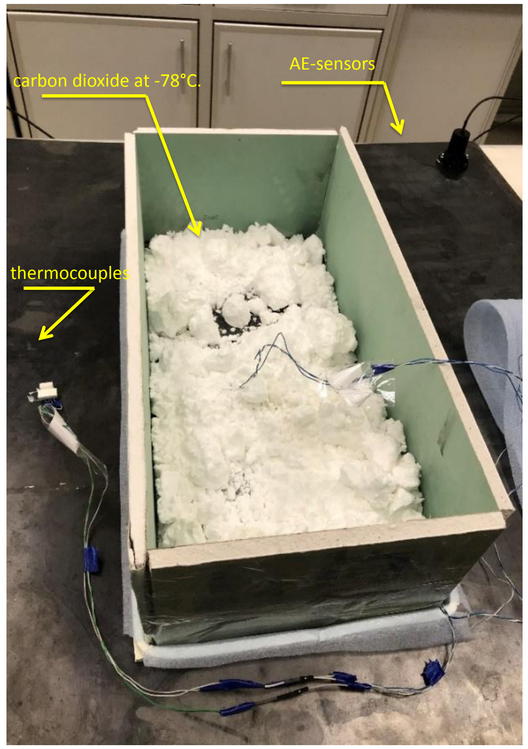
Scheme of local low-temperature thermal loading of the flat plate specimen

The values of tensile stresses in the direction of the "y" axis for a gradient temperature field:

$$\sigma_t = \frac{E\alpha_t}{2l}\int_{-l}^{l}\Delta t(y)dy$$

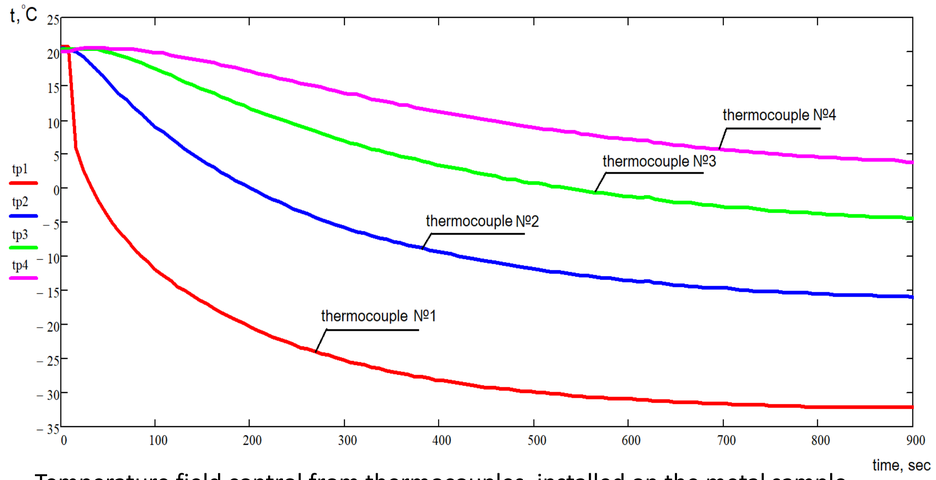
The stress intensity factor in a gradient temperature field:

$$K = \frac{E\alpha\sqrt{\pi a}\,f}{2l}\int_{-l}^{l}\Delta t(y)dy$$



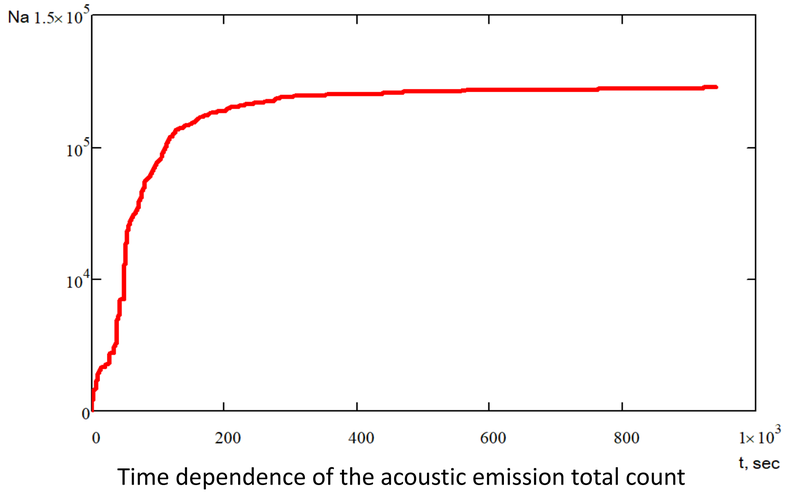
Registration of the AE-signals due to low temperature thermal loading according to the scheme on AE equipment "Expert-2014“ with 100-300kHz sensors. Low temperature zone cooled by carbon dioxide at -78°C.

$$N_a = \beta \cdot K^{\alpha}$$



Temperature field control from thermocouples, installed on the metal sample according to the scheme

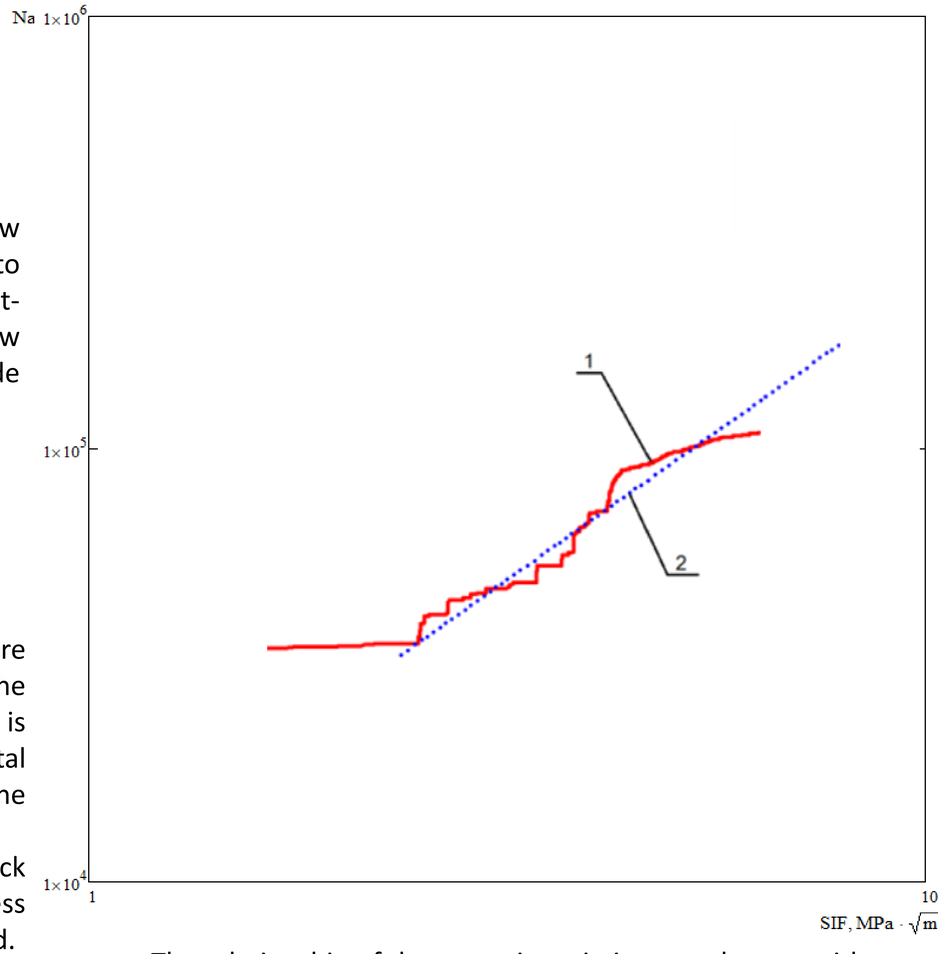
The scheme is designed for uniaxial loading of the central region of the plate with a distributed tensile load with negligible stresses along the "x" axis. Two holes are made to compensate for deformations in the x-axis direction. In the plate's remote region, which is not subject to low-temperature influences, there is a displacement due to the rigidity of the plate



Time dependence of the acoustic emission total count under local low-temperature thermal loading.

Conclusion

- The possibility of using the method of the low-temperature thermal loading for acoustic emission control to predict the defect behavior in constructions is shown. The method is based on the initiation of a local stress-strain state on metal construction, which is formed when a specific area of the construction is cooled from low-temperature carbon dioxide.
- The signals from acoustic emissions emanating from the crack tip on the plate specimen of steel “St.3” are studied, the stress intensity factors in a gradient temperature field are calculated.
- The power-law relationship of the acoustic emissions total count with the stress intensity factor for the method of the low-temperature thermal loading was shown.



The relationship of the acoustic emissions total count with the stress intensity factor for the local low-temperature thermal loading.
1 ¬– experimental data, 2 – theoretic formula