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THE COMPACTIBILITY OF FREE FLOW MATERIALS UNDER VIBRATIONS

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S y n o p s i s. The compactibility of free flow materials was investigated in this paper. The research had been realized with the use of electrodynamic vibrator. As the result of the executed research, it had been concluded, that the compaction process is dependent apparently on the parameters of the vibrations causing that compacting.

INTRODUCTION

The problem of the compaction of free flow materials of plant origin has so far been discussed by a few authors, though that process is of great practical importance in storing and transporting of these materials. That process is influenced by many factors, on which the maximal degree of compacting is dependent. The rate of compactibility of materials is determined by means of density, with no knowledge of which it would be impossible to state the storing capacity and to calculate the efficiency of transporting and processing machines.

The objective of the study is the examination of the course of free flow materials compactibility process caused by vibrations and the dependence of density on the various frequencies, amplitudes and time of compacting. The research was realized with the use of an electrodynamic vibrator. The material was compacted in a cylindrical aluminium container.

MATERIALS AND METHODS

Five kinds of loose materials have been chosen for the research: field-pea, buckwheat, wheat - Alfa variety, spring vetch and lucerne. The choice of those materials was determined by the differences of the size and shape of particles. The moisture content of the examined materials was 12.7%. The bulk density of materials before compacting was as follows:

- field pea ρ = 828.5 km/m^3
- buckwheat ρ = 633.2 kg/m^3
- spring vetch ρ = 859.3 kg/m^3
- "Alfa" - wheat ρ = 783.3 kg/m^3
- lucerne ρ = 787.3 kg/m^3

The research set was composed of the following elements:

- an electrodynamic vibrator - ESE 201 of the electromagnetic coil's resistance for direct current about 2 Ω, maximal amplitude $\pm 0.45 \cdot 10^{-2}$ m and range of frequency 5-2000 Hz;
- a power generator - type PO-21 with power output 10 W;
- a power amplifier with power output 25 W and resistance 4 Ω;
- a laboratory resistor;
- a measuring cylinder of volume 1 dm^3 and height to diamater ratio H/D = 2.5;
- an element fixing the measuring cylinder to the electrodynamic vibrator;
- an aluminium disk of a diamater ϕ = 0.079 m and a thickness x = 0.9 mm;
- a system for amplitude measurement;
- a depth gauge;
- a WS-11 balance - with the range of weighing to 2000 g and the accuracy of reading to 0.5 g;
- a stop-watch.

The measuring cylinder was placed on the special element fixed to the electromagnetic vibrator. The power generator was used to supply the vibrator. The generator's output was amplified by the amplifier with the laboratory resistor connected in series to the power supplying circuit. The range of frequency was controlled with the knob of the power generator. To determine the needed amplitude of the vibrator, a system working on the base of the micrometer screw fixed to the casing of the vibrator was used.

Between the measuring clips of micrometer the indicator of vibrating system of thickness 0.2 mm, fixed to the element fixing the cylinder, was placed.

To make the measurement of the amplitude value precise an electric system with light bulb was used.

The compacting of all materials was carried out, in all cases, with four values of amplitude: $0.1 \cdot 10^{-3}$ m; $0.2 \cdot 10^{-3}$ m; $0.4 \cdot 10^{-3}$ m and $0.5 \cdot 10^{-3}$ m and with frequency of: 20, 40, 50 and 60 Hz. The compacting of the materials in the cylinder was measured in such a way that after: 5, 10, 15, 20, 25, 30, 40, 50, 60, 90, 120, 180 and 240 s the set was disconnected and the values of the displacement of the aluminium disk in the cylinder were measured with a depth gauge.

THE RESULTS

All results of density gained during research were initially processed statistically, determining mean values and standard deviations.

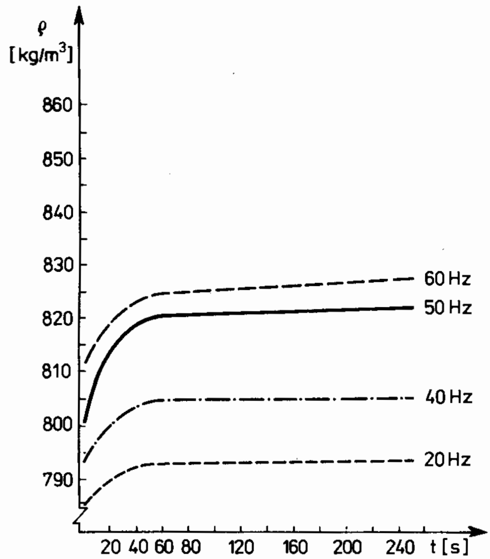

Fig. 1. The dependence of the density on the time with A = $0.1 \cdot 10^{-3}$ m for lucerne

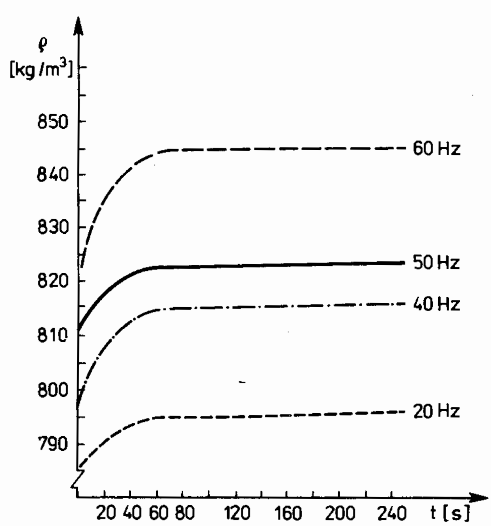

Fig. 2. The dependence of the density on the time with A = $0.2 \cdot 10^{-3}$ m for lucerne

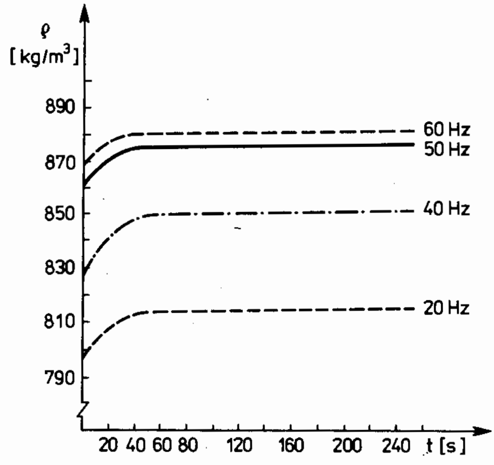

Fig. 3. The dependence of the density on the time with $A = 0.4 \cdot 10^{-3}$ m for lucerne

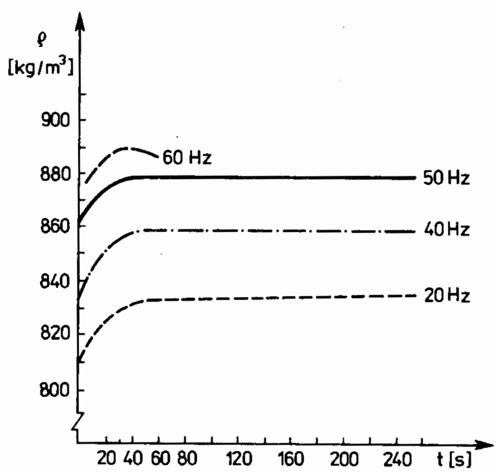

Fig. 4. The dependence of the density on the time with $A = 0.5 \cdot 10^{-3}$ m for lucerne

In the case of field pea with amplitudes $0.1 \cdot 10^{-3}$ m and $0.2 \cdot 10^{-3}$ m the compacting of material began with frequency 50 Hz and 60 Hz and density increased to 880 kg/m^3. The increase of amplitude to $A = 0.4 \cdot 10^{-3}$ m and $A = 0.5 \cdot 10^{-3}$ m stimulated the compacting at the ranges of frequency. Field pea reached the maximal value of density $\rho = 886.2$ kg/m^3 (7% more) at $A = 0.5 \cdot 10^{-3}$ and $f = 60$ Hz.

In the case of buckwheat at $= 0.1 \cdot 10^{-3}$ m and $f = 20$ Hz the compacting was not observed. In the other cases the material was compacted and reached the maximal value of density = 699 kg/m^3 (10.4% more) with $A = 0.5 \cdot 10^{-3}$ m and $f = 60$ Hz (similarly to field pea).

The examined spring vetch was compacted at $A = 0.1 \cdot 10^{-3}$ m and $0.2 \cdot 10^{-3}$ m and f = 20 Hz.

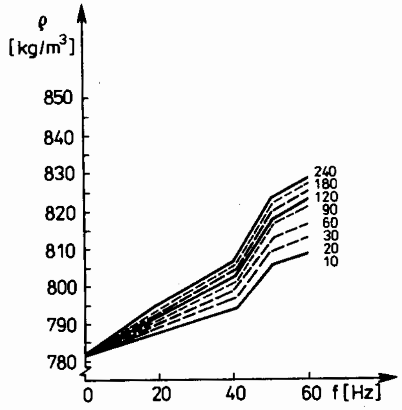

Fig. 5. The dependence of the density on the frequency with $A = 0.1 \cdot 10^{-3}$ m for lucerne

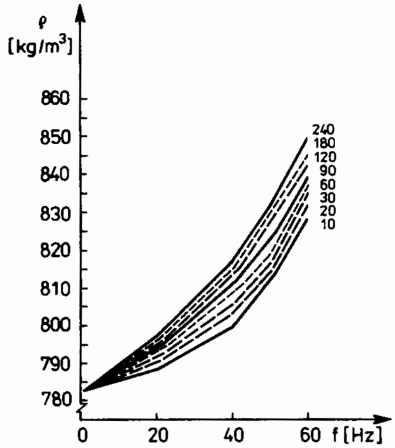

Fig. 6. The dependence of the density on the frequency with $A = 0.2 \cdot 10^{-3}$ m for lucerne

An increase in frequency resulted in the compacting of the material.

At the amplitudes of $A = 0.4 \cdot 10^{-3}$ m and $0.5 \cdot 10^{-3}$ m the compacting appeared at all the ranges of frequency. Vetch reached the maximal value of density $\rho = 922.6$ kg/m^3 (7.4% more) at $A = 0.5 \cdot 10^{-3}$ m and f = 50 Hz, though at $A = 0.5 \times 10^{-3}$ and f = 60 Hz that value was $\rho = 922.2$ kg/m^3.

In the case of wheat of "Alfa" variety, the compacting appeared at all the values of amplitude and frequency.

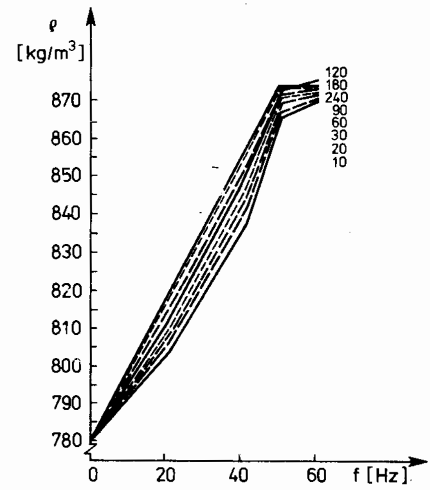

Fig. 7. The dependence of the density on the frequency with $A = 0.4 \cdot 10^{-3}$ m for lucerne

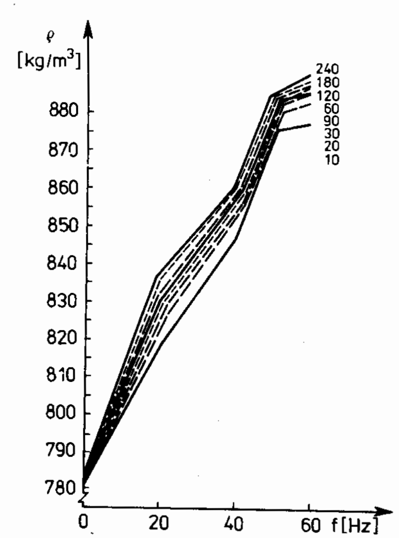

Fig. 8. The dependence of the density on the frequency with $A = 0.5 \cdot 10^{-3}$ m for lucerne

The maximal value of density $\rho = 868.4$ kg/m^3 (10.8% more) was obtained at $A = 0.5 \cdot 10^{-3}$ m and f = 60 Hz.

In the case of lucerne compacting was present in all trials. In Fig. 1-4 the dependence of density on time at constant amplitude has been presented graphical-

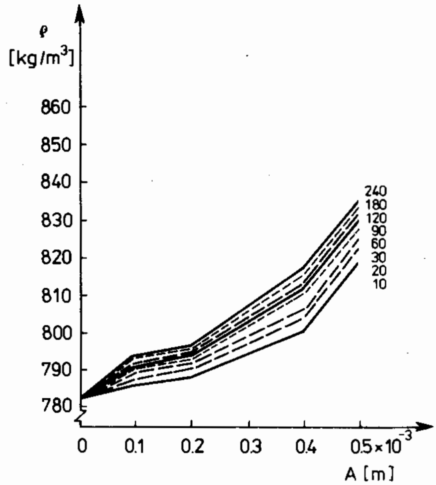

Fig. 9. The dependence of the density on the amplitude with f = 20 Hz for lucerne

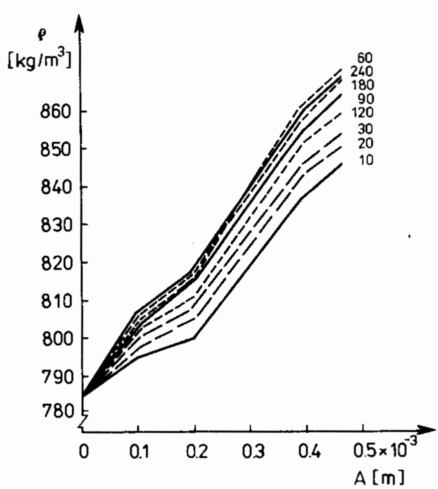

Fig. 10. The dependence of the density on the amplitude with f = 40 Hz for lucerne

ly. In Figs. 5-8 the dependence of density ρ on frequency f at various time of compacting has been shown. In Figs. 9-10 the dependence of density ρ on amplitude A at frequencies f = 20 and 40 Hz is observed.

For lucerne the maximal value of density $\rho = 889.3$ kg/m^3 (12.9% more) was obtained at $A = 0.5 \cdot 10^{-3}$ m and f = 60 Hz.

CONCLUSIONS

The results of the research carried out let us draw the following conclusions:

1. The density of materials is apparently dependent on the parameters of measurements (time of compacting, amplitude and frequency of the measuring cylinder's vibration).

2. For each flow material there are strictly determined parameters of compacting.

3. For all materials density reaches the extremal value in the determined range of frequency.

4. During the compacting of materials the choice of the amplitude of the measuring vessel's vibration is dependent on the frequency. Those parameters should be determined experimentally.

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2. Tzeng R. C., Bilanski W. K.: Settling Corn Using Vibration. Transactions of the ASAE, 1982, 25, 1, 242-255.

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ZAGĘSZCZENIE MATERIAŁÓW SYPKICH POD WPŁYWEM WIBRACJI

S t r e s z c z e n i e

Tematem pracy jest zagęszczenie materiałów sypkich.

Badania były realizowane przy użyciu elektrodynamicznego wibratora. W wyniku badań stwierdzono, że proces zagęszczania zależy od parametrów wibracji wywołujących to zagęszczenie.

Ю. Грохович, Б. Слоска-Гживна

УПЛОТНЕНИЕ СЫПУЧИХ МАТЕРИАЛОВ ПОД ВЛИЯНИЕМ ВИБРАЦИЙ

Р е з ю м е

Темой работы является уплотнение сыпучих материалов. Исследования реализовались с применением электродинамического вибратора. В результате исследований отметили, что процесс уплотнения зависит от параметров вибраций, вызывающих это уплотнение.