UDC 621.928.3

V.M. Golubtsov, professor, d.t.s.
O.A. Usova, engineer

TO CALCULATION OF PULP CLOSENESS IN FORCE-FEED HYDROCYCLONES

Zaporozhe state engineering academy, Ukraine

Analytical dependence over is presented at calculation of pulp closeness on input in force-feed hydrocyclone at the conditions of joint work of lines for its downlow and slime bleeds. The results of calculation for pulp closeness on the brought dependence over are given and comparing of them with the experimental facts is executed.

Keywords: force-feed hydrocyclone, lines downlow and slime bleeds, pulp, closeness, calculation

Force-feed hydrocyclones which use for the selection of the self-weighted parts (pulpes) from a light solution use in industry. Together with the decision of questions for quality of cleaning or degree of enriching of products important is a question of determination of the productivity of the noted apparatuses.

Existent empiric formulas [1-8] for calculation determination of the volume productivity for hydrocyclone it is given without the account of influence of pulp closeness on it entrance, and also lines of downlow and slime nozzles. Therefore analytical dependences which are worked out and presented in work [9], allow to define the volume productivity of hydrocyclone taking into account the above-mentioned closeness.

It is therefore necessary to work out dependences which would determine the pulp closeness with their next use during the calculations of the volume productivity and other parameters of force-feed hydrocyclones, why and this article is dedicated.

The pulp closeness in hydrocyclone is determined, going out the generally accepted presentations [10], as attitude of matter mass to it volume, or relation of the mass productivity of hydrocyclone to it volume productivity, id est

$$\rho = \frac{m}{Q}\ , \qquad (1)$$

where m is the mass productivity of pulp, kg/s, $m = G + W$; W, G – are accordingly the mass productivity of liquid and hard phase of pulp, kg/s; Q is the volume productivity of pulp, m^3/s.

The volume productivity of pulp for hydrocyclone is expected at the formula of example by «a» works [7], what is complemented for the use during the calculation of any liquid which forms pulp, and it is presented in a next kind

$$Q = \frac{G}{\rho_h} + \frac{W}{\rho_l} = G \cdot \left(\frac{1}{\rho_h} + \frac{R}{\rho_l} \right)\ , \qquad (2)$$

where a relation G/ρ_h, W/ρ_l are determine the volume productivity of hard and liquid phase of pulp, m^3/s, accordingly.

Coming from a formula (2) pulp closeness, which consists of hard and liquid phase, on the basis of correlation (1) it is possible to define as

$$\rho = \frac{m}{Q} = \frac{G+W}{\frac{G}{\rho_h}+\frac{W}{\rho_l}} = \frac{\rho_l \cdot (1+R) \cdot \rho_h}{\rho_l + \rho_h \cdot R} = \frac{(1+R) \cdot \rho_h}{1+\frac{\rho_h}{\rho_l} \cdot R}\ , \qquad (3)$$

where ρ is pulp closeness, kg/m^3; ρ_l, ρ_h – are accordingly closeness of liquid and hard phase, kg/m^3; R is a degree of dilution of pulp, kg/kg.

It goes out from a formula (3), that the pulp closeness which consists of hard and liquid phase is determined by its closeness and degree of dilution R.

The degree of dilution of pulp in the lines of downlow and slime nozzles in accordance with a formula (4) is determined by content for its hard phase, which, in turn, is determined by catching possibility of hydrocyclone and depends both on constructional and regime it parameters.

If closeness of hard ρ_h and liquid ρ_l phases in pulp are constsnt sizes, then the pulp closeness, according to a formula (3), depends only on the degree of dilution R. Therefore, set by the different values of degree of dilution R on a formula (3) carried out the calculation of pulp closeness which consists of mixture for hydrate of lime with the closeness ρ_h = 2.3 g/sm^3 and tapwater with the closeness (ρ_l = 1.0 g/sm^3.

At R = 0 pulp closeness equals the closeness of hard phase ($\rho = \rho_h$ = 2.3 g/sm3), at $R \Rightarrow \infty$ the pulp closeness equals the closeness of liquid phase, id est ($\rho = \rho_l$ = 1.0 g/sm^3, id est answers physical sense. Dependence, which is got, shows treason to the pulp closeness during treason of degree it dilution.

It is possible to see that in ascenting degrees of dilution the pulp closeness diminishes. During realization of experiments as pulp was used mixture which consists of hydrate lime and tapwater. In the process of implementation of experiments, at constant content of hard phase G = const, changed the degree of dilution for mixture R due to treason of content of liquid phase W by addition of water and, opposite, at constant content for liquid phase W = const, changed the quantity of hard phase G to additions of lime. Thus samples of lime G weighed on electronic balances, and the volumes of water W and pulpes V degreed in the graduated test tube.

On results experiments expected the degree of dilution R, mass of pulp m, and it closeness ρ was calculated on a formula (1). Mass of pulp determined from a condition, that 1.0 ml folds 1.0 sm^3 and for a liquid phase evened 1.0 g.

The values of pulp closeness are got thus are compared with calculation facts. The analysis shows the satisfactory running back of experimental and calculation results, which is within the limits of exactness of experiment, that carryed out. It testifies that a formula (3) can be applied for the calculations of closeness of pulp in force-feed hydrocyclones. It is similarly possible to define that on the size of pulp closeness influences only degree of dilution, while absolute values of hard or liquid phases which are in pulp, on the size of pulp closeness does not influence. So if the degree of dilution which is evened two then pulp closeness from experimental facts, regardless of content in it the quantity of hard or liquid phase are folded by 1.26 g/sm^3 (1.26 tone/m^3). It is set experiments, that on the degree of dilution, that less than one, pulp grows into raw hard mass.

Conclusions. Analytical dependence for the calculations of closeness is offered, that it is possible to apply for determination of the volume and mass productivity of pulp on an entrance to force-feed hydrocyclone, and also in the lines of him downlow and slime nozzles. On the size of pulp closeness at the known closeness of hard and liquid phase, the degree of it dilution influences only, and absolute values of hard or liquid phase, which are in pulp, on the size of her closeness does not influence. Thus the increase of dilution of pulp results to decrease of it closeness. For investigational pulp (limewater) after the degree of dilution less than one, there is its consolidation.

LIST OF LITERATURE

1. Скирдов, И. В. Очистка сточных вод [Текст] / И. В. Скирдов, В. Г. Пономарев. – М. : Обогащение руд, 1960. – 176 с. – Библиогр. : с. 173-175.
2. Шмачков, И. А. К вопросу определения производительности гидроциклона [Текст] / И. А. Шмачков // Научные труды Харьковского горного института. – Харьков : ХГИ, 1962. – Т XII. – С. 157-161.
3. Барский, В. Г. О методе расчета производительности гидроциклона [Текст] / В. Г. Барский // Известия вузов. Цветная металлургия. – 1963. – № 6. – С. 51-63.
4. Клячин, В. Т. Расчет гидроциклонов [Текст] / В. Т. Клячин, В. И. Ревнивцев // Труды института Уралмеханобр. – 1963. – Вып. 10. – С. 51-78.
5. Поваров, А. И. Расчет производительности гидроциклонов [Текст] / А. И. Поваров, А. А. Щербаков // Обогащение руд. – 1965. – № 2. – С. 3-10.
6. Шестов, Р. Н. Гидроциклоны [Текст] / Р. Н. Шестов. – Л. : Машиностроение, 1967. – 79 с. – Библиогр. : с. 77-78.
7. Поваров, А. И. Гидроциклоны на обогатительных фабриках [Текст] / А. И. Поваров. – М. : Недра, 1978. – 231 с. – Библиогр. : с. 197-203.
8. Справочник по обогащению руд. Подготовительные процессы [Текст] : под ред. О. С. Богданова, В. А. Олевского. – 2-е изд., перераб. и доп. – М. : Недра, 1982. – 366 с. – Библиогр. : с. 362-364.
9. Голубцов, В. М. К расчету производительности напорных гидроциклонов [Текст] / В. М. Голубцов // Металургія : наукові праці Запорізької державної інженерної академії. – Запоріжжя : РВВ ЗДІА, 2011. – Вип. 23. – С. 175-179.
10. Павлов, К. Ф. Примеры и задачи по курсу процессов и аппаратов химической технологии [Текст] / К. Ф. Павлов, П. Г. Романков, А. А. Носков. – М. : ; Л. : Химия, 1987. – 576 с. – Библиография в конце каждого раздела.