ISSN : 0974 - 7524 Volume 7 Issue 3

Physical CHEMISTRY
An Indian Journal

Trade Science Inc.

Short Communication

PCAIJ, 7(3), 2012 [107-109]

Effects of non-ionic surfactant adding to sodium aliphatate on the three phase contact angle

Xiaojun Jiang*, Xiaoyun Shu, Hongbo Xu, Jian Wang
College of Chemical Engineering, University of Science and Technology Liaoning, Anshan, (CHINA)
E-mail: anshanjiangxj@163.com
Received: 30th January, 2012 ; Accepted: 21st February, 2012

ABSTRACT

The contact angles of industrial oleic acid, naphthenic acid and its accession at different temperatures adding the nonionic surfactant were investigated by determining of surface tension. It revealed that the industrial naphthenic acid could increase the contact angle of sodium oleate in silica surface and improve the mineral hydrophobicity. The optimized combination of fatty acids and nonionic surfactant enables separation temperature of silica and hematite dropped from 43 ºC to 23 ºC, the energy consumption was saved significantly.

KEYWORDS

Nonionic surfactant;
Fatty acid;
Contact angle;
Flotation.

INTRODUCTION

It is the key factor that the three-phase contact angle with which discussed the floatability of the mineral particles when surfactants as collectors to form association. The critical micelle concentrations (CMC) of some ionic surfactants have been investigated at different temperatures by the Lee-Wheaton equation using electrical conductivities[1]. S.A.Kondratev[2] reported that films bond strength on floated mineral pellet bubble increased by the addition of nonpolar reagent. The hydrophobic surface is more typical of the flotation practice surface. The angle can reach the maximum static wetting angle of more than 90°. His another research showed that identifying the capability to form flotation complex depended not only on the availability of a regent absorbed on a particle surface, but also on promoting the thinning-down of water interlayer between a mineral particles associated with particle and a bubble[3]. It can be rationally explained the function of additive in flotation the carboxyl salt as collector. At the mineral particles surface membranes adsorbed fatty acid salt, the hydrophobicity increase can promote the generation of the products[4]. The thin -layer wicking technique was proposed to measure the contact angle of liquid on powder[5]. B. A. Bezuglyi reported that a high sensitivity of response shape to the static curvature of liquid surface was used to improve the tilting-plate method. The results of measuring contact angles were well consistent with the data obtained by the sessile drop method[6]. With the automatic polynomial fitting algorithm (APF) was used to measure the contact angle, this method need not the parameters of fluid properties[7]. According to Stalder[8], they without assumptions by defining the contour of the drop as a versatile B-spline curve, taking advantage of the reflection of the

Short Communication

drop onto the substrate to detect the position of the contact points to test the contact angle of spherical droplets and non-symmetric droplets. Dingle used the finite element algorithm to deal with the appearance data of liquid droplet to determine the contact angle[9]. When a kind of liquid infiltrate a capillary with radius r, the climbing length L of the column bed and the time t can calculate the contact angle by Washburn equation, $L^2=\gamma rt\cos\theta/2\eta$. In this article the contact angles of different surfactants combination on SiO_2 were investigated under different conditions. By the optimized combination of sodium fatty acid and nonionic surfactants, flotation separation SiO_2 from the hematite in normal temperature gained an excellent result.

EXPERIMENTAL

The main instruments

Surface tension measurements were determined by a type of K100 surface tension instrument of Kruss Comp.. The viscosities of the mixed collector solution were determined by NDJ-7 rotative viscometer. The determination of contact angles were carried out with a self-made measuring instrument.

Reagents and materials

The quality of industrial grade oleic acid has 192.8mg KOH/g of acid value and iodine value 140. The quality of industrial grade naphthenic acid is of 142mg KOH/g of acid value and neutral oil content weight 18%. The surfactants include Tween 80, polyethylene glycol (PEG) 400 and polyoxyethylene - polyoxypropylene ether (2010). They all were of commercial chemicals and were used without further purification. The mineral of hematite was provided by Anshan flotation factory.

Experimental operation

Silica was prepared by depth scavenging from above factory tailing, with alcohol to remove organic matter, with 1:1 hydrochloric acid washed it twice, iron content of the silica was less than 0.1%, can be seen as pure silica, particle size distribution in the 200-325 mesh.

A tube inner diameter of 5.76 mm, to ensure the height of SiO_2 packed bed the SiO_2 filled was always 5.000g, bottom sealed with 0.05g cotton. All the experiments were performed at 22 ± 0.5 ºC and pH was fixed at 7.50. The completed capillary vertically inserted the surfaces of the test solutions, recorded a height L per one minute, by the Washburn equation to calculate the contact angle. The flotation separation operation was carried on in the 0.5L cell, 200g mineral samples grade 47.93% was floated in 22-23 ºC by the inverse flotation process to separate SiO_2 from the hematite.

RESULTS AND DISCUSSION

The calibration of effective radius of the particle bed column

On the SiO_2 column bed, the climbed heights of carbon tetrachloride at different times are shown in Figure 1.

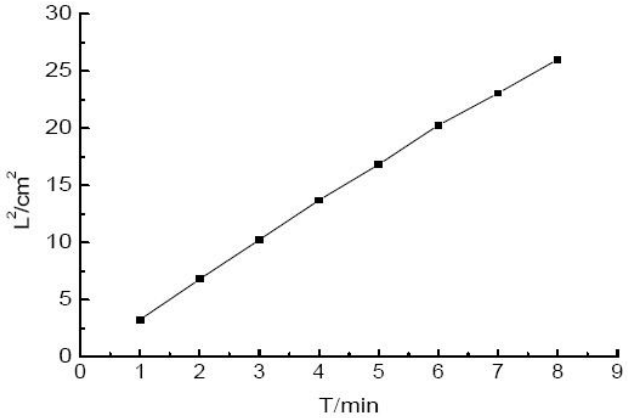

Figure 1 : L^2-t relationship of carbon tetrachloride on silica column (ρ= 0.9935)

The surface tension of carbon tetrachloride is 26.8 $\times 10^{-3}$N / m, viscosity is 0.965mPa.s. The complete wetting of silica by carbon tetrachloride, the cosθ is 1, calibrated column radius: $r = 2\eta \cdot L^2/\gamma t = 2.44 \times 10^{-5}$ m. The calibrated radius, compared with the 5.76×10^{-3} m radius of the glass tube filled with SiO_2 less two orders of magnitude. The calibrated radius expresses the gaps between the particles. In the following measurements of θ, the calibrated radius would be used.

Determination of contact angles

The total concentration of sodium oleate and sodium naphthenate was 1.0%, change the proportion of sodium naphthenate, the viscosity, surface tension and climbed heights at different times were measured. The results are shown in TABLE 1.

TABLE 1 : The contact angles on silica of sodium oleate and sodium naphthenate

Sodium naphthenate g/L	η/mpa.s	γ/ mN/m	ρ	θ
0	2.00	30.0	0.9923	94.03
0.2	2.00	28.2	0.9995	95.15
0.4	1.91	26.81	0.9955	95.52
0.6	2.02	30.11	0.9985	96.43
0.8	2.05	30.62	0.9999	95.52

It can be seen from TABLE 1 that along with the increase in sodium naphthenate the θ increased gradually, after sodium naphthenate 60% the contact angle no long increase. This is attributed to the industry naphthenic acid containing a certain amount of neutral oil, and in its long-chain no polar double bonds as opposite to oleic acid, which makes the former more hydrophobic, create θ value increase when absorbed on the SiO_2. Replace part of oleic acid, naphthenic acid to enrich tailings to be more easily adsorbed on the bubble. But an excess of sodium naphthenate leads to the total content of sodium fatty acid adsorbed on the SiO_2 decrease. Sodium maphthenate comprehensive consideration of appropriate scale is selected 60%, in which the maximum contact angle is get, most suitable for flotation of hematite.

Effects of surfactant on contact angle

Under the condition of mixed fatty acid sodium by 1%, adding 0.2% T-80 non-ionic surfactants, determining contact angle changes of various solutions, the results are shown in TABLE 2.

TABLE 2 : Effects of surfactants on contact angles of fatty acid sodium

Sodium naphthenate g/L	η/mpas	γ/ mN/m	ρ	θ
0	1.32	30.26	0.9995	92.76
0.2	1.71	31.57	0.9985	94.47
0.4	2.07	32.04	0.9992	95.57
0.6	2.11	32.46	0.9975	97.13

It can be seen from TABLE 2 that θ values are increase in the presence of sodium naphthenate. Non-ionic surfactants added may make fatty acid sodium more stretch, easy to disperse them to water, not changing the variation of contact angles.

The separation effects of fatty acid and nonionic surfactant composition for SiO2

200g containing iron 47.93% hematite, in 22-23 ºC was passed through a rough flotation, a refine flotation and three times sweep flotation, in the closed cycle separation the concentrate achieved 120.5 g, was of iron grade 68.29%, yield 85.8%. Tailing iron grade 14.9%, the throwing tail rate was only 12.3%. Compared the current industrial flotation temperature 43 - 45 °C, the hematite processing temperature reduce to 22 - 23 °C, which can attain the purpose of low carbon and energy saving.

CONCLUSIONS

The industrial naphthenic acid containing a certain amount of neutral oil, and without double bonds in their long-chain as oleic acid, which makes industrial sodium naphthenate more hydrophobicity, the bigger contact angles as adsorbed to the SiO_2 surfaces. With the optimized combination of fatty acids and T-80 to floate SiO_2 from hematite achieved excellent results. Mineral processing temperature reduce from industry 43-45 ºC to 22-23 ºC. This regents composition can be achieved hematite flotation at room temperature.

REFERENCES

[1] R.A.Khalil, A.M.Jameel, A.M.A.Saeed; Physical Chemistry: An Indian Journal, **6(3)**, **(2011)**.

[2] S.A.Kondrat'ev; Journal of Mining Science, **41**, 373-379 **(2005)**.

[3] S.A.Kondrat'ev; Journal of Mining Science, **44**, 628-638 **(2008)**.

[4] S.A.Kondrat'ev; Journal of Mining Science, **42**, 490-499 **(2006)**.

[5] R.F.Giese, P.M.Constanzo, C.V.Oss; J.Phys.Chem. Miner., **17**, 61 **(1991)**.

[6] B.A.Bezuglyi, O.A.Tarasov, A.A.Fedorets; Colloid Journal, **63**, 668-674 **(2000)**.

[7] A.Bateni, S.S.Susnar, A.Amirfazli; Colloid Surface A, **219**, 215-219 **(2003)**.

[8] A.F.Stalder, G.Kulik, D.Sage; Colloid Surface A, **286**, 92-103 **(2006)**.

[9] N.M.Dingle, M.T.Harris; J.Colloid Interf.Sci., **286**, 670-680 **(2005)**.