

THE OPPORTUNITY TO CHOOSE THE REGIMES FOR THE HEAT STRESS RELAXATION OF THE LARGEST EQUIPMENTS

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Abstract: In the paper there are presented the principles, the conditions and the working algorithms with which application assure optimal conditions from the technological and economic point of view for the direction of the stress relaxation heat treatment applied to a largest device in welded structure.

Keywords: stress relaxation heat treatment, welded structure, residual tensions, optimization.

1. GENERAL ASPECTS

The great number of welded joints that is supposed in the realization of the petrochemical and refineries devices generate important stress states that claim the application of a stress relaxation heat treatment before starting the equipment. In many situations, the dimensions of such devices (for example spherical tanks for depositing the liquefied petroleum gases) impose the transport in subassemblies and the final assembling building site, to the place where the equipment will be exploited. In these conditions it is necessary to apply stress relaxation heat treatments under the entire device (TTG global heat treatment), in the building site.

From the TTG practice in situ of some known international companies it results the possibility to use one of the following technological variants:

- Electric heating of the device on the entire external surface;
- The internal heating of the device by using burning gases;
- The internal heating directly with flame.

Often it is used the method of global heat stress relaxation by burning a combustible inside the device. In this situation, the equipment is foreseen with manholes in the superior part and also in the inferior one, the direction of the combustion gases may be thus descendent, ascendant or mixed and the draft may be forced (the air is introduced with a ventilator) or, eventually, by natural circulation.

2. ASPECTS CONCERNING THE CALCULUS OF THE COMBUSTIBLE CONSUMPTION TO THE TTG APPLICATION

Generally, the stress relaxation heat treatments applied to the welded structures may be directed respecting the diagram as it is presented in the figure 1. The debit of the burned combustible inside the device may be calculated using the relations [1]:

- during the heating of the tank (relation 1);

$$B = \frac{22,4 \cdot Q_a}{16 \cdot q} \quad [\text{N} \cdot \text{m}^3/\text{hour}] \quad (1)$$

where: Q_a represents the heat flux absorbed from the burned gases in the interval of time τ ,

$$Q_a = \frac{Q_0 + Q_{iz}}{\tau} + 3,6 \cdot Q \quad [\text{kJ}/\text{hour}] \quad (2)$$

Q_0 – heat quantity necessary to the steel wall heating with a gradient of temperature Δt_0 , kJ;

Q_{iz} – heat quantity necessary to the isolating layer heating with a gradient of temperature Δt_{iz} , kJ;

Q – the heat flux transferred from the external surface of the isolation to the environment (Newton's Law), W;

q – heat quantity yielded by the combustion gases, kJ/kg comb;

- during the maintaining of the treatment temperature, when $Q_0 = Q_{iz} = 0$ (relation 3);

$$B = \frac{22,4 \cdot 3,6 \cdot Q}{16 \cdot q} \quad [\text{N} \cdot \text{m}^3/\text{hour}] \quad (3)$$

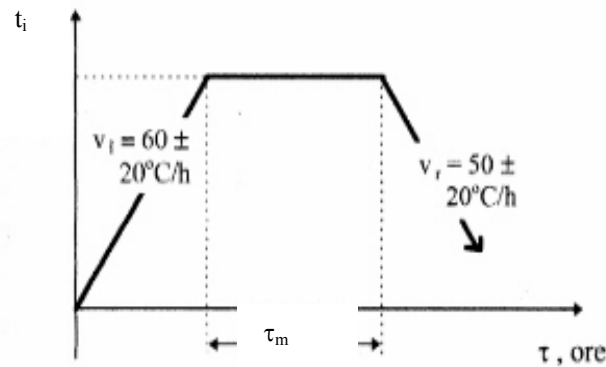


Fig. 1. Diagram of TTG applied to a welded structure:

t_i – treatment temperature; τ_m – duration of maintaining to treatment temperature

Starting from the relations (1) and (2) it may be established, depending on the heat treatment parameters, the mass of combustible necessary to the heating and to the maintaining of the device's jacket to the treatment temperature. Using an appropriate computer program (conceived by the authors of the paper), the results may be presented under a graphical form (fig. 2).

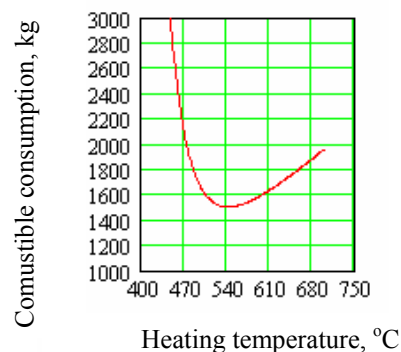


Fig. 2. Combustible consumption necessary to TTG
(according to a relaxation degree of the residual tensions GR = 75%)

3. THE CHOICE (THE OPPORTUNITY TO CHOOSE) OF THE SAFE REGIMES OF HEAT STRESS RELAXATION

The heat stress relaxation process of a welded structure assures a certain relaxation degree of residual tensions (GR), according to the pair (t_i , τ_m) that represents the coordinates of one of the points of the equi - stress relaxation curve (CED) having the parameter GR to an wished level [2] (fig. 3).

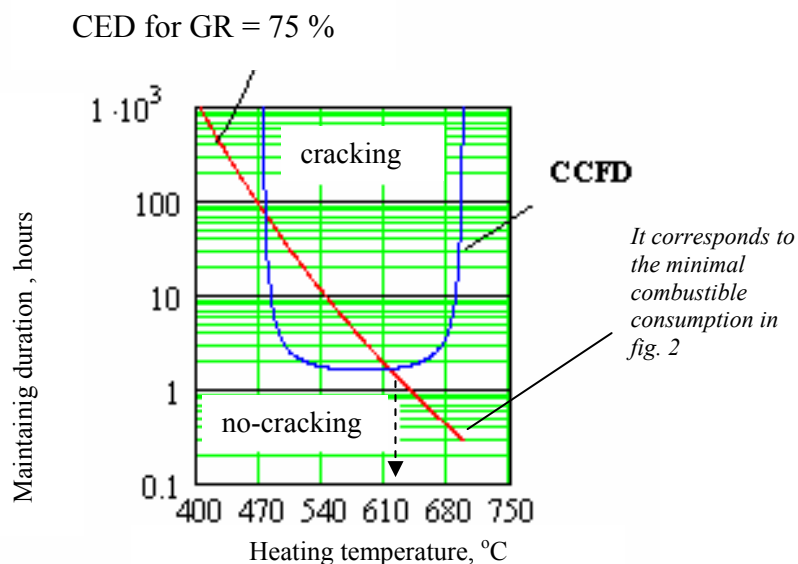


Fig. 3. Diagram of the safe heat stress relaxation for a welded construction from steel P 235 (for GR = 75%)

The safe heat stress relaxation regimes of a welded structure (for which there is no danger to appear cracks in the heat influenced zone of the welded joints) have the parameters (t_i , τ_m) according to the coordinates of the points situated in the exterior of the cracking curve characteristic to the stress relaxation (CCFD) of the material structure [2] (fig. 3).

4. OPTIMIZATION OF THE TTG APPLIED TO THE LARGEST EQUIPMENTS

For a metal structure type device made from certain steel, submitted to a stress relaxation TTG, there may be established, using the graphical representations as those from the figures 2 and 3, the optimal treatment variants from the economic point of view, thus:

- From the figure 3 it is identified for a certain value GR the safe domain of heat stress relaxation;
- According to the value pairs (t_i , τ_m) identified in the diagram from figure 3 it is chose from figure 2 the economical stress relaxation regime (it supposes a minimal combustible consumption).

In the previously presented example it was considered the case of a spherical tank having the capacity of 1000 m³, interior diameter $D_i = 12400$ mm, thickness of the jacket $s = 40$ mm. The jacket's tank (made by steel P235) is submitted to a stress relaxation TTG in the conditions where it is wished the internal stress relaxation tensions according to a value GR = 75%. The tank is isolated to the exterior with a mineral wadding layer having the thickness of 180 mm.

As a result of the analysis of the possible variants concerning the TTG regimes it was established that the economical optimal variant is characterized by the parameters $t_i = 620$ °C, $\tau_m = 1,2$ hours.

5. CONCLUSIONS

In the paper there are presented the principles, the conditions and the working algorithms of which application assure optimal conditions from the technological and economic point of view for the direction of the stress relaxation heat treatment applied to the a largest device in welded structure.

From the technical point of view, analyzing the situations as those presented in the figures 2 and 3 it finds out the existence of two possibilities of heat stress relaxation:

- The heating to a low temperature and the maintaining for a long period of time,
- The heating to a higher temperature and the maintaining to this temperature a shorter period of time.

In most cases it proves to be economical the second one to whom it corresponds a minimal combustible consumption.

Such graphical representations may constitute useful instruments for the correct direction of TTG.

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