CHARACTERIZATION OF Cu-Ni POWDERS OBTAINED THROUGH THE LIQUID PHASE ATOMISATION PROCESS

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ABSTRACT: This paper presents the characteristics of the powders obtained through the liquid phase atomisation process of the Cu90Ni10, Cu80Ni20, Cu70Ni30 and Cu60Ni40 alloys. The water atomization method and the powder features are also described. In optimal compacting pressure for the samples to be sintered in hydrogen was established according to the presability curve. The tehnological charactics of the obtained powders are presented. Powders morphologi by SEM was studied.

KEYWORDS: Cu-Ni alloys, atomisation, powder characterisation

1. INTRODUCTION

The main characteristic of the Cu-Ni alloys is their high resistance to corrosion in chemically aggressive enviromments, such as: sea water, organic acids, saline solution vapers etc., so that this feature makes them suitable for naval structures, steam condensation pipes, coins, jeweloy, domestic use objects, food industry etc[1].

The Cu-Ni alloys are difficult to cast (high casting temperature for 80%Ni compositions), have a high tendencey to absorb gases, to form shrinkage voids inclusions in the slag their fluidity is low, the casting concentration is high etc. [2, 3].

This is the reason for which we have started our present study on obtaining the materials mentioned above by means of powder metallurgy process whose outcome is homogenerous parts, free of segregation, inclussions and shrinkage.

2. ELABORATION AND ATOMISATION OF Cu-Ni ALLOYS

In order to obtain Cu-Ni alloys, 99.5% pure copper and nickel were used. They were melted in a induction furnance of 55 kW. The furnance lining is basic (MSM90 type, sodium sillicate being the binder). Table 1 presents the charge of the furnance for the four charge made and calculeted such as to replace the 2-3% burning during the process.

The bath was protected with a layer of charcoal and broken glass during copper melting and alloying. After the alloy components melted, the both was deoxided with phosphorus copper (copper with 10%P). The diameter of the outlet nozzle of the atomisation funnel was 6 mm and the head was cone-ring shaped and provided with 12 active jets.

***Table 1**. The furnance charge of the four charges prodused*

Powder Type	Chemical Composition		Materials used for atomisation		
	Cu [%]	Ni [%]	Cu [g]	Ni [g]	CuP [g]
Cu90Ni10	90	10	7200	800	121
Cu80Ni20	80	20	6400	1600	140
Cu70Ni30	70	30	5600	2400	149
Cu60Ni40	60	40	4800	3200	160

The parameters of the atomisation process in the case of the four powder types are presented in table 2

***Table 2.** Production and atomisation parameters*

Parameters	U.M.	**Cu90Ni10**	**Cu80Ni20**	**Cu70Ni30**	**Cu60Ni40**
Elaboration time	min	125	115	120	135
Charge weight	g	8121	8140	8149	8160
Melting temperature	°C	1200	1250	1295	1310
Atomization temperature	°C	1250	1320	1365	1380
Atomisation agent	-	water	water	water	water
Pressure	MPa	50 - 60	50 - 60	50 - 60	50 - 60
Outlet nozzle diameter	mm	ϕ 6	ϕ 6	ϕ 6	ϕ 6
Liquid metal flow	Kg/s	0.25	0.26	0.19	0.26
Atomisation time	s	33	31	34	32
Number of active jets	-	12	12	12	12
Apex angle nozzle	grd	25	25	25	25
Water consumed	l	44.8	43.57	84.5	84.5
Water flow	m^3/h	5.66	5.06	4.41	4.41
Water consumation charge	l/kg charge	5.5	5.4	10.3	10.3

3. DESCRIPTION OF THE POWDERS OBTAINED

The granulometric distribution of the Cu-Ni powder was obtained by sieving the powder with 1.25 mesh sieves. The powders was reduced in an atmosphere with hydrogen . At the beginning, the temperature in the crucible where the powder was introduced was 300°C, the powder was kept at 600°C for 60 minutes and it was subsequently cooled for 60 minutes.

The figures 1, 2, 3 and 4 represent the Cu90Ni10 and Cu60Ni40 powders siered and their representative curves: the curves for the refuz cumulat and the cumulated pass. No significant differences are noticed after powder reduction. It is obvions that the grain distribution focuses upon the 100-125 μm and 160-200 μm sorts. The average powder diameter yielding from the cumulated pass is circa 100 μm (at $T_c = 50\%$) for both oxidised and nonoxidised powders.

***Table 3.** Atomised powder fluidity and density.*

Powder Type	Fluidity [s/50g]		Apparent density [g/cm^3]	
	Non-reduced	Reduced	Non-reduced	Reduced
Cu90Ni10	32 s	30 s	4.1	4.4
Cu80Ni20	28 s	25 s	3.9	4.2
Cu70Ni30	31 s	29 s	4.0	4.2
Cu60Ni40	29 s	26 s	3.5	3.8

Table 3 shows that reduced powders have better fluidity than the non-reduced ones due to a thinner oxide layer and to a change in the grain shape, leading to interparticle friction decrease and a better flow of the reduced powders. Apparent density also increased because of particle shape alteration.

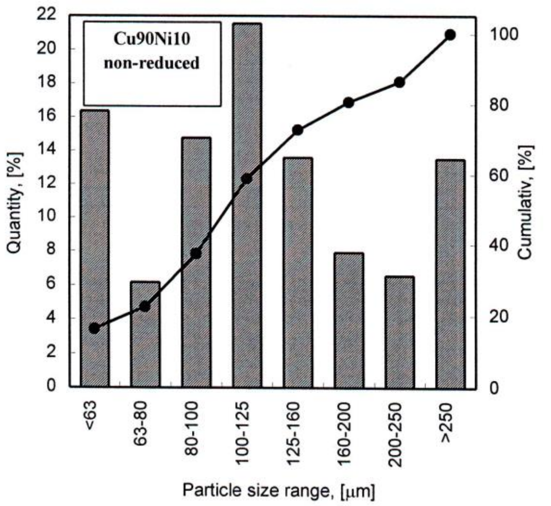

Figure 1. Particle size range and cumulative distribution of non-reduced powder grain class.

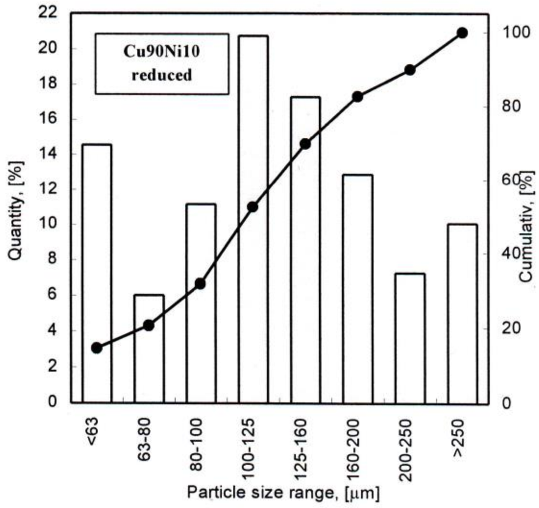

Figure 2. Particle size range and cumulative distribution of reduced powder grain class.

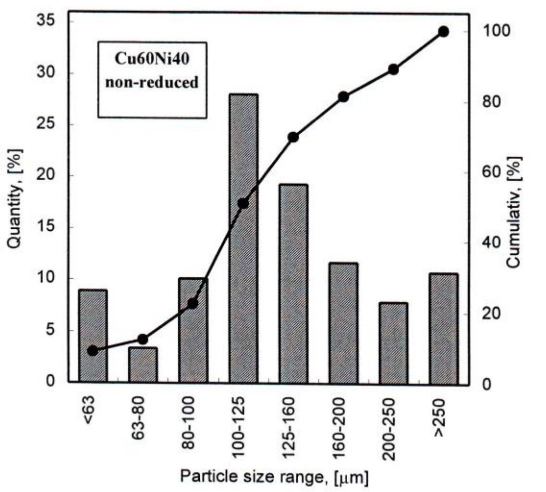

Figure 3. Particle size range and cumulative distribution of non-reduced powder grain class.

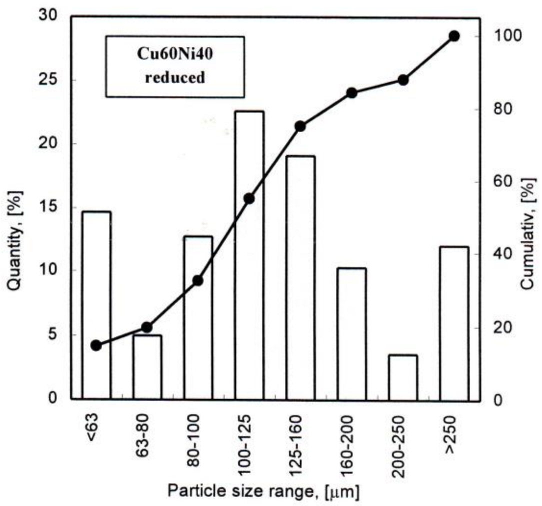

Figure 4 Particle size range and cumulative distribution of reduced powder grain class.

The powders have been homogenised in a TURBULA type spatial mixer for 10 minutes with lubricant, in all batches (the lubricant was 0.75% Zinc Stearate). The powders of various compositions have been pressed at compacting pressures varying between 200 – 800 MPa in a tensile testing machine.

The presability curves for the green compacts of various compositions are presented in fgiures 5 and 6. The presability curves of the mixtures indicating an increase at various compacting presures.For the determination of the green density less than 160 μm grain sized powder was used.

The alloyed powders with the highest copper content showed the best pressing behaviour. This can be explained by the fact that the copper powder undergoes a better plastic deformation than the nickel powder and the particle shape fills in more adegnately the voids between the grains.

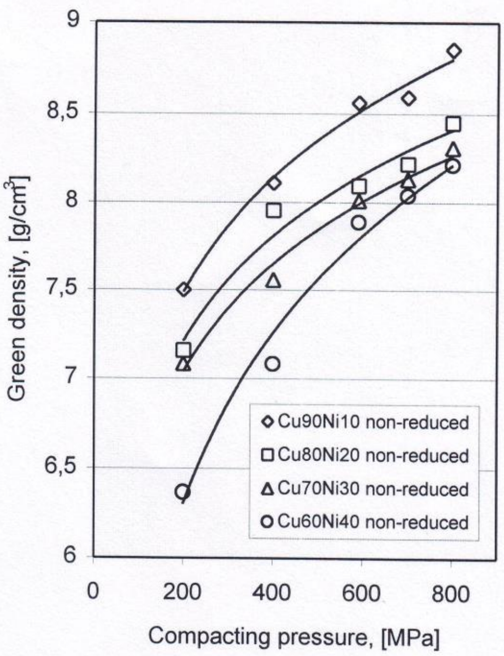

Figure 5. The presability curve of the atomised non-reduced powder

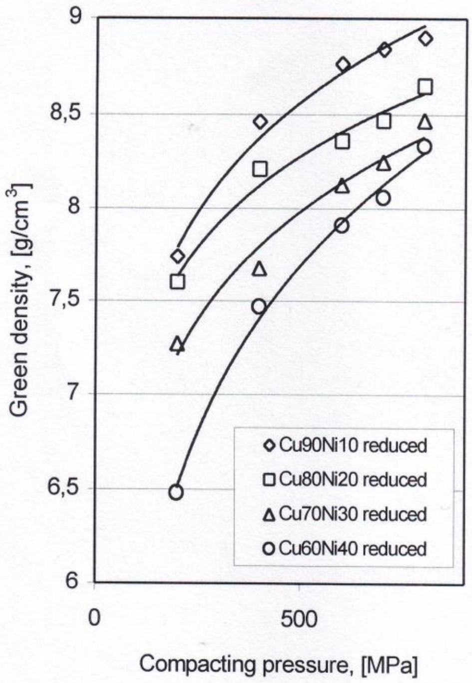

Figure 6 *The presability curve of the atomised reduced powder*

4. THE FORM AND MORPHOLOGI OF THE POWDERS OBTAINED

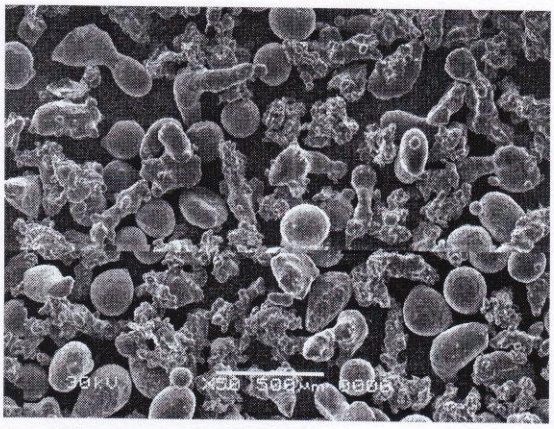

Figure 7. *Cu90Ni10 – non-reduced*

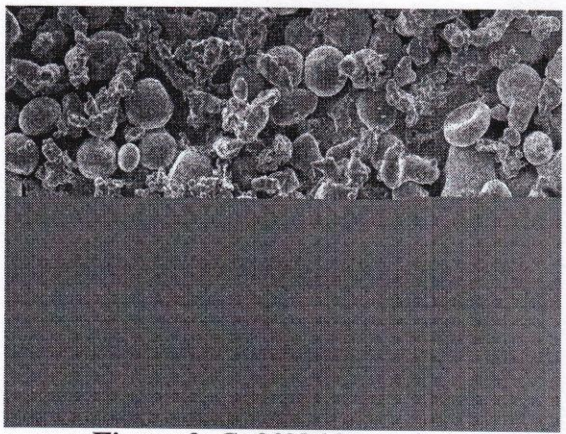

Figure 8. *Cu90Ni10 – reduced*

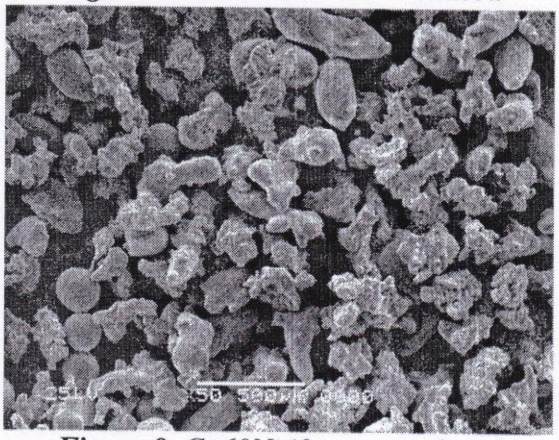

Figure 9. *Cu60Ni40 – non-reduced*

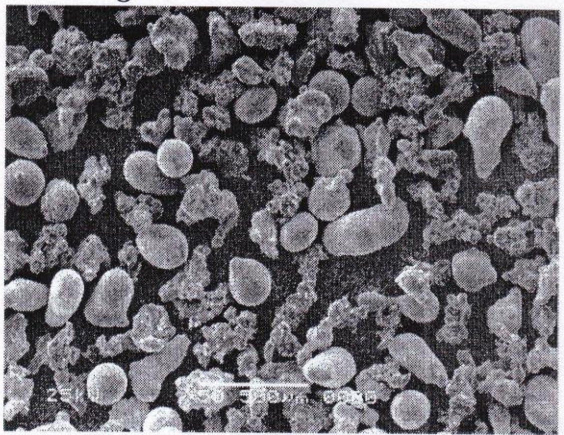

Figure 10. *Cu60Ni40 - reduced*

After collecting, dreping and screening the powders were examined with an electronic sweep SEM microscope provied with a JEOL JSM 5600. Figures 7, 8, 9 and 10 present the non-reduced and reduced Cu90Ni10 and Cu60Ni40 powder grains.

It is evident that the water atomised Cu-Ni powder presents various forms of grains, from spherical to iregular ones. The grain surface is oxidised in the case of the non-reduced powders, while the surface of the reduced grains is smoother due to oxide reduction.

5.CONCLUSION

The grain size analysis made for both reduced and non-reduced powders showed no significanty differences after the powders reduction.

The comparison of the pressability curves of the reduced and non-reduced powders indicates that the former, obtained by atomisation, is more compressible.

In so far fluidity is concerned, its level are higher with reduced powders due to a decrease of the oxide layer.

The SEM-based analysis points out that the Cu-Ni atomised powder includes quite a large range of grain shapes, ranging between spherical and iregular, that are maintained even with larger grain fractions and leading to more compaction.

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