The Thermal Decomposition of Iron(III) Nitrate Nonahydrate Followed by a Reaction with Hydrogen

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Six supplies of iron(III) nitrate nonahydrate each weighing 80.8400 g (0.20 moles) were heated in the same way as chromium(III) nitrate nonahydrate [1] but in 11 conical flasks to miminize the loss of the desired product due to spattering in the initial stages of heating. Dark red solids, weighing 15.9652 g on average, were obtained when the reactions were completed (99.970% based on iron(III) nitrate nonahydrate). Each product was combined as one.

A sample of the combined products was found to be soluble in hot concentrated mineral acids and the product was found to be non-ferromagnetic.

Six supplies of the combined products weighing 32.0000 g were subjected to a reaction with hydrogen in which 30.9303 g of black ferromagnetic solids were produced. These products were combined as one.

A sample of the non-ferromagnetic product and a sample of the ferromagnetic product were subjected to powdered diffraction X-ray analysis and the results compared favorably with those given in the literature [2].

The colors, the yields, the solubilities with respect to the mineral acids, the reaction of the non-ferromagnetic product with hydrogen and the X-ray analysis were evidence that alpha iron(III) oxide [2] and ferrosoferric oxide or iron(II,III) oxide were obtained in the reactions involving iron(III) nitrate nonahydrate and hydrogen.

The equations for the reactions based on the above observations are

$$4(Fe(NO_3)_3 \cdot 9H_2O) \xrightarrow{\Delta} 2Fe_2O_3 + 12NO_2\uparrow + 3O_2\uparrow + 36H_2O\uparrow$$

$$3Fe_2O_3 + H_2 \xrightarrow{\Delta} 2Fe_3O_4 + H_2O\uparrow$$

Since iron(II,III) oxide was obtained in the iron(III) oxide–hydrogen reaction, the yield for the ferromagnetic product was 99.997% based on iron(III) oxide.

Although the thermal decomposition of iron(III) nitrate nonahydrate was based on thermal decomposition of chromium(III) nitrate nonahydrate, the decomposition falls in the category with the thermal decomposition of copper(II) nitrate [3], lead(II) nitrate [3], strontium nitrate [4] and barium nitrate [4] in that the valence of iron is the same before and after thermal decomposition.

Iron(II,III) oxide or ferrosoferric oxide is also obtained by reacting iron(II) sulfide with excess oxygen [5], by the thermal decomposition of iron(III) oxalate pentahydrate [6] and by other means [6].

In addition to the thermal decomposition of iron(III) hydroxide which is characteristic of all hydroxides, iron(III) oxide is also prepared by: the oxidation of iron(II) sulfide in air in the 300 °C - 900 °C range [7]; the atmospheric oxidation of iron film in which a produced carbide causes this oxide to form [8] and the oxidation of pyrite pellets in which iron(II) sulfide and iron(II,III) oxide are produced before the desired oxide is obtained [9].

The production of iron(III) oxide by the thermal decomposition of iron(III) nitrate nonahydrate followed by reacting this oxide with hydrogen to produce iron(II,III) oxide are each supplemented by the above reactions.

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