THE INFLUENCE OF TEMPERATURE ON THE ALUMINUM ALLOYS

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Abstract: *In the technical literature are some correlations with reference to the influence of brazing temperature on aluminum alloys, but there is not a diagram generally accepted.*

This paper aims to establish a direct correlation between the mechanical properties and the retention time of the brazing temperature. The experiments were applied on samples of aluminum alloy 3L59. The retention time varies from T1 = 10 minutes to T3 = 30 minutes.

Keywords: temperature; aluminum alloys; influence;

1.INTRODUCTION

In most cases, brazing filler metals do not have a single melting point but melt over a specific temperature range. The temperature at which a brazing alloy can be used to make a joint must always be higher than the temperature at which it begins to melt:

- The solidus temperature of an alloy is the temperature at which it begins to melt when being heated from room temperature;
- The liquidus temperature of an alloy is the temperature at which it becomes completely molten;
- The temperature difference between the solidus and liquidus temperatures of an alloy is known as its melting range or plastic range;
- In those rare situations where the solidus and liquidus temperatures coincide and where, in consequence, there is a melting range of 0^0C, the material is known as a eutectic.

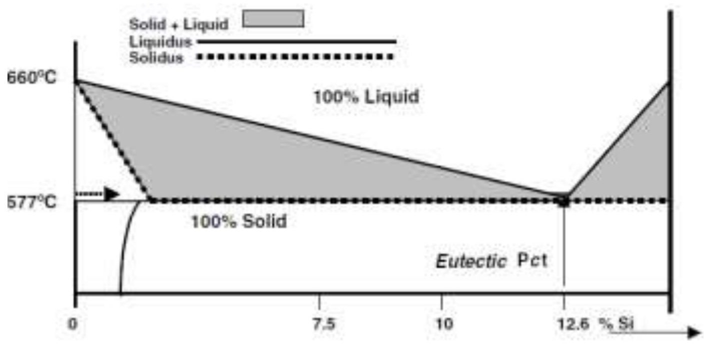

Fig.1 The relationship among solidus, liquidus, melting range and eutectic.[3]

As mentioned above, once a brazing filler material is heated to its solidus temperature, it begins to melt. As the temperature is gradually increased, more of the alloy becomes molten until, at its liquidus temperature, the material becomes 100% liquid. Throughout the melting range of the alloy, the ratio of the liquid phase to the solid phase increases as the temperature rises: the fluidity of the alloy also increases. The concept is illustrated in Figure 2:

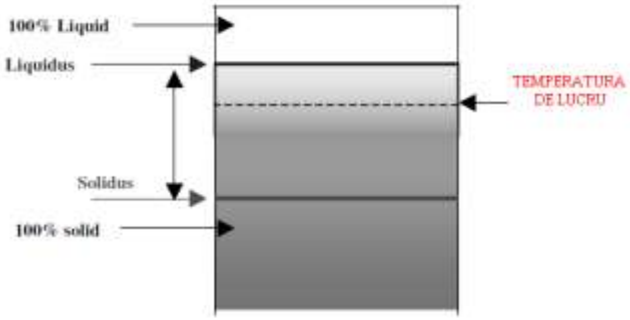

Fig. 2 Representation of working temperature.[3]

At a temperature above the solidus of the filler material, and quite often at a temperature that is below its liquidus, the molten filler material can possess a level of fluidity sufficient to enable it to flow into a capillary gap and make a joint. The temperature at which this occurs is known as the working temperature of that filler metal.

The technical literature presents several references to the working temperature: using regression we are seeing that this is 21^{0}C below the melting temperature of the base material, in the case where the two materials (both the base and the filler) are homologous. There are exceptions to the rule and therefor trials are needed to determine the working temperature of the filler metal if this is not specified in the technical instructions.

The fact that the majority of alloys used as brazing filler materials do not have a single melting point can be a source of trouble to the unwary. This is particularly true if the brazing alloy has a long melting range, is preplaced at the mouth of the joint as a perform and is subjected to a slow rate of heating. In these conditions, the time take to heat the component and the brazing filler material through the melting range of the alloy can be quite long; this factor often causes difficulties.

2.EXPERIMENTAL DATA

It should be noted that the working temperature for brazing with oxyacetylene flame is 400÷450^{0}C. For this trial, the samples were heated at a temperature of 430÷450^{0}C and maintained at these temperatures 10 ÷ 30 minutes, for much more time than the actual brazing conditions. The heating operation was carried out in an furnace. Thus emerged the following sets of samples shown in Table 1:

Tab. 1 The properties of the samples.

No.	Symbolization	Temperature [^{0}C]	Retention times [min]	Width of the sample X [mm]
1	Tt_01	20	0	9,52
2	Tt_02	20	0	9,56
3	Tt_03	20	0	9,56
4	Tt_11	430÷450	10	9,44
5	Tt_12	430÷450	10	9,48
6	Tt_13	430÷450	10	9,52
7	Tt_21	430÷450	20	9,45
8	Tt_22	430÷450	20	9,46
9	Tt_23	430÷450	20	9,52
10	Tt_31	430÷450	30	9,53
11	Tt_32	430÷450	30	9,46
12	Tt_33	430÷450	30	9,45

The used samples have the following shapes and dimensions.:

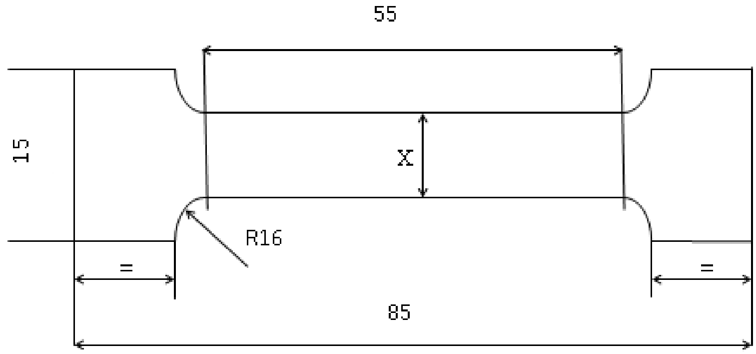

Fig. 3 The shape and the dimension of the sample.

Fig. 4 The fatigue testing system INSTRON 8801.

In order to follow the effect of temperature on the aluminum alloy, the samples presented in table 1 came under tensile tests. They were made on the fatigue testing machine INSTRON 8801 according to standards, loading speed was 1mm/min. To record local deformations, a strain gauge extensometer, 50mm gauge length, was used and was maintained up to a sample specific deformation of 3%.

Figures 5, 6, 7, 8 show the curves for the aluminum alloy that was not influenced by the temperature, samples that where kept at 10 minutes, 20 minutes and 30 minutes at a temperature range of $430 \div 450\ ^0C$.

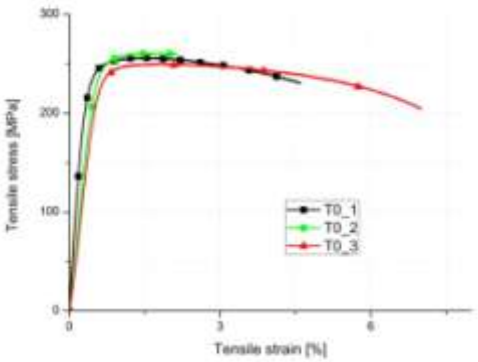

Fig. 5 The fatigue curves for not heated aluminum alloy.

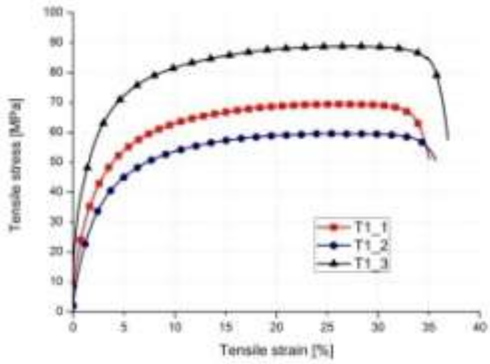

Fig. 6 The fatigue curves for aluminum alloy kept 10 minutes in the furnace.

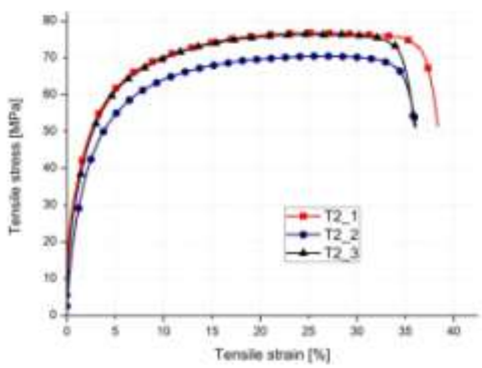

Fig. 7 The fatigue curves for aluminum alloy kept 20 minutes in the furnace.

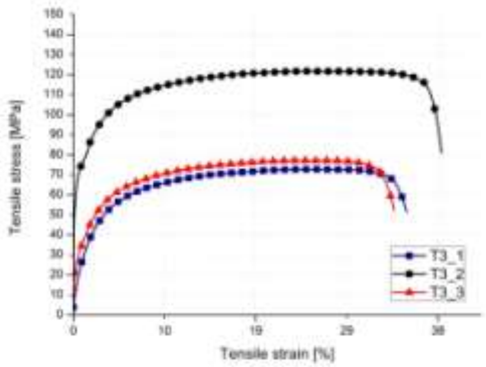

Fig. 8 The fatigue curves for aluminum alloy kept 30 min in the furnace.

3.CONCLUSION

In order to illustrate the behavior and the time of temperature effect on the aluminum alloy, there are shown in the same graph of the characteristic curves of the alloy not subject to heating and heated in an furnace maintained for 10, 20 and 30 minutes.

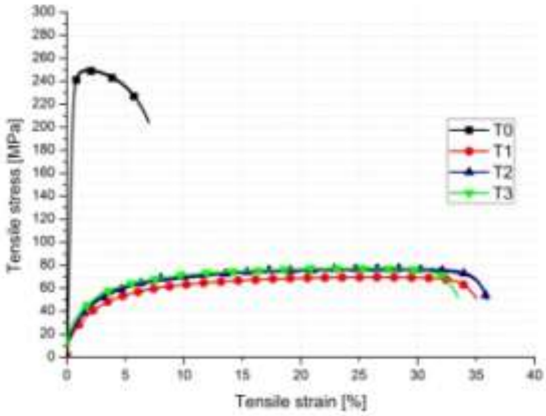

Fig. 8 The fatigue curves for aluminum alloy.

Figure 8 has shown that the heating of the alloy reduces its mechanical properties. Even a short time of 10 minutes implies a major transformation of the mechanical properties of the alloy.

It can be seen that as the retention time of the samples at the brazing temperature increases, there is a small increase in the mechanical properties.

The behavior of the alloy may lead to the degradation of the structure due to the area influenced by the brazing temperature.

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