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Development testing of the GEPARD-2 vibrating screen prototype operating in the mode of parametric resonance

1. Design and operation of the screen (Fig. 1)

The screen contains a transversely oriented and stretched string mesh. The tensile force is stabilized by end springs with adjustable tension values. The springs connect the longitudinal carrier beams with the frame of the screen. The edges of the mesh sandwiched between the upper and lower parts of the longitudinal beams, tightening by bolts. The load part of the screen is equipped with a hopper. The mesh is excited in its plane by vibrators attached to the longitudinal beams. To allow the screening material move along the mesh the screen is installed obliquely.

The design and operation method of the screen are protected by patent of Ukraine № 87369 of 10.07.2009 (priority of 10.07.2007).

For the screening tests the load hopper is equipped with a shutter with the option to adjust the width of the slit, and by a vibrator to ensure high moisture material smooth expiry.

This screen belongs to the high-frequency resonance of the vibrating mesh class. The special feature of the screen is its operation in the parametric resonance mode.

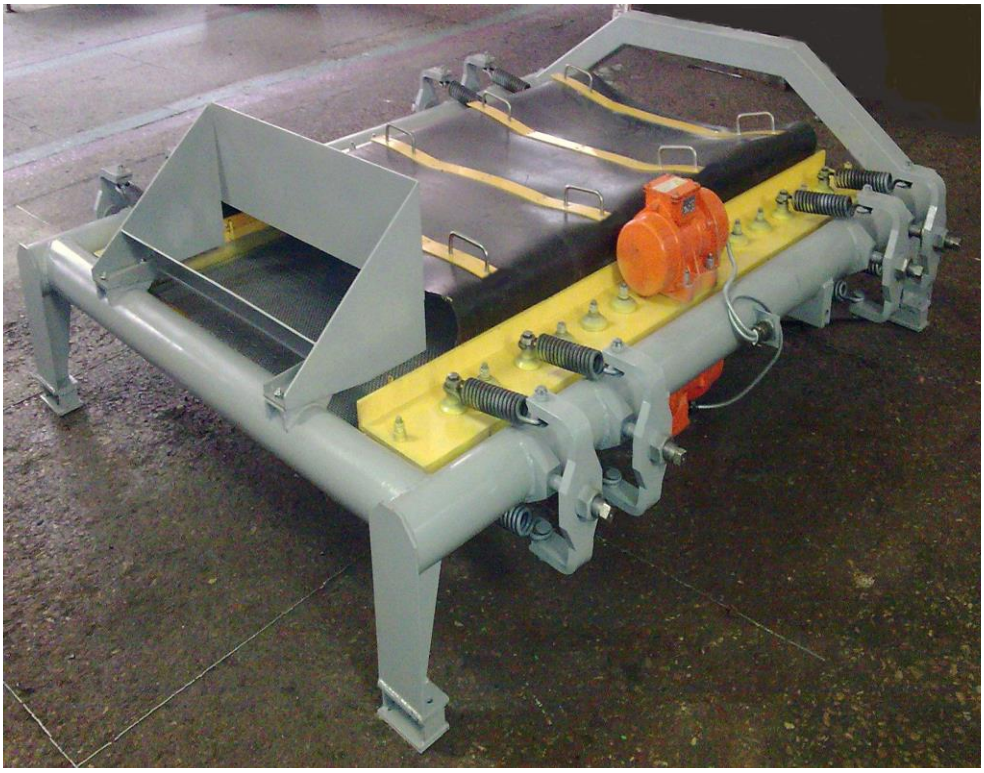

Figure 1. The vibrating screen "GEPARD-2" based on parametric resonance

2. Purpose

The screen is designed for fine separation of minerals and other granular materials of the size up to 20mm with the separating fracture from 0.2 to 5 mm. This includes materials elevated humidity and dust. The screen can be set for operation indoor, under the condition of non-explosive environments, and outdoor areas with ambient temperatures ranging from minus 30 to plus 40C.

3. Technical characteristics

The area of screening 1.5m^2
Number of meshes 1
The oscillation frequency 25 Hz
The mesh oscillation amplitude 20 ± 5 mm
Vibrator type ИВ-05-50, Quantity: 2
Electric power: 1 kW
Supply voltage: 380 V
Screen weight: 500 kg

4. Tests program

4.1 Idle mode. Measuring the oscillation amplitude in the PR mode.

Set the calculated tension of the springs. Put the mesh screening in the oscillations. Then by adjusting the spring tension obtain the desired resonance regime at the standard frequency, 50 Hz. Measure the amplitude of the oscillations by comparing the height of the suspended bead, hauled down to the contact with the vibrating mesh, with its height in the case when the mesh is at rest.

4.2. Loaded screen

4.2.1. Determination of moisture of the material in its natural state.

Prepare a clean, dry container, weigh it and record the weight (A).
Put the material in the container, weigh it and record the weight (B).
Determine the weight of the material by subtracting the weight of the container (G = B-A). Heat material to dry. Weigh the container with the dried material (D).
Determine the moisture of the initial material (%) (e = 100 • (B-D) / G).
Note. Permissible error of measurements and calculations should be not more than 0.5%.

4.2.2. Determination of initial material screening parameters.

Set the screen with a feed hopper at an angle of 30 deg. Install vibrator on the feed hopper. Clean the area under the screen. Fill feed hopper with the material in its natural state. Fill hopper with weighted portions. Record the weight of the material in the hopper.

Turn on the vibrator of the feed hopper using frequency converter at low speed. Vibrator spin should not cause severe vibration of the screen frame, but provide the normal expiry of the material from the hopper. If material is dry usage of this vibrator may be unnecessary.

Turn on the screen (first make sure that locks removed). Put the feed hopper valve latches to the middle position. Prepare a stopwatch, pull up to the stop valve the hopper and simultaneously start the stopwatch. Follow the release of material from the hopper. When output slot of hopper will crop up, stop the stopwatch.

Determine the performance according to the stopwatch and the weight of material passed out of the hopper. Collect the oversize material, dry and weigh it (can be part of it). Run sieving the dried oversize material and determine the amount of material below the sieve size (fine fraction in the oversize material). Record this amount as a percentage of the total volume of oversize material. Similarly treat undersize material, where the relative weight of a larger size product (coarse fraction in the undersize material) must be determined. Repeat the measurements by changing the output (by changing the valve settings) in order to determine the maximum performance at a given quality of separating.

4.2.3. Determination of screening parameters for materials of different moistures

In addition to the above tests with the natural material, carry out the tests with materials of humidity 5, 10 and 15%. Prepare material of moisture indicated above in quantity equal to the feed-hopper volume. Action points for it:
- Dry and weigh the material, then add the water by weight to get the respective moisture;
- Stir the mixture and load it into the hopper.

Perform analysis of the oversize and undersize products as shown above.

4.2.4 The screen slope variations

Perform mentioned above at the screen inclinations of 20 and 40 deg.

5. Test results

The tests were carried out on the string meshes of two types
Mesh 1. The opening size 1.6 mm; wire diameter 1mm, the specific weight of 2.9 kg/m^2
Mesh 2. The opening size 6mm; wire diameter 2mm, the specific weight of 4.3 kg/m^2

5.1 Idle screen

5.1.1 The mesh oscillation amplitude.
Three measurements for each mesh were preformed and the following values of the amplitudes were obtained:
Mesh 1: 22, 23 and 21mm
Mesh 2: 19, 20 and 18mm

5.2 Loaded screen

Test results (rounded to whole numbers) shown in Tables 1 and 2.

Table 1: Mesh 1. The border size 1mm

Type of material	Maximal size mm	Moisture, %	Screen inclinations, deg.	Productivity, Ton per hour	Fine fraction in the oversize material, %	Coarse fraction in the undersize material, %
Dropout of gravel production	5mm	5	30	20	3	2
				25	5	3
				30	8	5
			20	14	3	2
				20	5	4
			40	25	6	2
				35	9	3
		10	30	16	4	2
				18	5	4
				20	7	5
			20	12	4	3
				15	6	4
			40	18	7	3
				20	8	4
				11	4	2
				16	5	3
				18	8	5
				10	3	2
				12	5	4
				13	6	2
				16	9	3

Table 2: Mesh 2. The border size 5mm

Type of material	Maximal size mm	Moisture, %	Screen inclinations, deg.	Productivity, Ton per hour	Fine fraction in the oversize material, %	Coarse fraction in the undersize material, %
Dropout of gravel production	10mm	5	30	30	4	3
				40	5	4
				45	7	5
			20	20	3	2
				30	5	3
			40	35	4	2
				45	6	4
		10	30	25	4	2
				30	5	3
				35	6	4
			20	15	3	2
				20	5	3
			40	30	7	3
				40	8	4
		13	30	20	4	3
				25	5	4
				30	6	4
			20	15	5	5
				18	6	5
			40	25	6	4
				30	8	4

6. Findings

6.1. The PR-based screen operates properly being set according to the calculations based on the mathematical dynamic model. The amplitude of the oscillations also matches the one obtained by the calculations.
6.2. Inclination angle of the screen of about 30-40 deg. is optimal.
6.3. When the fine (coarse) fraction in oversize (undersize) materials limited by 5% bound of each, the dropout of gravel production performance in tones per hour (moisture in % indicated for each case) are as following:
- Sieving by 1mm size: 25 (5); 18 (10); 16 (13)
- Sieving by 5mm size: 40 (5); 30 (10); 25 (13).

6.4 Fatigue strength of the string meshes is insufficient. Development of different design meshes is required, including the split it in two: the screening mesh itself and a vibrating actuator under it.

Acknowledgement
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