J. Braz. Chem. Soc., Vol. 17, No. 8, S1-S2, 2006.
Printed in Brazil - ©2006 Sociedade Brasileira de Química
0103 - 5053 $6.00+0.00

Hydrous Non-Crystalline Phosphates: Structure, Function and a new White Pigment

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Aluminum phosphate preparation as described in US Patent application (reference 29) follows. For further information, see www.uspto.gov.

In this example, 535.0 kg of aluminum phosphate was prepared. The wet product was dried in a "turbo-dryer" and presented characteristics of hollow particles with 15% humidity and P:Al (phosphorus:aluminum) ratio of 1:1.50.

940.0 kg of fertilizer phosphoric acid containing 55.0% of P_2O_5 was prepared. In the initial preparation phase, the acid discoloration was carried out, which lasted approximately thirty minutes, at a temperature of 85 °C. For this phase, a solution with 8.70 kg of hydrogen peroxide containing around 50% of H_2O_2 was added to the acid. Then, the acid was diluted with 975.0 kg of process water, cooled to a temperature of 40 °C and then stored at the concentration of 27.0% of P_2O_5.

The aluminum source employed in this application was a commercial aluminum sulfate solution containing 28% of Al_2O_3. The solution was filtered and diluted with process water. Specifically, 884.30 kg of aluminum sulfate solution and 1,776.31 kg of process water was combined to create a solution of approximately 9.30% Al_2O_3.

This particular experiment used as a neutralizing reagent a diluted solution of commercial sodium hydroxide containing 20.0% of NaOH. Specifically, 974.0 kg of

Table 2 A standard paint formula currently used in the market and the corresponding formula using the aluminum phosphate. The amounts are given in grams

	Standard Formula using TiO_2	Standard Formula using novel slurry
Water	839.79	361.86
Propyleneglycol	30.00	30.00
Thickener/rheology modifier	84.00	4.50
Antifoaming agent	0.60	1.17
Sodium tetrapyrophosfate	0.87	9.00
Anti-oxidant	0.87	0.90
Dispersant	20.94	11.00
Ammine	0	5.00
AFE anionic	7.86	7.86
Bactericide	4.50	4.50
Fungicide	4.50	4.50
Ammonium hydroxide 25%	7.11	15.00
Kaolin # 325	169.50	169.50
$CaCO_3$ nat. micronized	161.28	161.28
Dolomite # 325	300.00	300.00
Aluminium silicate # 1000	60.18	60.18
Titanium dioxide	534.00	267.00
Aluminum phosphate slurry 35%	0	763.00
Acrylic resin	735.00	591.00
Antifoaming/mineral spirit	9.00	6.00
Coalescing agent	60.00	43.47
Total/(grams)	3030.00	2816.72

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sodium hydroxide solution with 50% of NaOH and 1,461.0 kg of process water were mixed. The final mixture was cooled to 40 ºC.

The three reagents were mixed simultaneously, for approximately 30 minutes, in a reactor with 7,500 liters. During the addition of the reagents in the reactor, the mixture temperature was kept in the 40 ºC. to 45 ºC range, the pH was controlled to stay in a range of 4.0 to 4.5. At the end of the addition of reagents, the mixture was kept sloshing for approximately 15 minutes. The pH at this point was controlled at approximately 5.0 with the addition of a sodium hydroxide solution containing 5.0% of NaOH. The resulting suspension was approximately 7,000 kg with a density of 1.15 g/cm sup.3, presented 6.5% of solids, which represent around 455.0 kg of precipitate.

Then, the suspension was filtered in a press-filter resulting in 1,300 kg of wet cake and 5,700 kg of filtrate. The filtrate consisted primarily of a sodium sulfate solution (Na_2SO_4). The cake consisted of approximately 35% solids. The cake was washed, directly in the press filter, with 3,860 liters of process water, at room temperature, being kept at a washing ratio of approximately 8.5 cm^3 of the washing solution *per* ton of dry cake. The filtrate generated in the washing of the cake was stored for optional future use or for effluent treatment. The cake extracted from the filter, around 1,300 kg, was then transferred to a disperser (of approximately 1,000 liters) through a peristaltic pump. The dispersed solution, containing approximately 35% of solids, had a density of 1.33 g/cm^3 and viscosity of 17,400 cPs.

The dispersed aluminum phosphate suspension, with approximately 35% of solids, was then pumped to a turbo-drier. The product was heated, through a hot air stream, at a temperature of 135 ºC. Approximately 535.0 kg of aluminum orthophosphate with 15% of humidity was produced. The final product was micronized and its granulometry was kept below the 400 mesh. The final analysis of the dry product presented the following results: the phosphorus content in the product was approximately 15.0%; the aluminum content was approximately 8.7%; the pH was approximately 7.0; the water content was approximately 15%; specific density of 2.20 g/cm^3, and average diameter of particles from 5 to 10 μm.

In tests comparing a standard paint dry film to a film with aluminum phosphate, a standard market formulation of a semi-matt acrylic paint was chosen and titanium dioxide was progressively replaced by the novel aluminum phosphate product described herein. Water content and other paint components were adjusted as required. Several of the modifications in the formula in this embodiment are related to a decreased use of thickener/rheology modifier, dispersant, acrylic resin and coalescing agent.

In the formula above, a replacement of 50% TiO_2 (on a weight basis) was achieved, keeping the opacity and whiteness conditions of the dry film. In addition, the other properties of the novel product as a rheological modifier and also as a film structuring agent were explored. Comparison between the two formulas above shows that the pigments made according to embodiments of the invention will lead to additional cost reduction beyond that derived from the replacement of titanium dioxide pigment. Moreover, such gains may be obtained while producing a better performance in the applied paint film.