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DETERMINATION OF THE EFFECTIVE SIEVE BLOCKING COEFFICIENT

Katarzyna LAWINSKA, Piotr WODZINSKI

Department of Process Equipment, Technical University of Lodz, wodzinsk@wipos.p.lodz.pl

Abstract. This paper presents the results of considerations concerning the ratio of blocking of screen holes and the importance of particular independent variables affecting the process of blocking of sieve holes. The phenomenon of blocking the holes is unfavorable since it reduces the flow area of the lower size fraction through a sieve under scrutiny. The study was conducted, using laboratory sieves. Fine-grained materials: sand (loose sedimentary rock of irregular form) and agalite (spherical mineral) were applied as investigated mineral media.

keywords: screening, sieve, granular material

1. Introduction

The phenomenon of blocking the holes of the sieve is a process resulting from two processes occurring simultaneously at the time of clogging and declogging of sieves (Beeckmans et al., 1985). The fundamental relationship that appears in this case is f = f (t), where f is the coefficient of screen blocking and t denotes time. It is defined as the ratio of the number of free holes to the total number of sieve holes. Furthermore, one can define it as the ratio of surface area occupied by grains clogged in the holes (or slots) of grain and the total area of the screen. It is a dimensionless value (Apling 1984, Wesselbaum 1984). Figure 1 depicts this dependence for a typical course of the initial screening period (Banaszewski 1990). At the moment, when the material is provided to the screen with blocked holes, this state is defined by blocking coefficient f_0. This means that the screen has not performed any pulsating movement and blocked holes are present in the screen. Furthermore, with time t, the value of screen blocking coefficient f tends to the final value of f_∞. The final state can be achieved along curve 1 or 2. Curve 1 demonstrates the case when $f_0 > f_\infty$ while curve 2 when $f_0 < f_\infty$.

Figure 2 shows the course of a typical function f = f (t) marking the points being characteristic for this plot. Attaining f_∞ occurs after t_u regarded as the time of establishing the process equilibrium. This time is usually longer than the duration time of an industrial process t_{pwc}, to the residence time of a statistical grain on a screen sieve. Therefore, there were introduced two blocking coefficients f_1^* and f_2^*. The coefficient of sieve blocking f_1^* is a ratio of the mean coefficient and the duration time of the process t_{pwc}, i.e. residence time for an industrial sieve. The material residence time on an industrial sieve, in general is from several to 60 seconds. For the blocking coefficient f_2^* of a sieve, time of establishment of process equilibrium is equal to 200-600 s. The present study is devoted to determination of effective screen blocking coefficients.

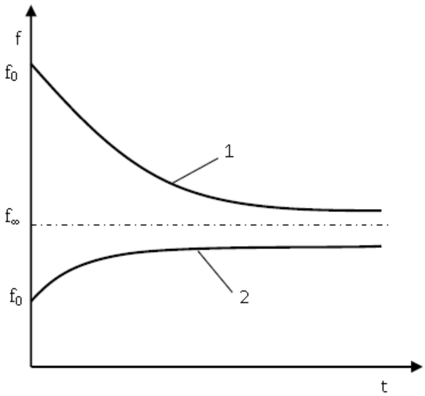

Fig. 1. Generalized plot of function f = f(t)

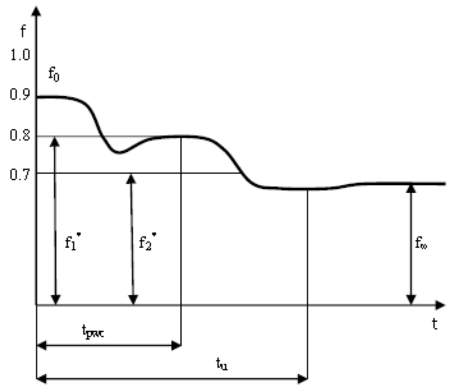

Fig. 2. A typical course of dependence f = f(t) with marked characteristic points

The present study is based on the results of investigations performed on laboratory screens for a regulated toss indicator. As the investigated medium dry sand and agalite of 0.1 – 2.5 mm in size were applied.

2. Process of blocking of screen holes

The course of screen blocking coefficients f as a function of time is defined as:

$$f = f_\infty + \left(f_0 - f_\infty\right)e^{-K_0 t} \tag{1}$$

where K_0 is the blocking constant which is expressed by the formula:

$$K_0 = \frac{1}{t_n}\ln\left|\frac{f_0 - f_\infty}{f_n - f_\infty}\right| . \tag{2}$$

Figure 3 shows f = f(t) for a mixture of sands for various values of toss coefficient K.

The course of the curve depends on f_0 - f_∞. One may notice that for all values of toss coefficient K, coefficient f_0 (f for time t=0) is the same. Therefore, parameter f_∞ has a decisive influence on the course of the f = f (t) function. The lowest values of f_∞ occur when the toss indicator is equal to K_{min}. In this case the blocking is the highest and deblocking is the lowest and K_{max} causes the greatest deblocking of blocked holes ($f_\infty \approx$ 1). Values of the blocking coefficients for different toss coefficients K are shown in Table 1.

Figure 4 shows the dependence of f = f(t) for spherical agalite. The conclusions are the same as in the case of sand.

Table 1. Values of f_0 and f_∞ for various dynamic coefficients

	K_1	K_2	K_{min}	K_{max}
f_∞	0.908	0.907	0.677	0.947
f_0	0.796	0.796	0.796	0.796
K_0	0.177	0.868	0.0164	0.230
$f_0 - f_\infty$	-0.112	-0.111	0.119	-0.151

Basing on the plots, it can be stated that the course of the f = f (t) curve depends first and foremost on the value of the toss coefficient K.

A series of investigations was also carried out for mixtures of different:

- shapes of materials
- compositions of the lower and higher size fraction
- contents of grains that are difficult to screen x_t
- ratios of the mean grain size $\bar{d}$ to the screen hole l.

Considering that the course of function to a considerable extent depends on the toss indicator, we can be certain that the course of the function, to a large extent, depends on the value of the toss indicator and that the value K has an impact on the value of f^* (Fig. 5.).

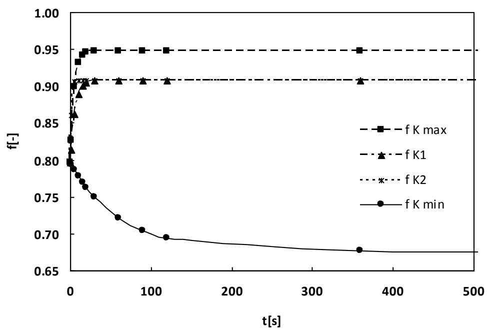

Fig. 3. Dependence f = f (t) for mixture of sands for various values of toss coefficient K

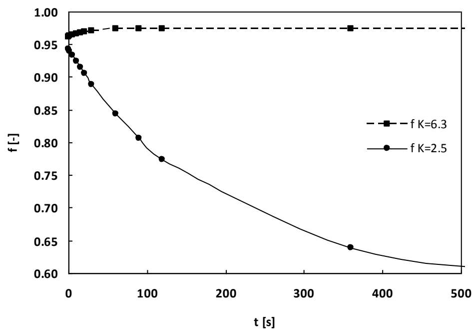

Fig. 4. Dependence f = f (t) for mixture of agalites for various values of toss coefficient K

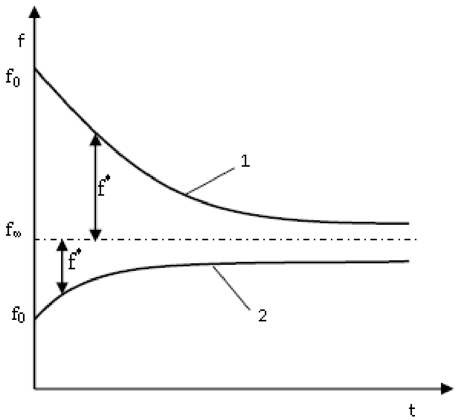

Fig. 5. The courses of dependence f = f(t) with characteristic coefficients

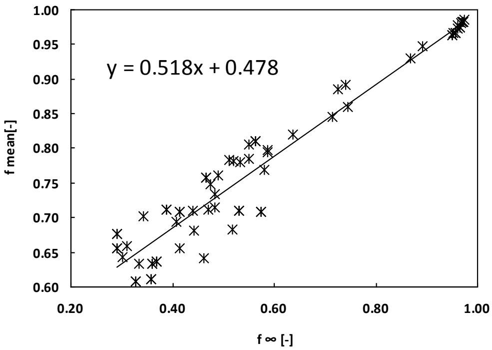

Fig. 6. Result f_{mean}=f (f_∞) for the toss coefficient K<1

To determine the value of the effective coefficient f^* for the investigated material/screen systems the mean value of blocking coefficient of screen holes $f_{śr}$ has to be establish. Basing on the course of the f = f(t) dependence (e.g. Fig. 3) for given periods of time one can calculate f_{mean} as an arithmetic mean of f values using time intervals from t=0 to t=t_u (without f_0 and f_∞values). Therefore, for different values of the toss indicator dependencies f_{mean}=f(f_∞) (Figs. 6, 7, and 8) has to be prepared. By approximation of the data points one can obtain linear dependencies for three intervals of the toss indicator.

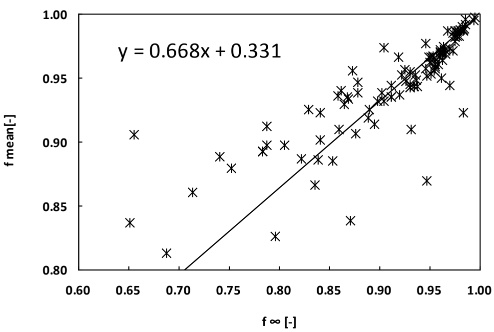

Fig. 7. Result f_{mean}=f (f_∞) for the toss coefficient K<1, 3.5>

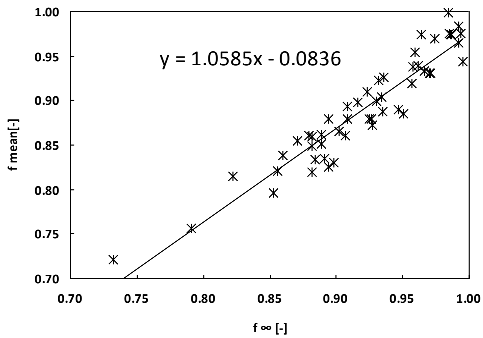

Fig. 8. Result f_{mean}=f (f_∞) for the toss coefficient K>6.2

3. Conclusions

The present study concerns the effective blocking coefficient of f^* as a function f_∞. The results are shown in Table 2.

It was proved that the most relevant parameter influencing the course of the plot of the screen blocking coefficient f is a function of toss coefficient K. Therefore, the coefficient decides about the monotonicity of the function f= f(t) and this influences the value of blocking coefficient f_∞. The example dependencies f = f(t) taking into consideration the values of f^* are shown in Figs. 9-14.

Table 2. f^* = f(f_∞) for different values of toss coefficient K

Value of the toss coefficient K	f^*= f (f_∞)
K <1	$f^* = 0.518\, f_\infty + 0.478$
K <1, 3,5>	$f^* = 0,668\, f_\infty + 0.331$
K >6	$f^* = 1,0585\, f_\infty - 0.0836$

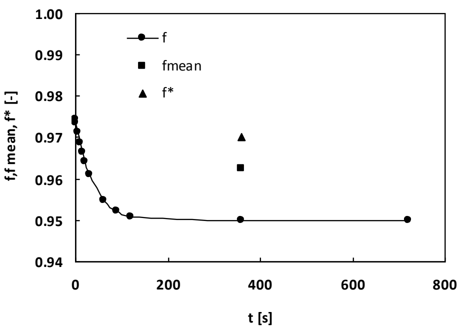

Fig. 9. f = f(t) for agalite, sieve size 0.63 mm, K=0.62, x_t = 20%

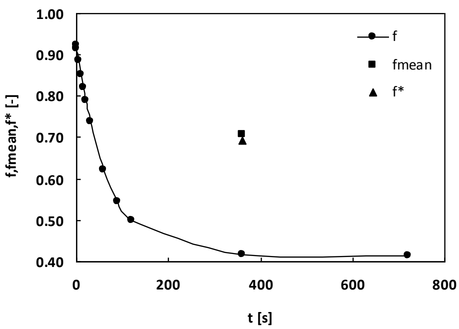

Fig. 10. f = f(t) for agalite, sieve size 1 mm, K=0.62, x_t = 70%

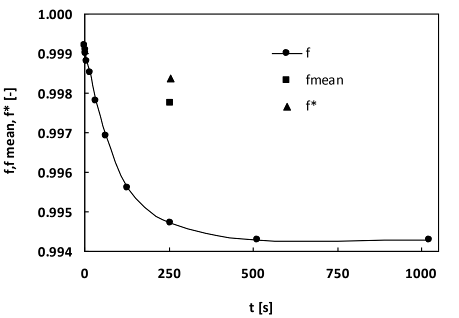

Fig. 11. f = f(t) for sand, sieve size 1 mm, K=1.5, x_t = 0%

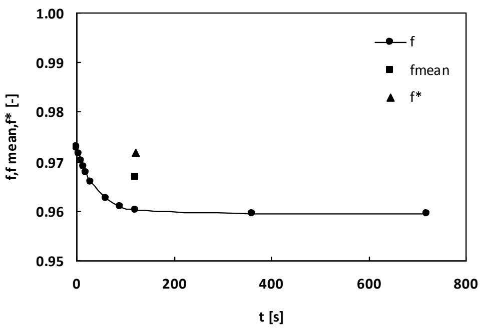

Fig. 12. f = f(t) for agalite, sieve size 0.5 mm, K=3.5, x_t = 40%

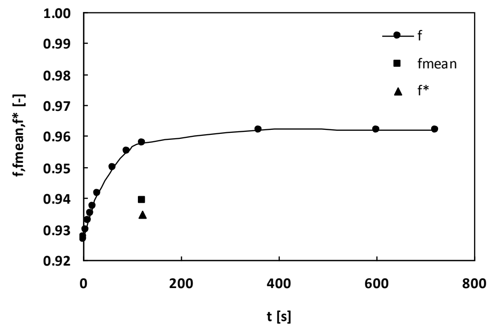

Fig. 13. f = f(t) for agalite, sieve size 1 mm, K=6.3, x_t = 50%

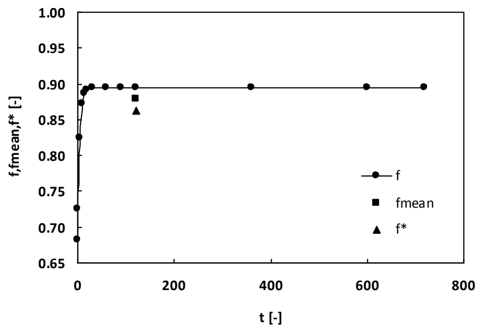

Fig. 14. f = f(t) for sand, sieve size 0.5 mm, K_{max}, x_t = 40%

Acknowledgments

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