"HENRI COANDA"
AIR FORCE ACADEMY
ROMANIA

GERMANY

"GENERAL M.R. STEFANIK"
ARMED FORCES ACADEMY
SLOVAK REPUBLIC

INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER
AFASES 2011
Brasov, 26-28 May 2011

STUDY ON THE INFLUENCE OF MECHANICAL VIBRATIONS ALLOYS PROPERTIES

Alexandru Stefan BANEA *, **Ionut Bogdan ROMAN** *,
Adrian GALEA *, Mircea Horia TIEREAN *

*D12 Ecotehnologii Avansate de Sudare, Universitatea Transilvania, Brasov, Romania,

***Abstract**: In this paper are presented the effects that occur during crystallization of alloys under the influence of mechanical vibrations.*
Because the decrease of viscosity and surface tension, if mechanical vibration is applied on cast alloy, it can be observed dynamic effects that cause a significant increase in the fluidity of alloys, although in terms of vibration intensifies heat transfer.
Advantages of mechanical vibration on the alloys can be: reduction of internal tensions, eliminate non-metallic inclusions, increase flow and reduce segregation alloys.

Keywords: *vibration, oscillation, mechanicals, alloy, effects.*

Introduction

Increased chemical purity, the phase composition and structural steel is one of the most important current problems of design and casting practice, knowing that the operational behavior of the steel depends on the shape, distribution and nature of inclusions segregation.

It is known that alloys containing significant amounts of non-metallic inclusions that lower than mechanical and operating properties of parts produced.

Inclusions present in the alloy solidified metal from forming impede flow, structural defects affect the distribution and movement of dislocations.

Multiple factors are affecting quality and manifested throughout the development process, casting, solidification and deformation in the hot and cold.

1.1 Physical processes occurring in vibrating mechanical alloys.

1.1.1 Action of impulse forces.

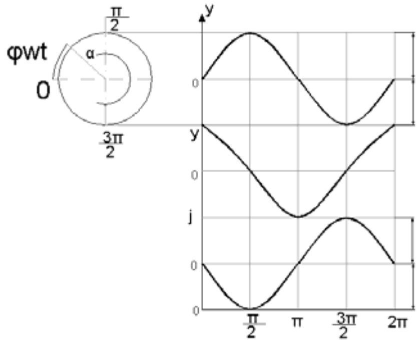

Fig.1 The correlation between trajectory, velocity and motion acceleration in the case of sinusoidal oscillations.

Applying forced harmonic oscillations (center of gravity moving an alloy after a sinusoidal law of mass m, acceleration j changes its meaning to each period of oscillation (fig.1) in the liquid alloy leading to the emergence of two alternative y1 and inertial forces y2 height equal but opposite sign:

$$y_1 = -m \cdot \left(-a \cdot w^2 \cdot \sin(\varphi)\right) = m \cdot j$$
$$y_2 = -m \cdot \left(a \cdot w^2 \cdot \sin(\varphi)\right) = -m \cdot j$$

Taking into account the force G = mg, G_{EF} actual weight will change over time, according to the relation:

$$G_{ef} = m \cdot (g \pm j) = m \cdot (g \pm a \cdot w^2 \cdot \sin(\varphi))$$

If j = j_{max} = g, the force acting in the liquid alloy is highest in the first half period, resulting in the following optimal correlation between the amplitude and frequency.f - frecvența de oscilație

1.2 Macroscopic mass transfer

If mounted at the bottom of the cavity shape of a vibrating rod whose front surface comes into direct contact with the liquid alloy, melt movement comes with j> g_f.

Macroscopic mass transfer depends on the correlation between parameters a and f taking place in areas II and III, not the field I (Fig. 2) when the alloy is independent of the vibrating rod. In zone III separation occurs equal to 0 while in the second separation is made for:

$$\varphi \in \left(0, \frac{\pi}{2}\right)$$

1.3. Phenomena of cavitation.

Under the action of mechanical oscillations of the alloy is moving the flow Reynolds criterion imposed by the expression of which involved the vibration amplitude and frequency.

Cavity occurs when the relative velocity between fluid and crystal is larger than a critical speed.

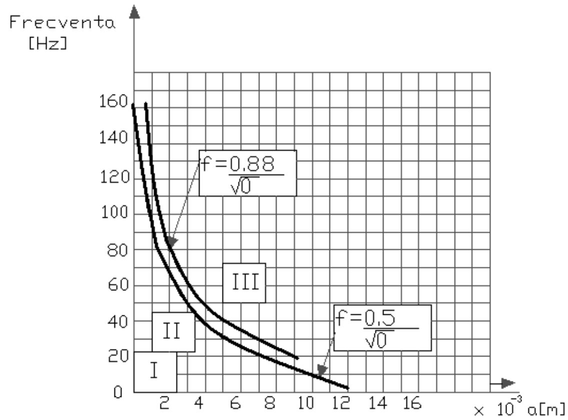

Fig.2 Vibration macroscopic effect on mass transfer

On the other hand, high speed travel of the liquid alloy cavitation process can occur outside the boundaries of the crystal. Following the destruction of cavitation bubbles, the gas within it is compressed nearly adiabatically. It produces an implosion that has the direct effect of a significant increase in local pressure, accompanied by crushing the crystal growth process.

1.4. Size of the degree of sub cooling

By vibrating the liquid alloy increases the coefficient of convective heat exchange, resulting in size criterion value and thus increase the heat transfer. Fragmentation of crystals on the surface of the solidification front is an effect of vibration.

At the same time the transfer of heat from the crust solidified alloy intensifies.

Thermal analysis shows that under these conditions during the solidification conditions increase and improve the appearance and development of solid phase.

1.5. Changing conditions of equilibrium solid – liquid

Changing conditions of equilibrium solid - liquid crystal affect the appearance. So, for each pressure there is a temperature of solidification, the solidification started or well established. Variation of temperature with pressure is given by the Clausius - Clapeyron:

$$\frac{dT}{dp} = \frac{Ts(V_L - V_S)}{\Delta Hs}$$

where:

VL - VS - is the difference in volume contraction due to the passage of fluid in the solid alloy. If VL - VS> 0 (the case of steel and ferrous alloys) where dT / dp> 0, increasing pressure increases the temperature of solidification and conditions appear favorable for germination crystals.

Vibrations affect the surface tension Inter phase messengers - liquid downwards, leading to a decrease in minimum radius of the nuclei on which they remelt but is no longer a development process.

2.1 Technology Effects

2.1.1 Homogenization and finishing structure

Due to vibration, nascent dendrites break and fragments are made by natural convection currents or vibrations in the body of alloy. It creates favorable conditions for the emergence of many small crystals and preventing columnar macrostructure development of the area. Increasing the cooling rate as a result of vibration, leading to pronounced finishing solidification structures.

2.1.2 Size capacities cast materials

Get a compact cast material is provided if the rate of penetration of the alloy in the area of capillary channels is equal to the speed biphasic contraction. Following experimental research found that applying vibration during casting results in considerable increase capacities material to fill the cast and rigorous form.

2.1.3. Degassing alloys

In order to form an alloy in the form of distinct separation, gas pressure must be equal to or greater than the total pressure:

$$P_t = P_{at} + pgH + 2\sigma/r$$

where:

P_t – total pressure;

P_{at} – atmospheric pressure;

pgH – metal-static pressure;

$2\sigma/r$ – pressure caused by surface tension;

r – radius of gas bubble

After training, the rate of gas separation is given by Stokes law. Under the action of vibration has been a decrease in surface tension σ and viscosity along with an increase in the volume of bubbles, creating favorable conditions for their training and lifting gas separations.

2.1.4 The reduction of internal stress.

The most dangerous tensions that can arise from thermal cooling are tensions, both because of their higher values and difficulties of returning to their occurrence.

Mechanical vibrations reduce the temperature differences on sections of walls resulting in lower parts of the developing trend of internal stress.

2.1.5 Reducing segregation.

Macro segregation reduces vibration phenomena by increasing the solidification rate as a result of intensification of heat transfer to form capillary channels and through the two-phase segregation.

Layers are destroyed at the limit between the solid and the liquid which causes a reduction in intensities micro segregation processes.

2.1.6 Increased flow capacity of the alloy.

Due to the decrease of viscosity and surface tension, if applied mechanical vibration on cast alloy, one can observe dynamic effects that cause a significant increase in the fluidity of alloys, although in terms of vibration intensifies heat transfer.

Theoretical analysis of the influence of vibrations on the flow capacity of the alloy can be made taking into consideration of Fig. 3:

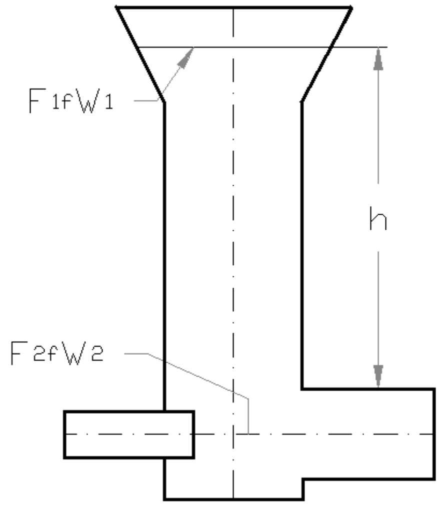

Fig. 3. Alloy flow under the influence of vibrations

From these equations it follows that the vibrations increase the flow velocity and flow of the alloy by decreasing the surface tension

BIBLIOGRAPHY

1. Farshid Taghavi, Hasan Saghafian, Yousef H.K. Kharrazi; *Study on the effect of prolonged mechanical vibration on the grain refinement and density of A356 aluminum alloy*; Materials and Design 30 (2009) 1604–1611
2. Buzdugan, Gh., Mihailescu, E., Rades, M.; *Masurarea vibratiilor*; Editura Academiei R.S.R 1979
3. Chongsheng Li , Liangsheng Qu, *Applications of chaotic oscillator in machinery fault diagnosis*, Mechanical Systems and Signal Processing 21 (2007) 257–269

ACKNOWLEDGEMENT: This paper is supported by the Sectoral Operational Programme Human Resources Development

(SOP HRD), ID76945 financed from the European Social Fund and by the Romanian Government

Fund and by the Romanian Government under the contract number POSDRU/6/1.5/S/6

ACKNOWLEDGEMENT

This paper is supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social