THE DETERMINATION OF THE RESIDUAL AUSTENITE QUANTITY BY THE METHOD OF PULLING OUT FROM MAGNETICAL FIELD

GHEORGHIAN MIRELA, CIUCESCU DORU

University of Bacau

Abstract: After the quenching treatment of the steels, the microstructure contains martensite (hard and brittle) and residual austenite (soft and tenacious). The quantity of residual austenite in the final structure of the quenched steels depends on many factors: the speed of heating, the chemical composition, the speed of cooling, the position of critical points M_s and M_f.
There are several methods to determine the quantity of the residual austenite: the X rays diffraction, the expansion analyze, the metallographic analyze, the magnetic investigations, the ultrasonic investigations.
The quantitative determination of the residual austenite based on the magnetic characteristics, may be realized by measurement of the saturated magnetization, measurement of the coercive field, measurement of the magnetic permeability etc. All these methods have as fundament the correlation between the magnetic properties and the structural constitution of the steels.

Keywords: residual austenite, pulling out method

1. INTRODUCTION

The experimental method for measurement of the quantity of the residual austenite is based on the determination of the attraction tear away force of a permanent magnet or of a core of an electromagnet to from the piece undergoing the investigation. The pulling out method has, as principle, the dependence between, on one hand, the intensity of the necessary current to detach the core of an electro-magnet and, on other hand, the percent quantity of the α`- ferromagnetic phase (martensite) from the microstructure.

The experiments have demonstrated that the applying of a ultrasonic field to the cooling fluids increases the physico – chemical cooling capacity of the media, eliminating, in the same time, one of the most dangerous phase – the calefaction. The ultrasonic vibrations, situated near the product undergoing the cooling, produce the implosion of the vapor bubbles trending to form on the surface and so, the re-establishing the heat change at the values of intensity near to those from the beginning and, in the same time, to eliminate the thermal shocks which produce deformations and microcracks at the cooling of steels /1/**.**

2. THE EQUIPMENT AND THE PRINCIPLE OF RUNNING

It was experimentally found that between the value of the detaching force (F_d), respectively of the detaching energy (E_d), on one hand and the percent quantity of the ferromagnetic phase, on other hand, there is a relation as follows:

$$E_d = a \cdot \alpha` + b \cdot \alpha`^2 \quad (1)$$

where a and b are constant coefficients depending on the chemical of the α`-phase. But the detaching energy depends on the intensity of the detaching current I_d which supplying the coil of the traducer. So:

$$E_d = \int_{t1}^{t2} c i_d dt = \int_{t1}^{t2} c \frac{U_d}{R} dt = c \ \ `U_d(t_2 - t_1) \tag{2}$$

where: c is the constant coefficient depending on the construction of the transducer;
U_d – the supplying voltage of the transducer;
$(t_2 – t_1)$ – the duration of the acting impulse of the transducer;

Equalizing the relations (1) and (2) it is establishing the condition of the principle of the pulling out method:

$$a \cdot \alpha` + b \cdot \alpha`^2 = c`U_d(t_2 - t_1) \tag{3}$$

The relation (3) may be implemented on digital structures using PWM (Pulse With Modulation) method – fig. 1.

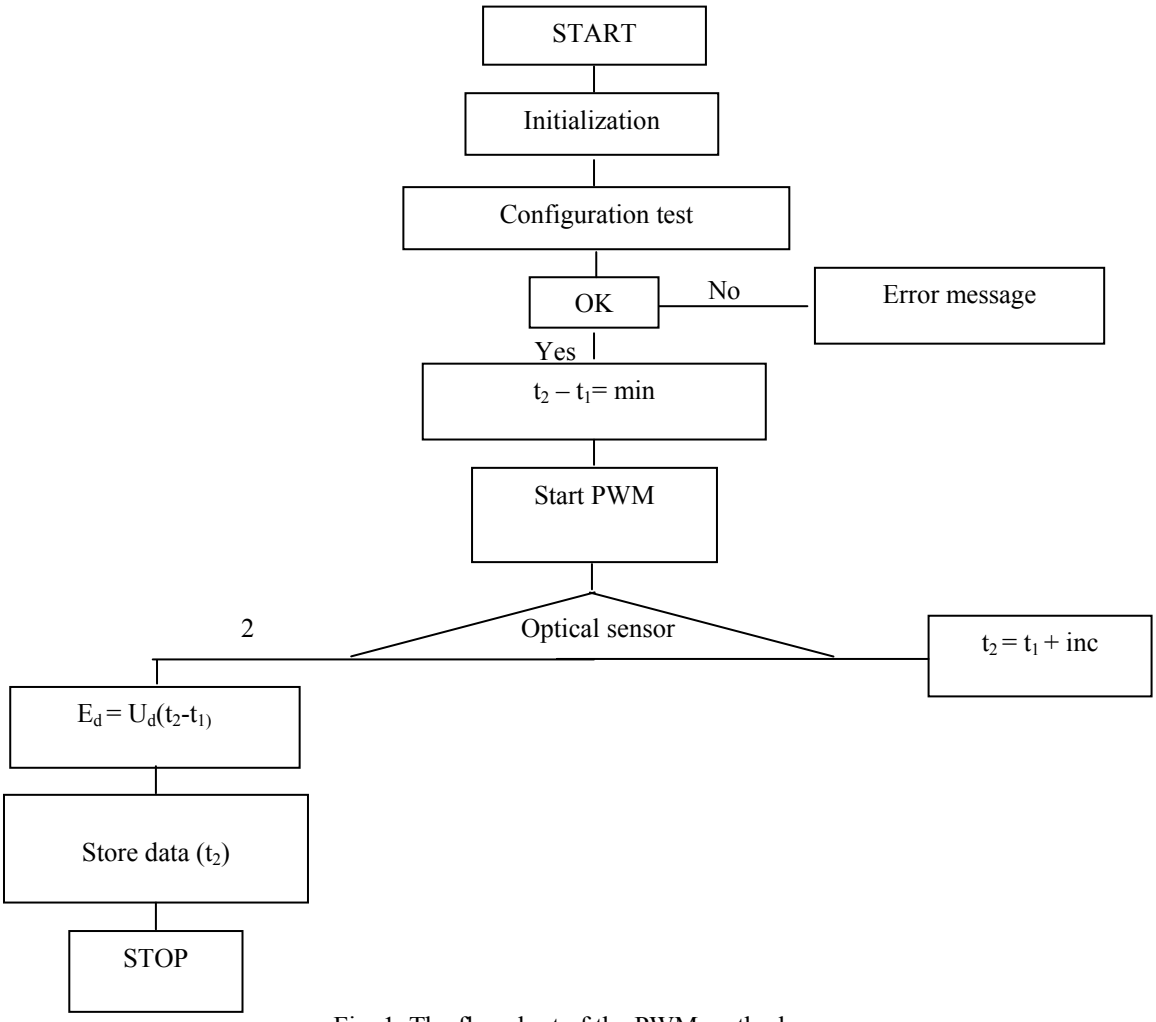

Fig. 1. The flowchart of the PWM method

During the measurements it is applied to the electro–magnet an increasing voltage till to the detachment of the magnet from the surface of the specimen. The consumed current by the electro-magnet in the moment of the detachment is dependent on the percentage of residual austenite, according to the relation (3).

To increase the precision of the measurements it is used an increasing voltage which is generated by a digital analog converter. The moment of the detachment is put in evidence by the help of a photo-coupler which endorses the space between the middle armature and the core of the electro–magnet. In this mood, the detaching current is evaluated digitally. For this reason, it is recommended that the measurement system to be connected to a process computer.

To determine the quantity of the residual austenite, from a bear ring considered as specimen, for example, it were used two gauge rings corresponding to the minimum and maximum quantities of the residual austenite. The two devices permit the gauging of the apparatus.

Afterwards, the ring is introduced the ring specimen and is determined the corresponding dispatching energy by referring to the two gauges.

The general view of the apparatus to measure is given in the figure 1 /2/. This is formed by two main parts: the traducer and the electrical equipment to measure and to regulate the dispatching current. The traducer is an electromagnet whose the coil is supplied by electrical current (I_d = max. 0,3 A) is given by the block of measurement.

The mobile element of the traducer is formed by a copper rod which is fixed at one of his end with a permanent disc

Fig. 2. The general view of the austenite-meter

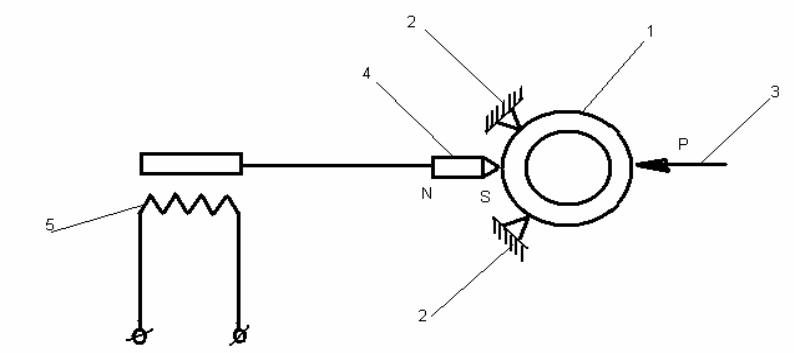

Fig. 3. The schema of the austenite-meter: 1 – bear ring; 2 – fixing support; 3 – constant pushing force; 4 – permanent magnet; 5 – electro-magnet.

The mobile aramture is sustained by two elastic blades forming a closed frame-type system, which assure the co-axiality with the static armature. The coupling rod have to assure in the most measure the isolate the

magnetic field of the permanent magnet to that of the electro-magnet. To accomplish the measurements it is applied to the electro-magnet an increasing voltage till the detachment of th electromagnet from the surface of the piece. The consumed current by the electromagnet in the moment of the detachment is dependent to the percentage of residual austenite.

The electromagnet is programmed by the computer. There are many measurements on a point (at least 5) and at least 4 points of measurements.

4. CONCLUSIONS

To establish the effect of the cryogenic thermal treatment, it is necessary to determine the quantity of the residual austenite.

After the determinations of the residual austenite on different bear steels, which were treated by different clsic and non-conventional methods, it were found values very closed whith those determined by the X –ray diffraction method.

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