INTENSIFICATION OF TECHNOLOGICAL PROCESSES WITH ELECTROMAGNETIC IMPULSES

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Abstract: Forming of guided electromagnetic impulses by the generators with or not of condensers allows design they efficiency in the field of intensification various technological processes in metallurgical engineering, for transport dry materials, metal working and mechanical engineering.

Control of amplitude and time of force impulse may be realized by voltage and condenser parameters as well as by variation parameters of inductor and concentrator of electromagnetic field.

Use of new technology is given: for magnetic-impulse powders pressing, acceleration of material flow out processes from bunkers, disarrangement and transport powders. Schemes of realizing any processes and obtain properties are given.

Key words: electromagnetic field, dry material, processes intensification.

1. INTRODUCTION

Methods of processes intensification for production and transport dry materials have very importance in the various industry branches. The main area of they using is discharge and dosing materials, compacting of powders, obtain mixture and they sorting. Exist various methods of technological processes intensification, for example, use of vibration, mechanical loosen, mechanical shaking [1]. Similarly utilization of ultrasound vibrations, electrical discharge and electromagnetic fields is known [2]. In this report methods of technological processes intensification for production and transport dry materials by use of electro impulse generators are observed. Interest to these methods is determined by generation of last year's very high efficiency and compact electro impulse generators [3, 4].

2. GENERATION OF ELECTRO IMPULSE FORCE ACTION

Electro impulse force action is generated by electro impulse generator condenser model. Change voltage of generator's charge may be controlled amplitude and time of current inside inductor and respectively may be obtained various step of force impulse action of electro magnetic field interaction (Fig. 1.).

![Fig. 1. Parameters of impulse current charge i(t), pressure p(t), velocity v(t) and displacement v(t) at frequency of discharge 10 kHz (a) and 100 kHz (b).](image)

The main equations of calculation are [6]:

\[ i = I_m e^{-2\alpha t} \sin \omega t \]  
\[ p = \frac{H_0}{2} H^2(t) \]

where \( I_m \) – maximal value of discharge current;
\( \alpha \) – coefficient of damping; 
\( \omega \) – angular frequency; 
\( H \) – voltage of magnetic field inside inductor; 
\( p \) – pressure of electric magnetic field; 
\( \mu_0 \) – magnetic constant.

Efficiency of impulse action much depends of electro conductivity of preparation materials in which acted electro magnetic field, as well ass of it strength and plasticity properties.

3. INTENSIFICATION OF POWDERS COMPACTING PROCESSES

Pressing powders materials inside matrix often do not reach high density of materials which depends of plastic deformation of powder \([2]\). To get density more about 80 \% or for pressing small dispersion powders needs very high pressing force. This force decrease may be realized by additional impulse force loading. One of the respectively method in this direction is combined compacting in which in time of pressing by hydraulic or mechanical press the additional impulse forces to powder material is added from impulse electro magnetic field \([7]\). The scheme of equipment is shown in Fig. 2. In one cycle of punch strike 3-4 impulses are added.

![Fig. 2. Scheme of combined pressing by use of electromagnetic impulse generator](image)

The method allows arise density above 5-10 \%, implement pressing small layers with difficult materials as well as obtain multilayer product (Fig. 3).

![Fig. 3. Multilayer product made of sand – cement mixture covered by Si, obtained with impulse electromagnetic field (200 x 150 x 20 mm) \([7]\).](image)

4. SINTERING OF POWDERS WITH APPLIED FORCE IMPULSES

The method of sintering, connected with impulse packing is interesting for cover surface with powders composite materials, for example, blend of ferrous powders and ftoroplast materials.

Powder mixture first regular distributes along detail surface and then put into ceramic form between two electrodes (Fig. 4).

In the processes of accumulate energy discharge simultaneously take place powders packing and sintering.

As parameter of main technology efficiency is assume value of current density \( (i_e) \), flow through powder:

\[
i_e = \frac{I_m}{S} n \tau;
\]

where \( I_m \) – maximal value of discharge current; 
\( S \) – area of covered surface; 
\( n \) – number of discharge impulses; 
\( \tau \) – duration of discharge impulse.
Fig. 4. Scheme of impulse loading combined sintering.
1 – capacity accumulator; 2 – matrix; 3 – electro conductive plate; 4 – inductor; 5, 6 – punches; 7 – powder.

How investigation shows the high quality of cover may be obtained in a case when initial density of porous layer is more 60%. If density is less this level the irregular coating take place by not uniform distribution of impulse current inside volume of material. Obtained data of material properties is given in table 1.

Table 1. Exchange of relative density $\Theta$ and strength of adherence $\sigma_s$ for ferrous powder ASC 100.29 under iron pallet with electro sintering by additional impulse loading.

<table>
<thead>
<tr>
<th>Parameters of process</th>
<th>Property of powders</th>
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<tbody>
<tr>
<td>$i_e$, kA</td>
<td>$p_{max}$, MPa</td>
</tr>
<tr>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>300</td>
<td>120</td>
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<tr>
<td>450</td>
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<td>450</td>
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5. INTENSIFICATION OF TRANSPORT PROCESSES BY DRY MATERIALS

In Riga Technical University made impulse method for transport ferromagnetic powders [3]. For this reason were created some series compact impulse current generators with capacity from 0.5 kJ to 2 kJ. On the base of this generator experimental device allows transporting ferromagnetic powder (powder of ferrous AHC) straight vertically with mass 1 kg in the one impulse cycle at the height more 2 m.

Very important are devices of use magnetic – impulse driver with common vibration and shock action mode. Experimental device was made on the base of generator Impulse – BM 6 (Fig. 5.). In this system plane inductor is mounted on the plate of device. Electromagnetic action has frequency from 50 to 220 cycles/min.

Device allows realize ferromagnetic powders transporting and they dosing. Plane inductor may be mounted on the wall of bunker (Fig. 6). Then impulse action increase dry material flow velocity through bunkers outlet hole (Fig. 7).
CONCLUSION

1. Use of electromagnetic impulses open long-range possibilities for intensification of different technological processes.
2. By the exchange parameters of electromagnetic impulse generator may be controlled amplitude and time of impulse action as well form of impulse and it frequency.
3. Investigations of impulse generators allow design new combined presses.

REFERENCES