Thermochimica Acta, 90 (1985) 353–354
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

Note

HEATS OF REACTION OF $FeSO_4 \cdot 7\ H_2O$ WITH SODIUM, POTASSIUM, RUBIDIUM, STRONTIUM AND BARIUM CARBONATES

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Iron (II) sulphate heptahydrate undergoes double decomposition reactions with alkali and alkaline earth metal carbonates to form iron(III) oxide and the corresponding metal sulphate. These reactions may be represented as

$$FeSO_4 \cdot 7\ H_2O + M_2CO_3 + 1/4\ O_2 = 1/2\ Fe_2O_3 + M_2SO_4 + 7\ H_2O + CO_2 \quad (1)$$

M = Na, K, or Rb

$$FeSO_4 \cdot 7\ H_2O + M'CO_3 + 1/4\ O_2 = 1/2\ Fe_2O_3 + M'SO_4 + 7\ H_2O + CO_2 \quad (2)$$

M′ = Sr or Ba.

The reaction between the heptahydrate and sodium carbonate was used to develop a commercial process for the simultaneous production of red iron oxide pigment and sodium sulphate [1]. Subsequently, its reactions with other carbonates were also studied from a commercial point of view [2]. In this connection it was necessary to calculate the heats of double decomposition for design purposes.

The double decomposition reaction studies involved the heptahydrate and carbonates of sodium, potassium, rubidium, strontium and barium. For this purpose, analytical reagent quality carbonates of the aforementioned metals were utilised. Iron(II) sulphate heptahydrate was prepared as described below.

Commercial grade iron(II) sulphate heptahydrate was dissolved in hot 2 N sulphuric acid to make a saturated solution, and hot filtered. To the filtrate, absolute alcohol (about half the volume of the filtrate) was added with stirring and the mixture was allowed to cool. The crystallized hydrated iron(II) sulphate was filtered and washed several times with absolute alcohol. The crystals were then dried by pressing between the folds of a filter paper. Further drying was done by passing a stream of dry carbon dioxide over the sample placed in a suitable container.

The double decomposition reactions were carried out in cylindrical crucibles using a derivatograph (M/s Metrimpex, Budapest, Hungary). The

0040-6031/85/$03.30

TABLE 1
Heats of double decomposition of $FeSO_4 \cdot 7\ H_2O$ with some alkali and alkaline earth carbonates

Solution No.	Carbonate	ΔH (kJ mol^{-1}) of the heptahydrate		Reaction temp. (°C)
		Calc.	Obs.	
1	Sodium carbonate	234.76	196.50	200–440
2	Potassium carbonate	198.81	192.28	200–400
3	Rubidium carbonate	197.14	171.38	200–400
4	Strontium carbonate	266.80	229.0	240–380
5	Barium carbonate	241.86	188.10	540–750

instrument simultaneously and photographically records DTA, DTG, TG and T curves. The areas under the DTA curves were used for the purpose of calculating the enthalpy changes of the double decomposition reactions. The areas relating to the reactions under investigation were compared with that of the melting endotherm of sodium nitrate.

The heats of double decomposition were also calculated at 25°C using the standard heats of formation of the reactants and products, taken from the literature [3,4]. The experimental and calculated values of the heats of double decomposition are presented in Table 1. The agreement between the calculated and observed values is considered to be fairly good. As the heats of thermal double decomposition are endothermic in nature, the observed values are expected to be lower than the calculated values.

ACKNOWLEDGEMENT

The author is grateful to Professor P.K. Jena, Director, for permitting the publication of the results.

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