FERRIC OXIDE AND ALUMINA

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In a paper on the yellow color in bricks, Keane[1] showed that this was due to finely divided, anhydrous ferric oxide stabilized by alumina and possibly to some extent by other substances. In the Mars pigments there is enough alumina to keep the ferric oxide from agglomerating while it is in the hydrous state; but not enough to keep the ferric oxide from turning red when all the water is driven off. He concluded that it should be possible to obtain a buff product which would stand heating if one should precipitate a relatively small amount of ferrous hydroxide along with a relatively large amount of alumina. I have made a few experiments to test this point. Mixtures of ferrous sulphate and aluminum sulphate were made up in triplicate so that after oxidation they would contain 2, 3 and 4 parts of Fe_2O_3 per hundred parts of $Fe_2O_3 + Al_2O_3$. These mixtures were dissolved in water and treated, respectively, with sodium carbonate, sodium hydroxide, and calcium hydroxide. Care was taken to make the precipitation complete and to avoid an excess of the precipitants. The precipitates were washed thoroughly by decantation, filtered, and placed in porcelain crucibles. They were dried gradually, heated gradually, and finally blasted at a temperature of about 1000° C. The resulting colors are shown in Table I.

It is quite evident that an anhydrous yellow ferric oxide can be obtained provided agglomeration is prevented. That it is only present consistently where the iron is precipitated with lime water seems to indicate that the calcium serves to stabilize the iron oxide in the yellow form. It may be, however, that the important thing is the dilution of the precipitate with calcium sulphate. This could be tested by starting with ferrous chloride and aluminum chloride instead

[1] Jour. Phys. Chem., **20**, 734 (1916).

of with the sulphates. Unfortunately, the time at my disposal did not permit of my making this experiment.

TABLE I

% Fe_2O_3	Precipitated by		
	Na_2CO_3	NaOH	CaO_2H_2
2	Non-uniform product, colored red, pink, pale yellow, and white	Uniform, pinkish white	Uniform, white tinged with yellow
3	Non-uniform, buff predominating	Uniform, decided pinkish tinge	Uniform, white tinged with yellow
4	Non-uniform, red and straw-colored	Uniform, pink	Uniform, cream color

Another set of experiments was made to see how the color changed when the percentage of iron was increased and lime water was used as the precipitating agent. The result was a splendid gradation of color as can be seen in Table II.

TABLE II

% Fe_2O_3	Color (precipitation with lime)
2	White with faint yellow tinge
3	White with yellow tinge
4	Cream color
6	Buff
8	Deep buff or light brown
10	Brown
12	Reddish brown
15	Reddish brown
20	Chocolate

Since a yellow-burning clay will turn red before it goes yellow, it should be possible to obtain the same results by starting with the red hydrous ferric oxide. In the preceding experiments the conditions of precipitation do not give the red form directly and consequently the alumina merely has to prevent the agglomeration and is not required to peptize an already agglomerated form. Amounts of ferric chloride and aluminum sulphate were taken which corresponded to the four and six percent mixtures of Table II. The hydrous oxide was precipitated with ammonia and the alumina with calcium hydroxide. The two precipitates were mixed intimately and treated as in the preceding runs. After heating in the blast lamp the resulting color was pinkish gray in both cases, the pinkish tinge being lighter in the one containing less iron. The war prevented further experiments being made.

The conclusions to be drawn from these few experiments are:

1. When lime water is added to a mixture of ferrous and aluminum sulphates, the resulting precipitate is buff colored even after heating to about 1000° C, provided the percentage of ferric oxide in the ferric and aluminum oxides is less than eight.

2. When solutions of ferrous sulphate and aluminum sulphate are precipitated with sodium hydroxide or sodium carbonate, a uniform buff color is not obtained even when there is only two percent of ferric oxide.

3. It is not known whether the important factor is the mere addition of a lime salt or is the presence of calcium sulphate in the precipitate.

4. An anhydrous yellow ferric oxide can be obtained in presence of alumina and calcium sulphate.

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