RESEARCH ON PHYSICAL CHARACTERISTICS OF HYDRAULIC FILLING MASS

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Abstract

This paper presents the experimental results of the filtration coefficient, samples density and porosity value changes on the basis of concreteferruginous quartzite beneficiation tailings against humidity in the range 1-30%. Specified dependencies are characterized by approximation reliability of 0,87-0,96 and can be used when choosing the ways of directed impact on hydraulic filling mass allowing to change its condition.

Keywords

Hydraulic filling, ferruginous quartzite beneficiation tailings, filtration coefficient, humidity, granulometric parameters, pressure gradient, flocculants, strengthening of mass.

1 Introduction

The hydraulic filling of developed chambers at the Gubkin mine (OJSC KombinatKMAruda) by the ferruginous quartzite beneficiation tailings solves many environmental problems related to its placement on the surface. However, this non-waste technology has the number of significant drawbacks. Since the beneficiation tailings are supplied to the underground chamber without binding material, the use of hydraulic filling doesn't allow mining of the pillars. Besides when mining the chambers placed under stowed excavated space by hydraulic filling, there is a danger of exploration wells intersection by which hydraulic filling pulp starts to flow into underlying chamber that can lead to an emergency.

It is necessary to change the condition of hydraulic filling mass cardinally in order to create environmentally compatible technologies. The choice of ways of directed impact on concrete block allowing to change its condition is caused by its physical characteristics, the most important of which is water penetration.

Water penetration is a capacity of materials to be passed through itself by water at some pressure drop.

Water penetration depends on filtration rate equal to an amount of water flowing through the unit of cross-sectional area of filtering rock and is characterized by filtration coefficient, i.e. filtration rate at the pressure gradient equal one [1].

Consolidation of hydraulic filling mass on the basis of ferruginous quartzite beneficiation tailings of OJSC KombinatKMAruda lasts for up to a year or more [2]. The humidity of concrete block and its physical characteristics are changing as a consequence.

2 The determination of filtration coefficient

The aim of this study was to investigate the influence of humidity of hydraulic filling mass on the basis of concrete ferruginous quartzite beneficiation tailings on its filtration coefficient. The changes of density and porosity were controlled at the same time.

The determination of filtration coefficient was carried in compliance with GOST 25584-90 by means of KF-00M device with KF-1 tube (SPETSGEO tube).

The tests were conducted at the different conditions of hydraulic filling mass samples – from air-seasoned in limit loose condition to humid (up to 30%) in maximum pressed condition.

The amount of added water to the samples to achieve the humidity needed shall be calculated in accordance with the following formula (GOST 22733-2002):

$$Q_{add} = M_g \cdot \frac{W - W_h}{1 + W_h}, \quad (1)$$

where Q_{add} is the mass of added water, g; M_g is the mass of selected sample, g; W is the humidity of the sample expressed as a decimal fraction; W_h = 0,01 is hygroscopic humidity of the sample expressed as a decimal fraction.

Filtration coefficient K_f shall be calculated in accordance with the following formula:

$$K_f = \frac{864 \cdot Q}{F \cdot T \cdot I \cdot t}, \quad (2)$$

where 864 is a conversion coefficient from cm/s to m/day; Q is the volume of filtered water, cm^3; F is cross-sectional area of the tube that is 56,5 cm^3; T is the time of filtration,s; I is the pressure gradient; t is the temperature correction in order to provide the values of water filtration coefficient at the temperature 10°C that shall be defined according to the formula:

$$t = (0{,}7 + 0{,}03 \cdot t_a) \quad (3)$$

where t_a represents actual water temperature during the test, ℃.

The experimental findings are shown in the Table 1.

According to the analysis of table's data, the values of filtration coefficient increase almost 5,5 times due to changing of humidity of hydraulic filling mass from 30% to 1%.

3 The changes of density and porosity

The density of the samples shall be calculated in accordance with the following formula:

$$\rho = \frac{M - M_0}{V}, \quad (4)$$

where ρ is the density of the samples, g/cm^3; M is the mass of filter tube, filled by the sample, g; M_0 is the mass of empty filter tube, g; V is the volume of the filter tube, cm^3

Changing of sample density of hydraulic filling mass against the humidity is good approximated by third degree polynomial function with reliability R^2=0,93:

$$\rho = -0{,}0002W^3 + 0{,}0076W^2 + 0{,}0737W + 1{,}9177$$

Figure 1 shows the dependence diagram.

The porosity of the samples shall be calculated in accordance with the following formula:

$$n = \frac{\rho_s - \rho_d}{\rho_s}, \quad (5)$$

where n is the porosity of the sample,%; ρ_s is the density of sample solids of hydraulic filling mass, that is 2,8 g/cм^3; ρ_d is the density of matrix blend, g/cm^3, that is determined in accordance with the following formula:

$$\rho_d = \frac{\rho}{1+W}, \quad (6)$$

where ρ is the density of the sample, g/cm^3; W is the humidity of the sample expressed as a decimal fraction.

Table1: Experimental findings of filtration coefficients determination

No.	Humidity,%	Volume of filtered water, cm^3	Time of filtration,s	Filtration coefficient, m/day	
				of the sample	average
	W	Q	T	K_f	$K_{f\,av}$
1	1 (loose)	10	9000	0,014	0,012
		5	3300	0,019	
		5	15420	0,004	
		15	16500	0,011	
		40	32400	0,015	
2	1 (pressed)	10	3720	0,034	0,018
		5	2400	0,026	
		10	13020	0,009	
		10	7260	0,017	
		10	8640	0,014	
		15	16500	0,011	
		20	7800	0,033	
		15	16500	0,011	
		5	8100	0,007	
3	5 (pressed)	30	30900	0,012	0,010
		30	31200	0,012	
		25	30900	0,009	
		25	33480	0,009	
4	10 (pressed)	30	30900	0,012	0,012
		30	31200	0,012	
		30	30900	0,012	
		35	33480	0,014	
5	15 (pressed)	15	33840	0,005	0,0057
		12,5	32700	0,0049	
		15	32820	0,0059	
		15	32700	0,0059	
		17,5	33000	0,0086	
6	20 (pressed)	20	33000	0,0078	0,0073
		10	32820	0,0039	
		35	32700	0,0138	
		10	33000	0,0039	
7	25 (pressed)	10	30000	0,0043	0,0045
		12,5	31800	0,005	
		11	31800	0,0044	
8	30 (pressed)	7,5	31500	0,003	0,0022
		2,5	30300	0,001	
		10	31800	0,004	
		2,5	31800	0,001	

Changing of sample porosity of hydraulic fillingmassagainst the humidity is good approximated by third degree polynomial function with reliability R^2=0,96:

$$n = 0{,}0051W^3 - 0{,}2235W^2 + 1{,}9115W + 36{,}222 \quad (7)$$

Figure 2 shows the dependence diagram.

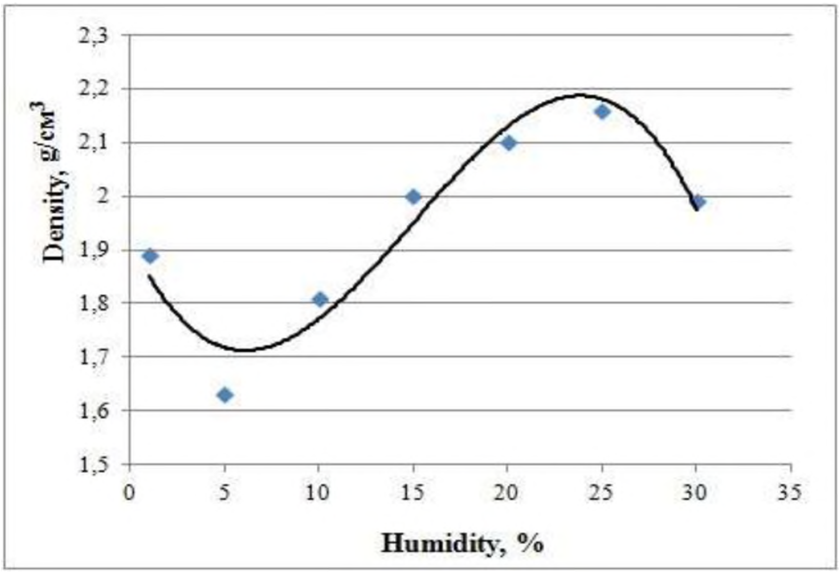

Fig.1: The dependence diagram of samples density of hydraulic filling mass against its humidity

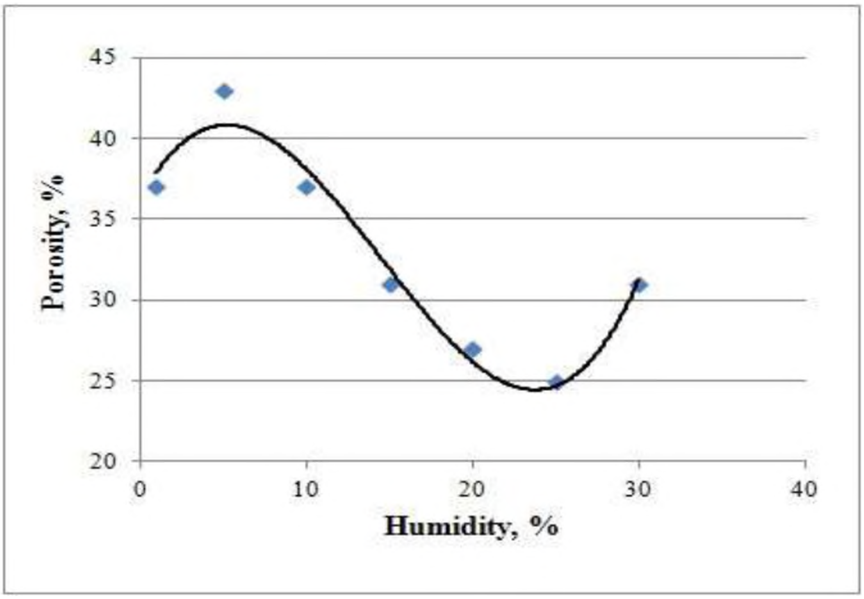

Fig.2: The dependence diagram of samples porosity of hydraulic filling mass against its humidity

4 Conclusions

The obtained dependencies allow to predict the physical properties of hydraulic filling mass and to develop the effective ways of directed impact allowing to change its condition in order to create environmentally compatible technologies of development.

References

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