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HIGH TECHNOLOGY PROCESSES BASED ON AEROACOUSTIC EFFECTS

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Abstract

At present there is an increasing interest to using acoustic fields in technologies of different industries (Metallurgy, Chemical, Food-processing, Oil-producing, etc.). Unlike the ultrasound, which has been applied for a long time, using the sonic-range acoustics fields began quite recently. It was connected with: a) obtaining the results of the researches on the influence of sound-range acoustics fields on different substances, technological processes and b) development of relatively simple and efficient gas-jet sonic generator (GSG).

INTRODUCTION

Results of investigation of some high technologies using powerful acoustic fields of the sound range of frequencies generated by GSG are presented.

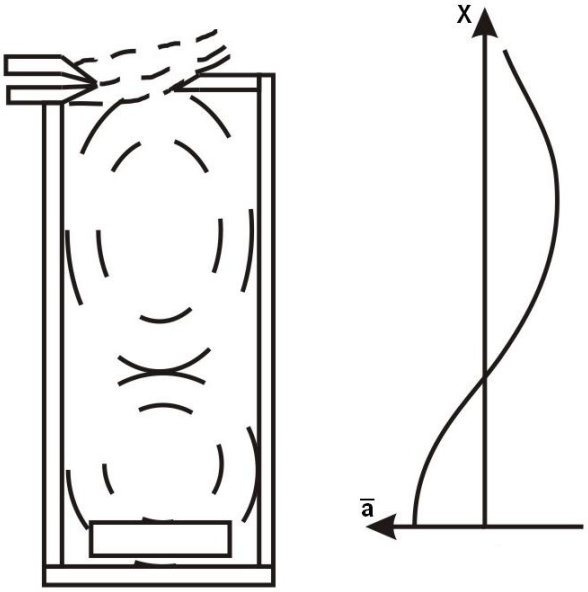
For a number of years the authors of this work have been researching GSG and creating new science-intensive technologies on its basis.

AERO-THERMO-ACOUSTIC PROCESSING (ATAP) OF METALS, ALLOYS AND WARES MADE OUT OF THEM

Many scientists from different countries are involved in research concerning technologies of metals and alloys improvement. For such research they use the latest achievements in different fields of scientific knowledge (heat exchange, gas dynamics, acoustics, firm body physics, thermodynamics etc.). During the creation of new science-based technologies special attention is paid to complex means of processing (temperature and force fields, cryogenic, laser and polycyclic processing etc.).

The actual report presents the results of research on aero-thermo-acoustic processing of metals, alloys and wares made out of them.

The ATAP technological process includes: heating of parts that are being processed to certain temperatures and further cooling in the GSG's (gas-jet sonic generator) resonator while influenced by powerful acoustic field (which has discrete frequency rates and sound pressure level of about 150-170 dB) and gas flow (see pic.1). There are several patents regarding this technology.



Working body – air, nitrogen, argon; T=var; $\bar{a}$ - amplitude

Figure 1 – Scheme of technology equipment (GSG)

The control of aero-thermo-acoustic processing parameters (temperature, cooling speed, gas flow speed, amplitude and frequency characteristics) is fulfilled through varying the geometrical characteristics of technological plants, parameters of working gas and time of processing.

The research and practical experiments were conducted on standard samples, parts and tools made of carbonaceous, alloyed, structural and tool steel, from hard alloys, nonferrous metals and cast iron. Several static and dynamic tests took place in which samples which have passed standard thermal processing and those after the ATAP were compared.

After the tests considerable improvement of all strength characteristics has been achieved. Hardenability, plastic characteristics and resistance (tenacity) were improved too. Cold-shortness threshold has been decreased. The results of tool tests after the ATAP showed moderate augmentation of wear-resistance (from 2 to 6 times). For in-depth study of changes in the structure of metal optical and electrical photography methods were used. These observations showed substantial decomposition of grain structure (about 2 times smaller grain) and carbide

components lessening. This leads to tenacity improvement (due to increased number of fibers in fracture).

ATAP affects the formation of austenite and martensite structures. Lessening of these components' crystals provides favorable changes of properties.

All ATAP tests were conducted without the use of cooling liquids (oils, polymers etc.) which very often can be dangerous for ecology and hard to utilize.

Thus a new method of purposeful control over structural and mechanical properties of metals and alloys was suggested and tested. Some versions of low cost and ecologically clean technological plants and processes were suggested too.

AERO-ACOUSTIC PROCESSES OF PSEUDO-LIQUATION AND PNEUMATIC TRANSPORTATION

The active influence of acoustic waves on matter, leading to irreversible processes, or acoustic influence on physical processes, which affects their parameters, is determined by nonlinear effects in sonic field. Such influence of acoustic fields is widely used in industrial technologies (depending on purposes the mechanism of acoustic effects differs).

In gases the main working factor are acoustic flows which cause intense agitation of the gas medium and accelerate processes of heat-mass exchange by several times. It's necessary to mention that the action of acoustic flows is much more effective than of common hydrodynamic flows. The acceleration of heat-mass exchange processes can be used in pseudo-liquation, sonic drying and in some chemical processes in technology which take place in gas mediums.

Authors of the actual report conducted experimental research of pseudo-liquation processes in freely-flowing materials to determine the effectiveness of acoustic fields in the reactor's technological zone. Acoustic fields were generated by the GSG (which is at the same time the gas-feeding device).

During the common gas feeding through nozzles or grating (the gas-dynamic way) several problems may occur which determine the effectiveness of the whole process. In most cases it is the realization of ineffective conditions (drop, bubble, piston) when major part of gas doesn't interact with matter.

If we bring the acoustic fields in the process we can manage with the problem of ineffective conditions. Generation of acoustic fields with GSG provides the creation of stationary waves in the reactor with freely-flowing material which in complex with gas flow creates the "boiling" layer (pseudo-liquation).

The research showed high effectiveness of the method.

Pic.2 represents dependencies between the gas-feeding pressure and the layer of freely-flowing material for gas-dynamic and aero-acoustic ways. The use of GSG allows to lower the pressure by 1,5-1,9 times.

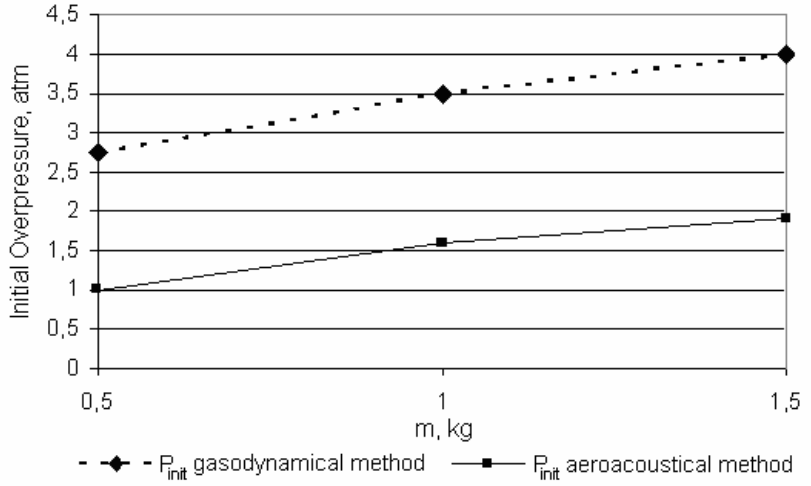


Figure 2 – Dependencies between the gas-feeding pressure and the layer of freely-flowing material for gas-dynamic and aero-acoustic ways

Pic.3 shows dependencies between the thickness of pseudo-liquefied layer and gas-feeding pressure for m=const (for gas-dynamic and aero-acoustic processes).

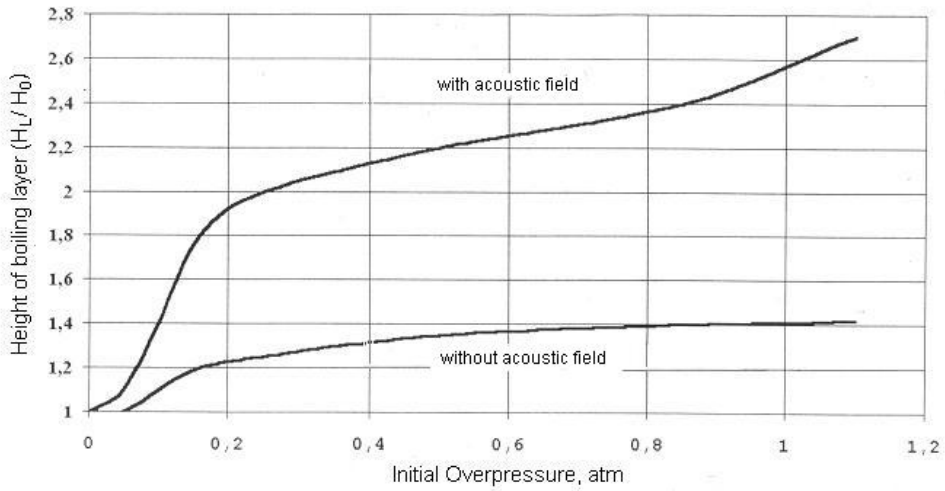


Figure 2 – Dependencies between the thickness of pseudo-liquefied layer and gas-feeding pressure for m=const (for gas-dynamic and aero-acoustic processes)

The analysis of amplitude-frequency characteristics of acoustic fields allows to summarize some observations. With given geometrical properties of GSG and reactor, mass and parameters of freely-flowing materials, the range of working frequencies is 600-2500Hz, sound pressure levels are 95-125dB. Varying geometrical properties of the GSG can provide optimal processes of pseudo-liquation (the achievement of needed gain-frequency characteristics with minimal gas expenses).

The results of the tests show that that the new acoustic technology of pseudo-

liquation and pneumatic transport is economical, doesn't need additional energy resources and serious constructional changes of the existing plants. It provides effective interaction between freely-flowing materials and gases.