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MELTING-CASTING PLANT USING VIBRATING OF MELTS IN ORDER TO OBTAIN COMPOSITE WITH TEHNOLOGICAL UTILITY

Vasile BASLIU, Ionut CONSTANTIN,
Gina Genoveva ISTRATE, Ionel PETREA
“Dunarea de Jos” University of Galati
email: vbasliu@ugal.ro

ABSTRACT

This paper presents the obtaining of composites materials with technological utility through vibration technology. In order to obtain these composites, and plant was designed and manufactured. In order to show the possibilities of these technologies, a number of composite samples were produced.

KEYWORDS: vibration, ferroalloy, composite of technological utility, FeTi32

1. Introduction

The research objective was to find a method for the valorization of granular ferroalloy (FeTi32). Current ISO 5445/1995 standards require a grain with the lower limit of 3.5 mm used in the development of deoxidation steel stage.

Factors that affect the obtaining of a complex deoxidant, reinforced with particles, can be divided into: - metallurgical factors
- technological factors.

Metallurgical factors are the following: solid fraction, temperature, size, morphology, distribution of solid particles and liquid matrix alloy, chemical composition.

Technological factors are: frequency [Hz], amplitude [mm], acceleration [m/s^2], temperature alloy castings, [°C], time of vibration [min].

Following this process, because of continuous brawniene movement, additional material will be found in the mass of composite.

Benefits:
- reproducible results;
- low additional material segregation;
- wide range of working arrangements;

Disadvantages:
- very slow adjustment of the electric motor;
- the probability of accidental splashing vibrating mass.
- careful handling when pouring liquid metal;
-possibility of accidental splashing of vibrating mass.

The special part of these particular technical solutions adopted, consists in the fact that the complex deoxidant with technological role has incorporated diverse proportion of complementary material (FeTi32) which is controlled, known and reproducible.

2. Experimental conditions

Mechanical mixing using a vibrating plant

Getting the composite through this method involves melting the aluminum alloy in the presence of particles followed by an intense agitation of the crucible through vibration.

Through vibration, for the majority of alloys, a series of beneficial effects can be obtained, such as:
- finishing the structure and, hence, improvement of properties;
- increasing the solidified alloy compactness by reducing the porosity;
- reducing the chemical, gravitational and segregation processes;
- advanced degassing of the composite material.

While melting alloys in temporary shapes, the solidification starts from the cool walls of the mould, as a result of a heat exchange between the cast alloy and the casting mould.

The solidification of casting alloys in temporary forms starting next cold walls of the form, as a result of heat exchange between molten alloy and mold. At first it forms a solid crust consists of equiaxed crystals that develop over time a zone of columnar crystals. If after melting aluminum alloy particulate form is subject to a process of mechanical vibration, the vibration causes the turbulent motion of the liquid alloy which leads to fragmentation of the columnar crystals and their involvement in mass formation of liquid alloy, which will be partially re-melted or totally, the process is a function of temperature in the liquid alloy non-solidified and broken crystal fragment size. This has the effect of germination process intensification and intensification of broken crystals and re-melting. Heat involved in the mass of liquid alloy.

Favorable effect compaction vibration can be explained by the fact that mechanical oscillations create local pressures leading to increased penetration rate of the alloy in the area biphasic capillary channels.

Agitation melt under the vibration action has the effect of decreasing the viscosity of liquid, whether to create favorable conditions for lifting the gas separation surface (on rising speed increases with decreasing viscosity Stokes law). At the same time introduces additional material FeTi32.

The operating principle is explained by the kinematics scheme, presented in Fig. 1.

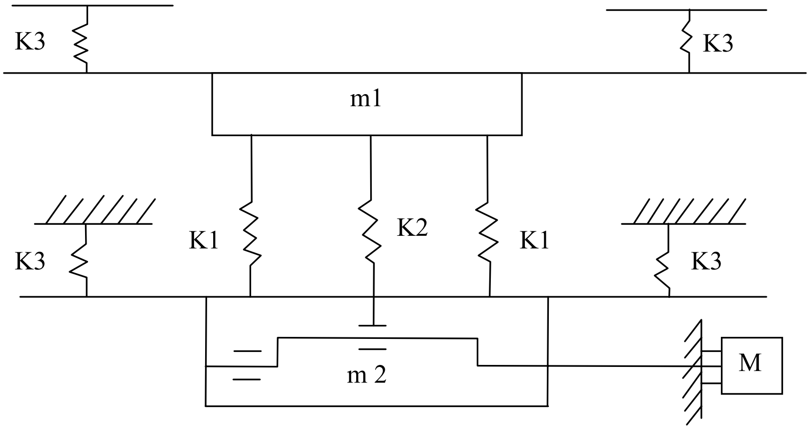


Fig. 1. *Kinematic scheme of the plant: m1 - the weight of the workpiece table and checked; m2 - reactive load weight (counterweight) K1 - stiff springs work, K2 - spring stiffness; K3 - stiff springs to maintain (control), M - electromotor.*

The stand functioning is based on the resonance phenomenon of two mass in vibration m_1 and m_2; each of them is suspended by the maintenance springs with K_3 stiffness; the mass are tied together with the working springs K_1.

Table 1. *Working regime for vibration mass*

Working regime		
Frequency, F,	**Amplitude, A**	**Acceleration, a**
[Hz]	[mm]	[m/s^2]
25	2.2	55
28	2.2	69
30	1.6	57.6
35	1.2	58.8
40	1.0	64
50	0.7	70

The stiffness of the K_1 working springs can be variable, depending on the position of adjusting nuts.

$$Q = \frac{A \cdot f^2}{25} \tag{1}$$

Where: A - amplitude [mm] F - frequency [Hz] a - acceleration [m/s^2].

Fig. 2. *Plant consists of three heating and vibrating stand for a crucible: 1- vertical furnace with forced bars, 2 - vibrating table, 3 - crucible.*

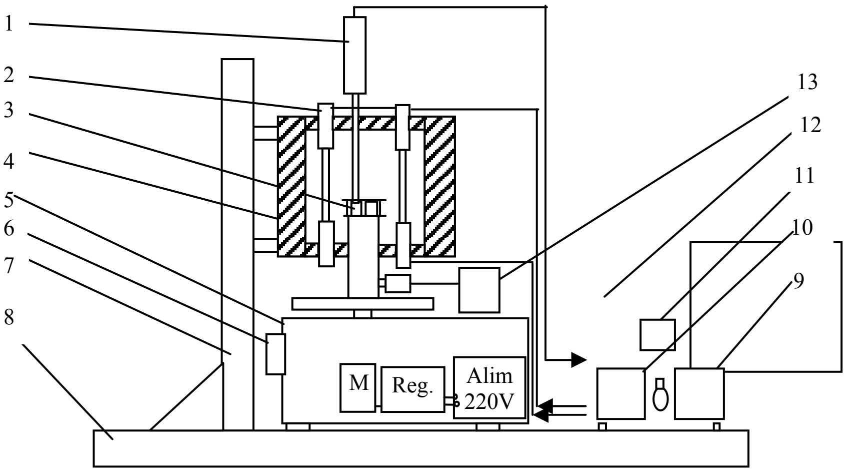


Fig. 3. *Plant components: 1 – temperature measurement system (thermocouple); 2 – heating elements; 3 – crucible steel; 4 – electric furnace; 5 – vibrating equipment; 6 – mechanical system for adjustment of amplitude and frequency; 7 – support column; 8 – motherboard; 9 – ampere indicator; 10 – voltage indicator; 11 – temperature regulator; 12 – power source provided with temperature; 13 – vibration measuring device (amplitude and frequency) X – Viber.*

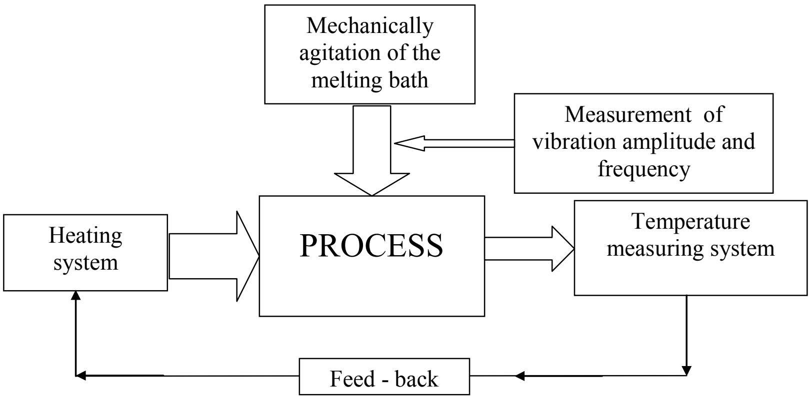


Fig.4. *Block diagram of experimental stand function, mechanical stirring, through vibration type during solidification.*

Characterization:

Charge:-weight, max. 40 [g]
Electric heating:
-forced bar heating elements:
-R = 4 [Ω]
-Power = 0 ... 3.6 [kW]
Temperature Control System:
-PID - 1RT96
-temperature sensor - K (chromel-alumel)
-range - 0 ... 900 [° C]
System for measuring amplitude and frequency:
-X-Viber.

Samples used:

We considered several options for obtaining the Al/FeTi32 deoxidant varying the reinforcing phase size - FeTi32 particles.

We performed their rank using set of sites with the following dimensions: 0.8 mm 0.63 mm 0.40 mm 0.32 mm 0.20 mm 0.16 mm 0.10 mm; 0.056 mm, 0.04 mm <0.04 mm as standard determination.

Working mode:

The working procedure has been established and followed consisted of:

- the composition of the load: it was dispensed by weighing the amount of aluminum and ferroalloy FeTi32 size sorting.

- uploading was made on the top of crucible steel.

- programming of temperature was done in accordance with established experimental procedure.

- melting: phase transition is from solid aluminum liquid temperature monitoring work with fixed by experiment.

- shaking vibrating bath of aluminum metal.
- cooling and removal of the cast from the crucible.

Experimental procedures:

Designing and making the experiment aimed to highlight the inclusion of different ferro-alloy granulometric classes in aluminum metal matrix. So, we varied the ferroalloy particle sizes (FeTi32) maintaining constant the other parameters: temperature, mixing duration, frequency, magnitude and composition of the load. We chose a 1:1 ratio Al/FeTi32.

Table 2. *Experimental data*

Nr. crt.	Load composition			Ratio Al/FeTi32	Temperature	Mixing time	Frequency	Amplitude
	Al	FeTi32						
		Mass	Granulation					
u.m	[g]		[mm]	[%]	[^{o}C]	[min.]	[Hz]	[mm]
1	20	20	0.800	1:1	750	10	46	1
2	20	20	0.400	1:1	750	10	46	1
3	20	20	0.056	1:1	750	10	46	1

On the evidence obtained, we made the following determinations:

a. Chemical analysis

We use X-ray fluorescence spectrometer mark Innov-X System.

Table 3. *Chemical analysis*

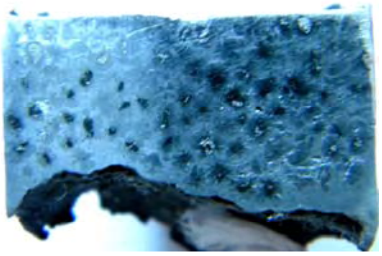
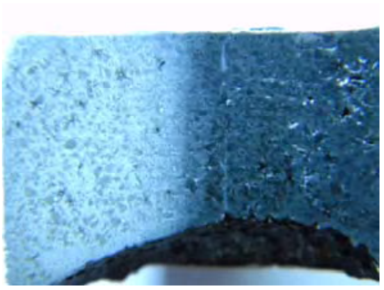
Nr. crt.	Granulation	Chemical analysis		
		Al	Fe	Ti
u.m.	[mm]	[%]	[%]	[%]
P1	0.800	65.36	8.73	12.94
P2	0.400	76.51	13.82	7.48
P3	0.056	58.73	24.55	12.91

b. Metallographic analysis

For this purpose, we collected samples from the Al/FeTi32 composite and we prepared them by grinding and polishing the samples.

When we obtained a high polish, we analyzed in a micro-structural way the prepared surfaces but without metallographic attack for the following increases (x64) in order to highlight the dispersion, shape and size of ferro-alloy particles embedded in aluminum metal matrix.

The same samples were analyzed after the metallographic attack with specific reagent (10% HF in H_2O). It can be seen the dispersion of FeTi32 particles into the aluminium matrix.

Nr. crt.	Ferroalloy particle diameter, FeTi32, mm	Macrostructures
1	0.800	
2	0.400	

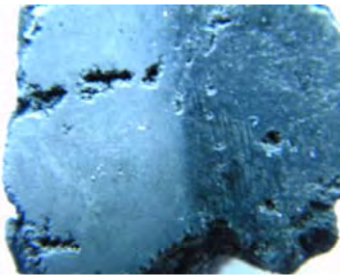
3	0.056	

Fig.5. *Macrostructures of the FeTi32 ferroalloy samples.*

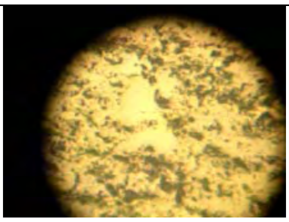
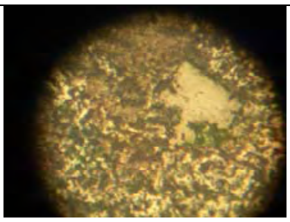
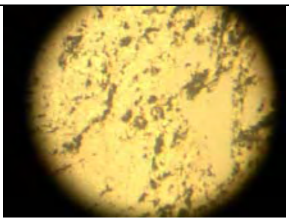
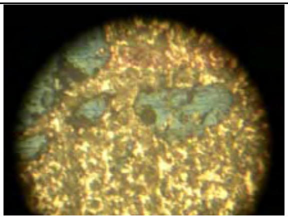
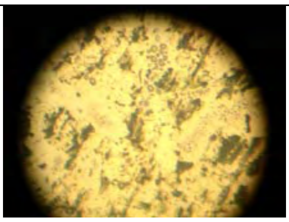
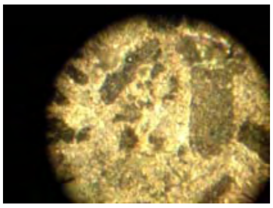
No.	**Ferroalloy particle diameter, FeTi32,** mm	**Microstructures**	
		un-attacked	attacked
1	0.800	 x64	 x64
2	0.400	 x64	 x64
3	0.056	 x64	 x64

Fig.6. *Microstructures of the FeTi32 ferroalloy samples.*

3. Conclusion

The research was completed with the achievement of a laboratory stand, elucidation some phases in homogenization and dispersion of the reinforcing phase in the metal matrix highlighted by microscopic analysis.

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