

Study of the Ultrasonic Behavior in the ($\alpha + \beta$) Brass Alloy

Mohammed Shaalan Abed Fathi

University of Mosul – College of Engineering – Mechanical Engineering Department

Abstract

Copper is one of the few metals with significant commercial uses. Although frequently used as a pure metal or with small amounts of metal additives, copper can form 82 binary alloys. Two of the most common are brass (copper-zinc) and bronze (copper-tin). This research work tries to study the ultrasonic behaviour in one of the important brass alloys represented by ($\alpha + \beta$) brass alloy.

Specimens of ($\alpha + \beta$) brass were machined to cylindrical shape with different thicknesses in order to study the effect of the sound scanning distance on the acoustic attenuation of the ultrasonic waves.

The results indicate that it is plausible to inspect ($\alpha + \beta$) brass using both 2MHz and 4MHz frequencies, and that the acoustic attenuation of ultrasonic waves has increased when 4MHz probe was used. In addition, the results illustrate that the acoustic attenuation increases as the sound path distance increases.

دراسة سلوك الموجات فوق الصوتية في سبيكة براس ($\alpha + \beta$)

محمد شعلان عبد فتحي

كلية الهندسة – جامعة الموصل

الخلاصة

يستخدم النحاس على نطاق تجاري واسع، وبالرغم من استخدامه بكثرة كمعدن نقي او مع بعض الاضافات المعدنية الا أن النحاس يشكل 82 سبيكة ثنائية. أثنان من أكثر السبائك شيوعاً هما البراس (نحاس- زنك) والبرونز (نحاس- قصدير). يحاول هذا العمل البحثي دراسة سلوك الموجات فوق الصوتية من خلال بعض العوامل التقنية في سبيكة براس ($\alpha + \beta$).

تم تشغيل نماذج من سبيكة البراس ($\alpha + \beta$) الى أشكال اسطوانية مختلفة السمك بما يتلائم مع مجسات الموجات فوق الصوتية. ووظفت مجسات الموجات التضاغية (Compression waves probes) بترددات (2MHz and 4MHz) لفحص النماذج.

أظهرت النتائج التي تم الحصول عليها من هذا البحث إمكانية ولوج الموجات فوق الصوتية لاغراض الفحص الهندسي باستخدام كلا الترددين (2MHz and 4MHz)، وكذلك إزدياد الاضمحلال الصوتي داخل النماذج باستخدام المجس ذو التردد 4MHz. كما بينت النتائج زيادة الاضمحلال الصوتي بزيادة المسافة المقطوعة باستخدام كلا الترددين (2MHz,4MHz).

1. Introduction

Although frequently used as a pure metal or with small amounts of metal additives, copper can form 82 binary alloys. Two of the most common are brass (copper-zinc) and bronze (copper-tin). The brasses comprise the useful alloys of copper and zinc containing up to 45% zinc, and constitute one of the most important groups of non-ferrous engineering alloys. If the amount of zinc is increased beyond 39% an intermediate phase β' equivalent to CuZn, will appear in the microstructure of the slowly cooled brass (Fig.1). Lead (up to 4%) often is added to brasses to enhance machinability and to fill pore spaces in the metal. Lead is essentially insoluble in copper and precipitates at the grain boundaries. As a result, the lead serves as a lubricant during machining [1, 2].

Among the techniques that are employed to assess and characterize the properties of brass alloys; Hünicke, et al [3] studied the possibility of the acoustic emission analysis to characterize the SCC process of the brass CuZn₃₇ under electronic regulated constant load conditions.

In addition, Tasic, et al [4] defined a method for monitoring the process of continuous casting that might affect the casting quality and enable the monitoring and management. Since this is a continuous process, convention monitoring methods with destruction are inadequate because the process needs to be decelerated during each sampling. The material used in this research belongs to the group of the special brass alloy. The results have illustrated that with an appropriate selection of parameters of gravitational casting into a metal casting mold (the style of pouring, a definite cooling velocity, etc.), it is possible to simulate continuous casting and obtain castings with the continuous casting macrostructure.

The current research work tries to study the ultrasonic behavior in one of the important brass alloys represented by ($\alpha + \beta'$) brass alloy.

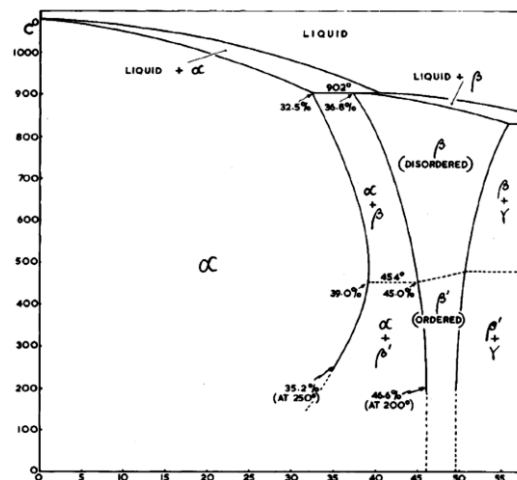


Figure 1: Thermal equilibrium diagram of copper-zinc system [1]

2.1 Materials and Methodology

Specimens of ($\alpha + \beta$) brass were machined to cylindrical shape with different thicknesses (20, 30 and 40 mm) in order to study the effect of the sound scanning distance on the acoustic attenuation of the ultrasonic waves. The ultrasonic test was carried out by using ultrasonic Krautkramer instrument (made in Germany) and compression wave probes with different frequencies (2MHz and 4MHz) to assess the effect of the frequency on the ultrasonic wave's behavior. The sensitivity level was chosen to be 80 % of F.S.H. (Full Screen Height); i.e., the echo received from the backwall of the sample was brought to four-fifth the screen height and the number of decibels required to bring the echo to this sensitivity level were recorded (Fig.2). Table 1 illustrates the chemical composition of the brass alloy included in this research.

Table 1: Chemical composition of the brass alloy included in this research

Element	Cu	Zn	Pb
Wt. %	57	40	3

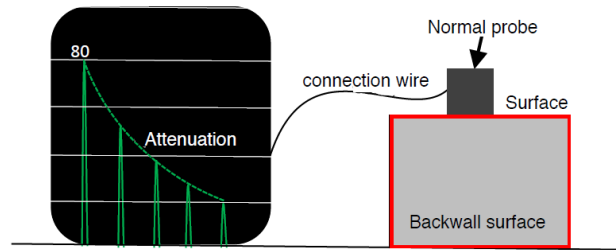


Figure 2: Schematic representation of the pulse-echo technique.

2.2 Metallography

A sample of the alloy included in the research was prepared for the microscopical inspection. Photomicrograph of this sample (X160) is shown in Fig. 3.

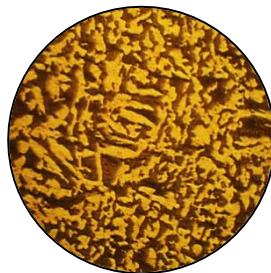


Figure 3: Photomicrograph of the ($\alpha + \beta$) brass (X160)

3. Results and Discussion

The ultrasonic waves have been transmitted into specimens of both 2MHz and 4MHz frequencies. Then, the energy (dB) required to bring the echo received from the backwall surface to four-fifth the screen height was

measured. The results obtained are represented in Fig. 4 and Fig. 5, these results indicate that it is plausible to inspect ($\alpha + \beta$) brass using both 2 and 4MHz frequencies. The acoustic attenuation of ultrasonic waves has increased when 4MHz probe was used. In addition, acoustic attenuation increases as the sound path distance increases for both 2MHz and 4MHz frequencies. In addition, equation [1] has been used to evaluate the ultrasonic longitudinal velocity in the alloy using the thickness measurements of the specimens; the average calculated value is 4614 m/s.

$$V_r = \frac{d V_L}{kT} \dots \dots \dots [1]$$

- V_r : the unknown velocity
- d : specimen thickness
- k : distance of one screen graduation.
- T : number of graduations.
- V_L : ultrasonic velocity in the calibration block.

Table 2: Date of velocity measurements using 2MHz normal probe.

Specimen thickness (mm)	Screen distance (mm)
20	24
30	38
40	52

4. Conclusion

The following points can be concluded from this work:

1. It is plausible to inspect ($\alpha + \beta$) brass using both 2 and 4MHz frequencies.
2. The acoustic attenuation of ultrasonic waves has increased when 4MHz probe was used.
3. The acoustic attenuation increases as the sound path distance increases.

References

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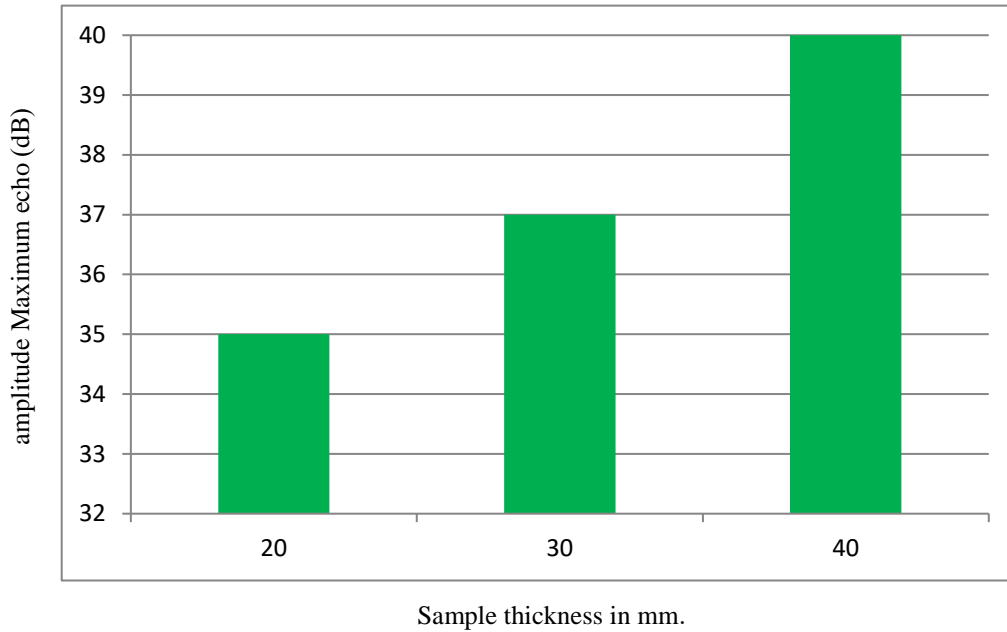


Figure 4: relationship between specimen thickness and maximum echo amplitude received from the backwall of the specimen, using 2MHz compression wave probe.

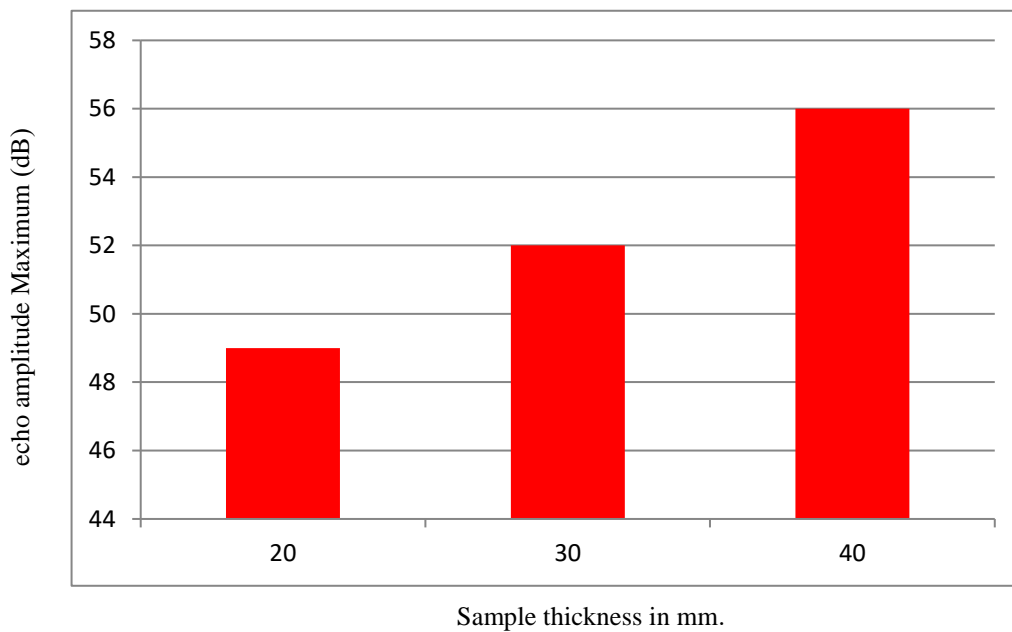


Figure 5: relationship between specimen thickness and maximum echo amplitude received from the backwall of the specimen, using 4MHz compression wave probe.