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Physical And Chemical Properties Of Calcium Nitrite

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The essence of the process of obtaining calcium nitrite is the absorption of nitrous gases, taken after the contact apparatus, with milk of lime with a concentration of 100-140 g/l. The reactions occurring during the absorption of nitrogen oxides by a solution of calcium hydroxide can be represented by the equations:

$$Ca(OH)2 + NO + NO2 = Ca(NO2)2 + H2O$$

$$2Ca(OH)2 + 2NO2 = Ca(NO3)2 + Ca(NO2)2 + 2H2O$$

The absorption of nitrogen oxides by lime milk has specific features, consisting in the possibility of the formation of a double salt of the composition $CaO \cdot Ca(NO3)2 \cdot 2H2O$, which causes thickening , and under certain conditions even solidification of the circulating solution.

In this regard, the formation of a double salt can cause great difficulties in obtaining concentrated solutions of calcium nitrite - nitrate salts in the process of absorption of nitrogen oxides by milk of lime [1].

In the technological process for the production of sodium nitrite, one of the intermediate products is calcium nitrite.

Therefore, the study of the density and viscosity of an aqueous solution of calcium nitrite is necessary to judge its technological properties.

Calcium nitrite synthesized under laboratory conditions was used for the study [2].

Aqueous solutions with a concentration of 5,6%; 8,4%; 11,2%; 20%; 40%; 50%; 60% were prepared from the synthesized calcium nitrite. These concentrations were chosen taking into account the production conditions.

The density of calcium nitrite solutions was determined using a hydrometer. On fig. 1 and table 1 presents data on the determination of density depending on temperature and concentration of calcium nitrite solution.

The results of the experiments show that with increasing temperature, the density of calcium nitrite solutions decreases.

For a 5,6% concentration of calcium nitrite solution with an increase in temperature in the range of 20 - 600C, the density is 1050, 1043 and 1037 kg/m3. With an increase in temperature to 40 and 600C, compared with a temperature of 200C, the density decreases by 7 and 13 kg/m3, respectively, i.e. in percentage terms, this is 0,7% and 1,2%.

For an 8,4% solution concentration, with increasing temperature, the density decreases by 5 and 13 kg/m3, respectively, which is also 0,5% and 1,2%.

For an 11,2% solution concentration, with increasing temperature, the density decreases by 7 and 10 kg/m3, respectively, which is 0,6% and 0,9%.

Thus, the decrease in the density of calcium nitrite solutions with an increase in temperature up to 400C is insignificant and amounts to 0,5-0,7%, up to 600C 0,9% - 1,2%.

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Increasing the concentration of calcium nitrite solution leads to an increase in density. At 200C, 8,4 and 11,2% solutions have densities of 1081 and 1117 kg/m3, respectively, i.e. they increase relative to the density of a 5,6% solution by 3 and 6%.

At 400C, the density was 1076 and 1110 kg/ m3 , respectively , i.e. the increase in density relative to the 5,6% solution was 3,0 and 6,0%.

At 600C, the density was 1068 and 1107 kg/ m3, respectively, i.e. the decrease in density relative to the 5,6% solution was 3,0 and 6,8%.

Summarizing the results, we can conclude that at 40 0 C the density of 8,4 and 11,2% solution relative to 5,6% calcium nitrite solution increases by 3,0%, and at 600C - by 6 -6,8%.

An increase in the concentration of a solution of calcium nitrite in the range of 20-60% leads to an increase in density up to 1580 kg / m3 (Table 4.3).

At 400C, 20 and 60% solutions have densities of 1132 and 1580 kg/m3, respectively.

Table 1.

The value of the density of calcium nitrite solutions depending on temperature and concentration.

Concentration of calcium nitrite solutions, %	Density of solutions (kg/m3) at a temperature, 0C			
	20	40	60	80
5,6	1050	1043	1037	1030
8,4	1081	1076	1068	1062
11,2	1117	1110	1107	1101
20	1140	1132	1121	1115
40	1351	1336	1321	1311
50	1418	1413	1437	1425
60	-	1580	1560	1541

Viscosity results 5,6; 8,4 and 11,2% solutions of calcium nitrite in the temperature range of 20-600C are shown in fig. 1.

Experimental data show that with increasing temperature, the viscosity of calcium nitrite solutions decreases. For a 5,6% solution of calcium nitrite with an increase in temperature in the range of 20-600C, the viscosity is 0,98; 0,92 and 0,85 Mpa s. With an increase in temperature to 40 and 600C, compared with a temperature of 200C, the viscosity decreases by 0,06 and 0,13 MPa s, respectively , i.e. in percentage terms, this is 6,0 and 13,3%.

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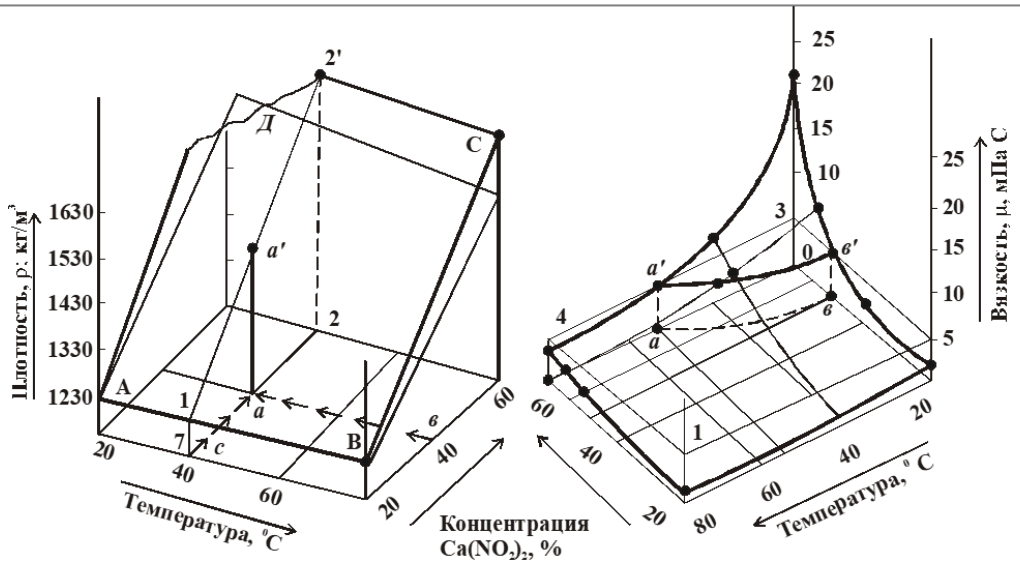

Rice. Fig. 1. Density (a) and viscosity (b) of calcium nitrite solutions versus temperature and concentration.

For an 8,4% solution concentration, with increasing temperature, the viscosity also decreases by 0,08 and 0,15 mPa s, respectively , which is 5,8 and 13,5%. For an 11,2% solution concentration, with increasing temperature, the viscosity similarly decreases by 0,06 and 0,14 mPa s, respectively , which is 5,6 and 13,0%. The decrease in the viscosity of calcium nitrite solutions with increasing temperature for 8,4 and 11,2% concentration compared to 5,6% concentration at 400C is 5,8-6,5%, and for 600C – 13,5-14,2%.

Table -2. viscosity values are presented for concentrated solutions of calcium nitrite at various temperatures.

Table -2.

Effect of temperature and concentration on the viscosity of calcium nitrite solutions.

$Ca(NO_2)_2$ concentration, %	Viscosity (mPa s) at a temperature, ^{0}C			
	20	40	60	80
5,6	0,98	0,92	0,85	0,78
8,4	1,05	0,97	0,9	0,84
11,2	1,08	1,02	0,94	0,88
20	2,09	2,07	2,05	2,04
40	3,46	2,85	2,25	2,24
50	4,75	3,53	2,33	2,31
60	23,85	12,29	8,10	5,37

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From table -2. it can be seen that increasing the concentration from 20 to 60% leads to a significant increase in viscosity. Thus, a 20% solution synthesized in the laboratory has a viscosity of 2,09, and 40%, 50%, 60% solutions have a viscosity of 3,46; 4,75 MPa s, respectively. At 60 and 800C, the viscosity of solutions changes slightly with increasing concentration.

The results of research show that low concentration solutions (up to 20%) at temperatures of 20, 40, 60 and 800C have a low viscosity. They are characterized by a viscosity of 2,09; 2,07; 2,05; 2,04 mPa s, respectively, i.e. there is no significant change in the value of indicators.

A solution of calcium nitrite of 40% concentration, in contrast to a 20% solution, has the highest viscosity. Thus, the viscosity of this solution relative to the previous one at a temperature of 200C increases by 39,6%, while at 800C this difference is 8,83%. A further increase in concentration to 50% also leads to an increase in the viscosity of the solution.

At 20 ^{0}C this sample has a viscosity of 56% more than a 20% solution and 27,2% more than a 40% solution . With increased temperature, this difference is insignificant and reaches 3% relative to a 40% solution and 11,7% relative to a 20% solution at 800C.

The results of the experimental data are presented in the form of a volumetric polytherm (Fig. 1), which makes it possible to determine the values of ρ α and η in the entire range of the studied concentrations and temperatures by graphical interpolation [3].

Ca(NO2)2 in %, at a temperature of 0C, it is necessary to draw a line parallel to the t0C axis from the solution composition point (c) until it intersects with the projection of the isotherm (c) based on the polytherm and from the obtained point (a) draw a perpendicular to the intersection with the surface ABCD. The height of the perpendicular aa ´ will determine the density of the solution. In this case, at 40 0C it is equal to 1336 kg/m3.

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