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Investigation of the generated heat during the treatment of metal samples. Part I: Heat generated during the stress of the metal samples (tubes).

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Abstract: *With strength tests extract information about certain mechanical properties of materials important for their further use in the production of various machines and equipment. Since tests completed most of the demolition, it is normal to them to work with specimens rather than finished products.*

Keywords: *strength test, temperature, heat transfer, heat emission*

1. Experimental arrangement

The tensile test is related to the static methods in which the loading force is increased gradually to a value when it destruction using hydraulic or electric press (Figure 1). The test specimen (tube) has two ends for attachment to the test machine and a working area in which should occur destruction. This zone has a first (computing) length Lo, mm, an initial diameter do, mm, and an initial cross-sectional area So, mm² (Figure 2). Fig.3 see experienced images made of different materials, as follows from the top down - Armco iron, steel 45 cast iron, aluminum alloy and copper alloy. Differing in this study was that in addition to monitoring the normal parameters for these tests (rate of deformation during deformation, strength at break and dimensions of the test specimen after breakage) we track and the temperature along the length of the model in real time. Thus it becomes possible to determine the heat and calculate how much of the work in a similar experiment goes deformation and what is converted into heat.

Figure.1. Press Instron 1195 testing tension and compression up to 10 tons.

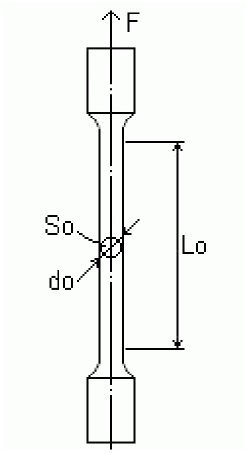

Figure.2. General view of test samples

Figure. 3. Specimens made of different material

As a result, each tensile test was recorded indicator diagram (general appearance of which is given in Figure 4), From this chart are defined following limits: Rp - limit of proportionality RE - yield strength, ReH and ReL - upper and lower yield strength, Rm - tensile strength, sU - destructive voltage, as, depending on the material these ranges are of different lengths, with some materials, some of the boundaries even they are not or are negligible.

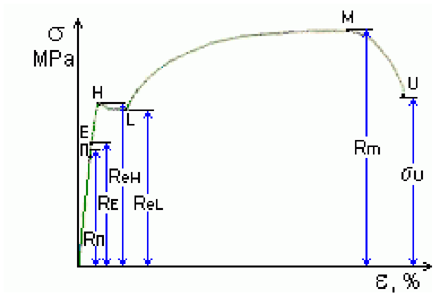

Figure.4. General view of indicator chart, at tensile load.

2. Results of experiments

After the experiments are found not need to after heating the specimen along its entire length, because in practice it is minimal. The heat is mainly in the area of formation of the neck and around it, in a plastic material.

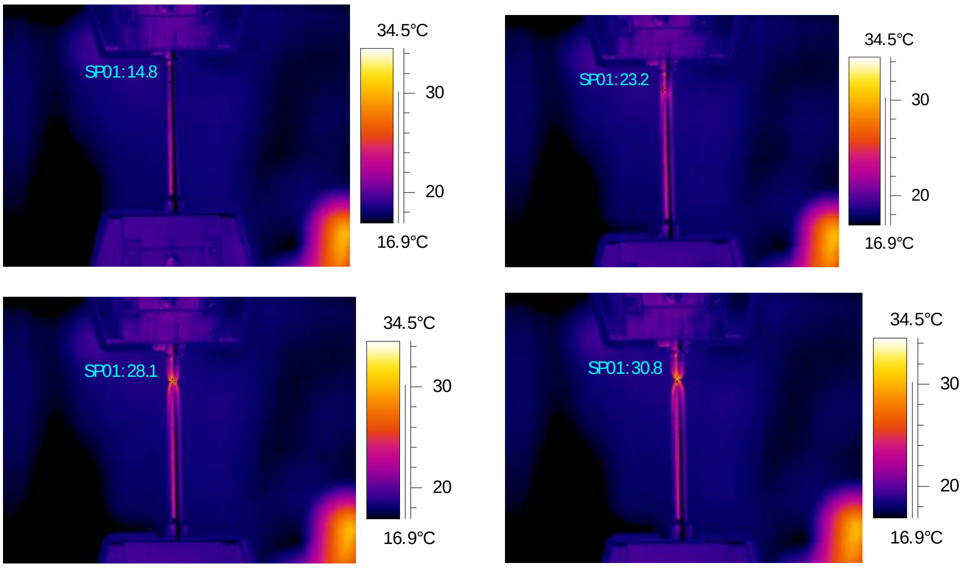

Figure 5. Images of an infrared camera in different stages of loading, they can see the difference in temperature before, during and after the necking, and then tearing the specimen from Armco iron.

The graph in fig. 6a shows the change of the temperature in the zone of the necking with an interval of 1 second. Of fig.6b shows the distribution of temperature along the length of the sample, where it is easily seen the zone of rupture of the samples (the sharp drop in temperature).

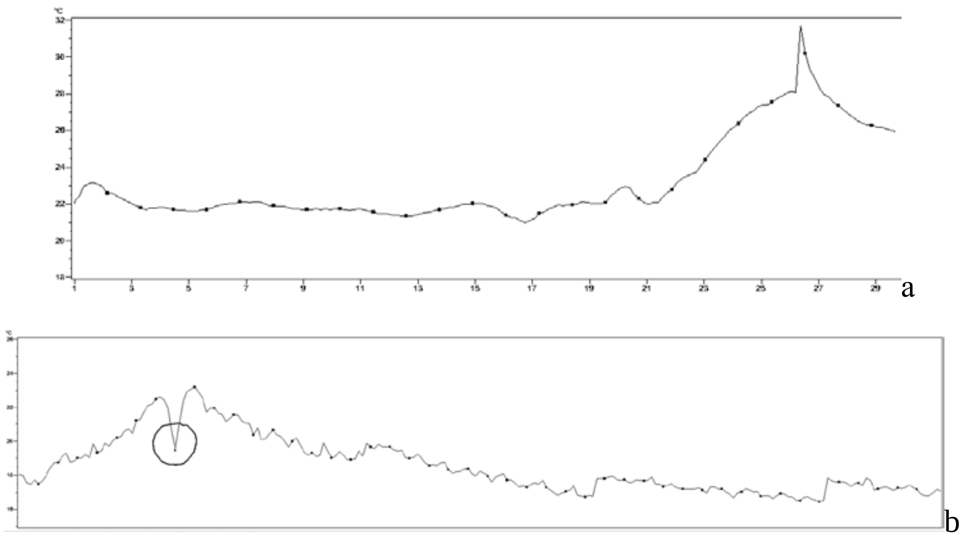

Fig.6.a Graph of change of the temperature in the zone of the necking. b- temperature distribution along the length of the specimen.

Attempts with Steel 45 showed similar results as those of Armco iron. Because almost the same carbon content and plasticity. In attempting to cast the results are quite different because of the lower ductility of iron in it does not form cancer because relative distortion is minimal. Heating in the region of the tear is about 4ºC., As can be seen from Fig 7.

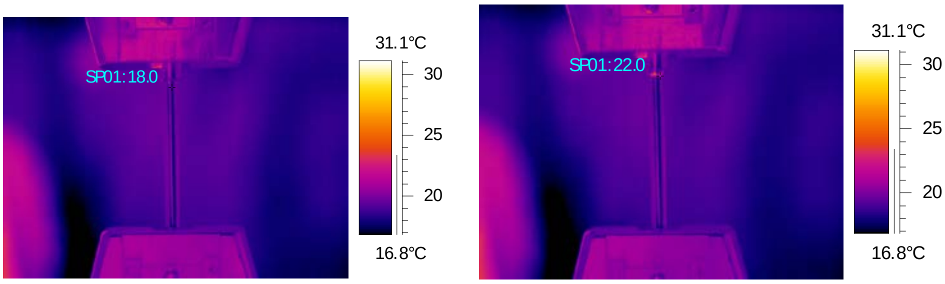

Figure 7. Photos from thermal camera before and after breaking the pattern of iron.

In the experiments we made with aluminum alloy also form a neck and the elastic deformation and minimal but shows highly specific cleavage at an angle of 45 ° (Figure 8). Heating and here is about 4ºC.

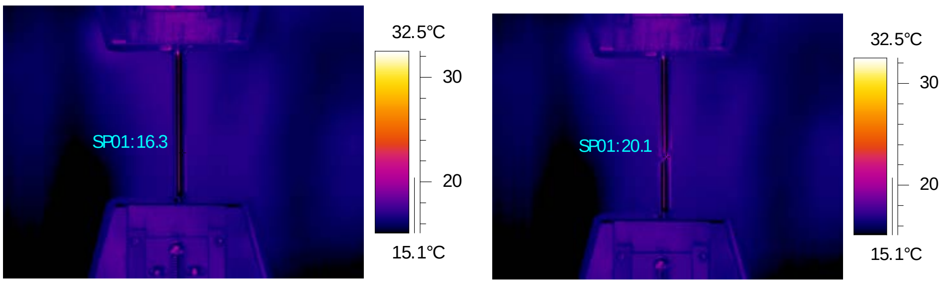

Figure 8. Photos from the heat chamber before and after the rupture of a sample of aluminum alloy.

In experiments with copper alloy is obtained neck before rupture and deformation before rupture is greatest. Another interesting thing in the copper alloy is almost negligible heating in the necking (Figure 9), this can be explained on the one hand with great plasticity and on the other with the great thermal conductivity of copper and the comparatively cool area in which we performed experiments (about 15ºC).

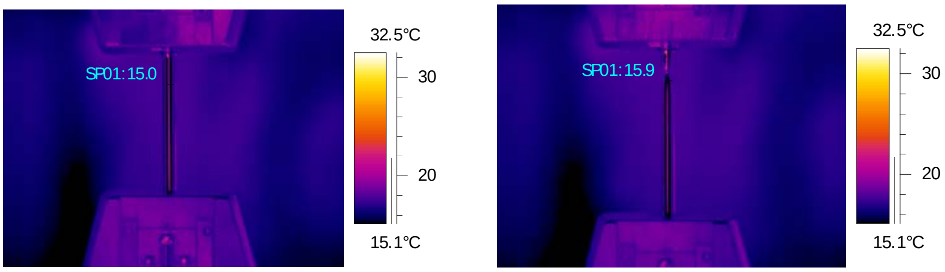

Figure 9. Photos from thermal camera before and after breaking the pattern of copper alloy.

3. The amount of heat and work.

Heat

- The amount of heat which receives one body by increasing its temperature, is directly proportional to the product of mass of the body, and the difference between the final and the initial temperature, the coefficient of proportionality depends on the substance of the body.

$Q = c * m * (t-t_0)$, (1)

where:

Q is a heat quantity,

m is the mass of the body,

C is a physical quantity called specific heat capacity

t - final temperature

t_0 - starting temperature.

* When $t > t_0$ $Q > 0$; at $t < t_0$ $Q < 0$.

Specific heat capacity:

From (1) we see that:

$c = Q / (m * (t-t_0))$ (2)

The specific heat capacity is characteristic for a substance quantity, which is measured by the amount of heat required to raise the temperature of 1 kg of this material by 1 ° C.

Work done in testing the strength. Work as energy is the area of the indicator diagram obtained by making the experiment. In the case when trying to cast iron sample (the simplest diagram of incurred) - 16604,0211 mm2 or about 16,6 KJ of energy.(fig.10)

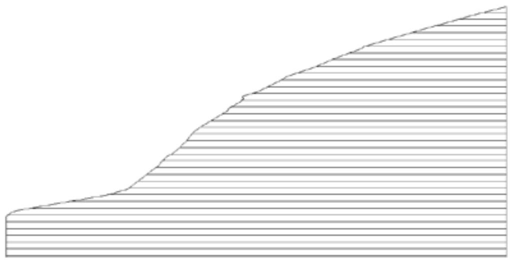

Figure. 10. The area surrounded by the indicator diagram obtained when testing the strength of a sample of the cast iron.

4. Conclusion

In the tensile test of a plastic material, the deformation of the sample is greater and the heating temperature higher. The heat that is released is not uniformly distributed along the length of the specimen and is centered at the point of necking (for plastics). In neplastichni materials, heating is minimal, and the deformation of this could be assumed that the heat output is distributed evenly along the whole length of the specimen.

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Исследование генерируемого тепла при обработке образцов металлов. Часть I: Тепло, выделяемое во время напряжения металлических образцов (трубок).

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Р е з ю м е

При испытаниях на прочность извлекается информация о некоторых механических свойствах материалов, важных для их дальнейшего использования в производстве разных машин и оборудования. Поскольку испытания завершают большую часть разрушения, для них вполне нормально работать с образцами, а не с готовыми продуктами.

Ключевие слова: стресс тест, температура, трансфер тепла, емисия тепла