

ABOUT THE SIEVING PROCESS OF VIBRATORY SCREEN

Gheorghe I. ENE

POLITEHNICA University of Bucharest, E-mail: ghene01@yahoo.com

Abstract: In this work are presented the conjugated influences on the sieving process of two elements:- the friction between the sift material and screen;- locking mesh of sieve with grains unable to cross the screen. The functional characteristics of the vibrating screen are determined, observing the influence of these factors upon the sieving process.

Key words: sieving process, vibratory screen

1. GENERALITIES

The sieving process needs, to achieved, the movment of the screening materials must be, in comparison with the sieve of screen, or by sliding, or by jump [1, 7, 8, 9].

To run the screen, as well as the sieving process, are influenced, by twoo factors: the friction between the material and the sieve, as well as locking mesh of sieve by fix of grains in that.

The movment of the material in the plan of the screen is determined, between others, by the friction coefficient between the material and the sieve. Generally, the friction between material and screen is defined by the coefficient of friction Coulomb, the sieve being cloth or sieve plate, a rugged surface.

The granular material, depending on the relation between their dimension and screen holes, can pass, or remain on screen, or fix in that, blocking them (difficult grains). The grains blocking the screen holes are an obstacle for sieving capacity, diminishing the real surface of separation and reducing the efficiency of the process. For eliminate the „difficult grains” from the screen holes, are necessary values of the acceleration higher than normal; this determine disorderly movement of the material on the sieve, with unfavourable consequences on the sieving process.

2. THE COEFFICIENT OF FRICTION BETWEEN MATERIAL AND SIEVE

The friction coefficient between material and and sieve depend on constructiv type of the sieve (screen mesh or sieve plate), on the kind of the material used for sift, an don the charactersics of this: granulation, granulometric composition, grains shape(roundness of edges and angles), microgeometry of surfaces of grains (their rugosity and porosity) etc. All these factors influence, with different weight, upon the friction (between material and screen) and also on the internal (between different grains stratum) [2]. The external friction influence the slide of material on the separation surface, and the internal one determine the segregate capacity of grains in stratum, both of them with influence upon the effincy of the sieving process and the energy consumption. Consequently, it is necessary to know, with precision, the friction coefficients, if it is possible,

by experimental determination. For the majority of the granular materials, the friction on sieve coefficient is $\mu = 0,4 \dots 0,6$ [3, 6].

In the images 1 and 2, are presented the variations of the friction coefficient on sieve cloth depending on the diameter of screen wire, consequently on its rugosity, determinate experimental for sand (fig. 1) and brick ground (fig. 2) [4].

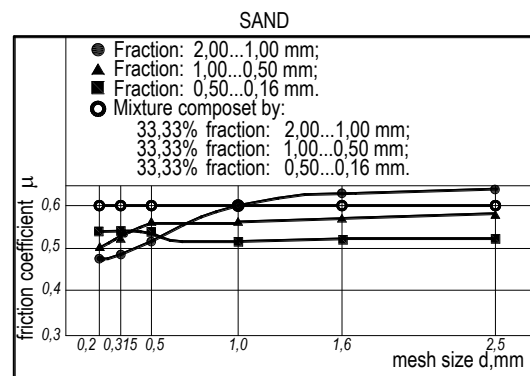


Fig. 1. Variation curves of the friction coefficient depending on sieve mesh dimension, for quartz sand

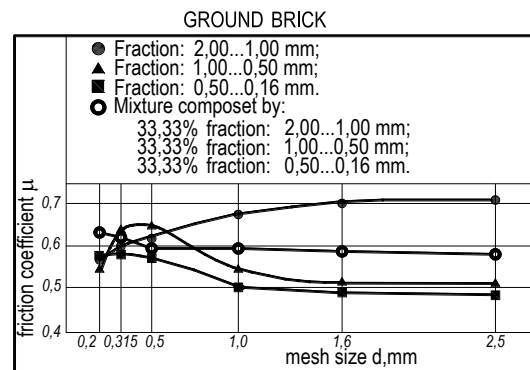


Fig. 2. Variation curves of the friction coefficient depending on sieve mesh dimension, for ground brick

The experiments were realised on laboratory stands screens, with different dimensions of the holes (0,2...2,5 mm) situated on a plane surfaces. Grain-size fractions 0,50...0,16; 1,00...0,50; 2,00...1,00 mm and a granular

mixture compound by all these fraction in 33,33% proportion (mass percentage) were tested.

From the graphics analyse of figures 1 and 2, we can deduce the next observation: From the fraction 0,50...0,16 mm, the friction coefficient has higher values for sieves with holes dimensions 0,200...0,315 and 0,500 mm, meaning comparable with the inferior limit of the fractions dimensions domain, because the grains put into screen holes.

When screen holes dimensions pass the superior limit of the domain of fraction dimensions, the grains penetrate in screen holes, the friction passing now between material layers, and the friction coefficient determined is the internal one.

For fraction 1,00...0,50 mm and 2,00...1,00 mm, the values of the coefficient of external friction also increase, in proportion with dimensions of the screen holes (its „rugosity”) until the dimensions of the screen holes become equal to the superior limit of the internal between dimensions of the fraction, after which the friction coefficient determined is that of internal friction. The grain mixture formed in equal parts from the three fractions (0,50...0,16; 1,00...0,50; 2,00...1,00 mm) has a constant friction coefficient, with equal value with internal friction. The fact is explicable by segregation of fine particles, by self acting during formation of material layer on the screen, passing through screen holes. In this way, the superior layers of grains do not rub direct on screen, but on layer of grains moved in its holes (the friction coefficient being the internal one).

3. THE CLEARING OF SCREEN HOLES

In general, the screen is considered as a continuous rugged surface, without consider the presence of holes and, consequently, the fixed grains in screen. In reality, the „difficult grains”, with dimension near of that of screen holes, remain fixed, blocking them and reducing the active surface area of screen, with known unfavorable consequences.

We consider a spherical grain with d_p diameter wich block the circular hole with diameter d , of the horizontal screen moving in its plane (fig. 3) [6].

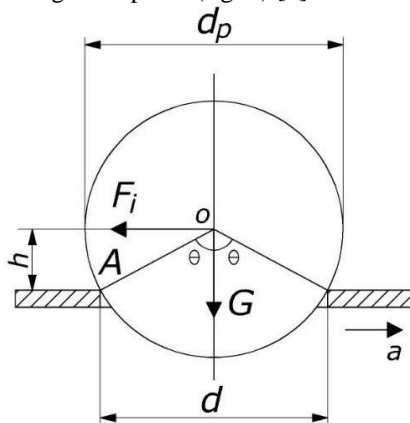


Fig. 3. Shutting of the screen hole by grain.

To remove the grain from the screen hole, it is necessary for that to have the acceleration a , conduct to appearance, upon the grain, of the inertia force:

$$F_i = m \cdot a = \frac{G}{g} \cdot a \quad (1)$$

where G is the weight force of grain mass m , and g – acceleration of gravitation.

For the grain leave the hole, it is necessary that the moment of inertia force, in comparison with green edge (point A), to pass beyond the moment of weight force in comparisson with the same point (fig. 3), that is:

$$\frac{G}{g} \cdot a \cdot h \geq G \cdot \frac{d}{2} \quad (2)$$

where the arm of inertia force has the expression:

$$h = \frac{d}{2} \cdot ctg\theta \quad (3)$$

From relationships (2) and (3) results:

$$a \geq g \cdot tg\theta = g \cdot k_b \quad (4)$$

where $k_b = tg\theta$ (4')

is the coefficient for blocking screen holes.

Because $a = r \cdot \omega^2$ (r – amplitude of vibratio of screen; ω – proper pulsation of the disturbing force), condition (4) become:

$$K_d = \frac{r \cdot \omega^2}{g} \geq k_b \quad (5)$$

where K_d is the dinamic coefficient of the the screen.

For limit: $K_d = \frac{r \cdot \omega^2}{g} = tg\theta = k_b$ (5')

If not considered the presence of holes (smooth plate, unperforated), the grain put in movment, then the inertia force pass beyond the force of friction between grain and screen, that is when since the acceleration of screen is:

$$a > g \cdot \mu \quad (6)$$

where μ is the coefficient of friction between the material and screen.

Consequently, the holes of the screen have no influence upon the movement of grains, if:

$$a = g \cdot tg\theta \leq \mu \cdot g \quad (7)$$

From the (7) condition, result: $tg\theta \leq \mu = tg\varphi$ (8)

or $\theta \leq \varphi$ (9)

where $\varphi = arctg \mu$ is the angle of friction Coulomb between material and screen, considered smooth (without holes).

For example, for $\mu = 0,4$ ($\varphi = arctg 0,4 \approx 22^\circ$), the grains will not block the screen holes if : $\theta \leq 22^\circ$.

From the figure 3 result:

$$\frac{d_p}{d} = \frac{1}{\sin\theta} = \frac{\sqrt{1+tg^2\theta}}{tg\theta} \quad (10)$$

nd condition that grains do not block the screen holes,

$$\text{become: } \frac{d_p}{d} = \frac{\sqrt{1+tg^2\theta}}{tg\theta} \geq \frac{\sqrt{1+tg^2\varphi}}{tg\varphi} = \frac{\sqrt{1+\mu^2}}{\mu} \quad (11)$$

For example, for $\mu=0,4$ the grains will not block the screen holes if:

$$\frac{d_p}{d} \geq \frac{\sqrt{1+\mu^2}}{\mu} = \frac{\sqrt{1+0,4^2}}{0,4} = 2,7$$

meaning if: $d_p \geq 2,7 \cdot d$

Using the relationship (5') and (11), the numerical dependences from the table 1 and graphic dependences from the figures 4 and 5 between the angle θ , block coefficient k_b and the report of grain dimensions and of hole d_p/d .

Table 1. Dependence between dimensions θ , k_b and d_p/d .

θ^0	10	20	30	40	50	60	70	80
$K_d = r \cdot \omega^2 / g = \text{tg}\theta = k_b$	5,80	2,90	2,00	1,50	1,30	1,15	1,06	1,02
d_p/d	0,059	0,346	0,560	0,825	1,172	1,692	2,691	5,555

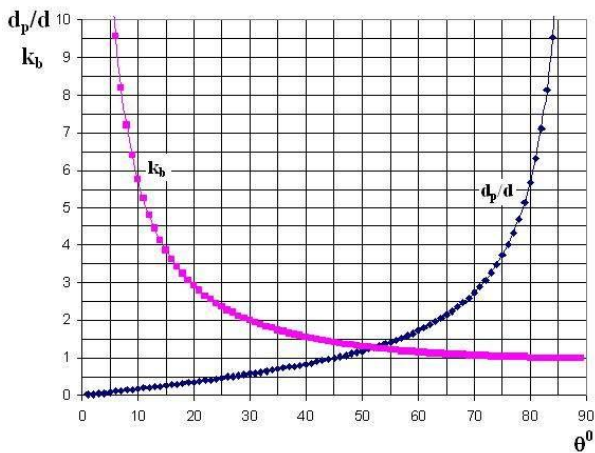


Fig. 4. The graphic representation of dimensions $K_d = r \cdot \omega^2 / g = \text{tg}\theta = k_b$ and d_p/d depending on the angle θ^0 , for horizontal screen.

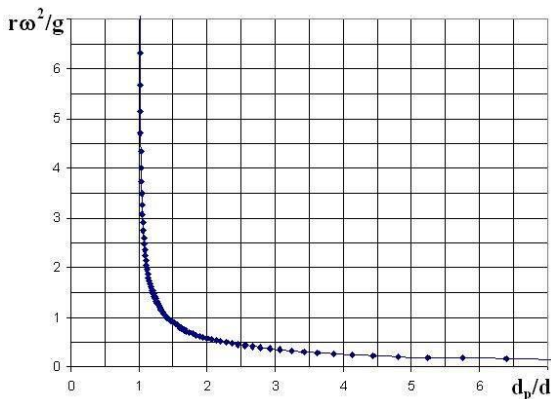


Fig. 5. The graphic representation of dimensions $K_d = r \cdot \omega^2 / g = \text{tg}\theta = k_b$ depending on the ratio d_p/d , for horizontal screen.

The holes blocking tendency is more reduced for screens inclined opposite to horizontal, which vibrate in their plane, for which the blocking coefficient, meaning more than values usual in practice.

4. CONCLUSIONS

The analyze of table 1 and of figures 4 and 5 make us observe that the tendency of blocking screen holes is higher when the grains dimensions are closer of holes dimensions. For example, for the „difficult” grains, with $d_p = 1,02 \cdot d$, the value of the blocking coefficient is $k_b = 5,55$, and the acceleration necessary for screen, to avoid the holes blocking is:

$$a = g \cdot k_b = 54,5 \text{ m/s}^2,$$

determined in a similar way with those for horizontal screen, has the expressio:

$$k_b = \text{tg}(\theta - \beta) \tag{12}$$

The danger of blocking the grains in screen holes is so much the less, as is bigger the inclination angle of the screen in comparison with horizontal plane.

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