Thermochimica Acta, 126 (1988) 403–406
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

Note

ISOTHERMAL DECOMPOSITION OF ALMORA MAGNESITE

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(Received 6 July 1987)

Thermoanalytical techniques are used extensively for the evaluation of kinetic parameters, viz. rate constant K, energy of activation E, order of reaction and reaction mechanism. The general approach in kinetic analysis is to express rate of reaction in terms of the degree of transformation α and a temperature dependent function $K(T)$. If the reaction is isokinetic over the range of temperature, the latter term becomes the rate constant governed by the Arrhenius law. Solid state thermal decomposition can be studied under isothermal and non-isothermal conditions. Under isothermal conditions, the temperature of the test sample is to be raised to a desired temperature without any appreciable decomposition taking place. Generally carbonates undergo stepwise endothermic decomposition due to the losses of water of hydration, hydroxyl ions and carbon dioxide and resulting in the formation of stable metal oxides.

EXPERIMENTAL

Decomposition of Almora magnesite, which was found to be magnesium hydroxide hydrate/hydro magnesite $Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$, was studied under isothermal conditions at 300, 400, 450 and 500 °C using a Stanton Redcroft simultaneous thermal analyser type STA 780. The initial rate used was 30 °C min^{-1}.

RESULTS AND DISCUSSION

Figure 1 shows typical α–t plots at five temperatures. Here α was considered as the ratio of weight loss at a particular instant to initial weight at time $t = 0$ under isothermal conditions. For the assessment of the energy of decomposition, α–t plots at different temperatures for a fixed target α may be used. The equation used here is

$$\ln t_\alpha = \text{const} + E/RT \qquad (1)$$

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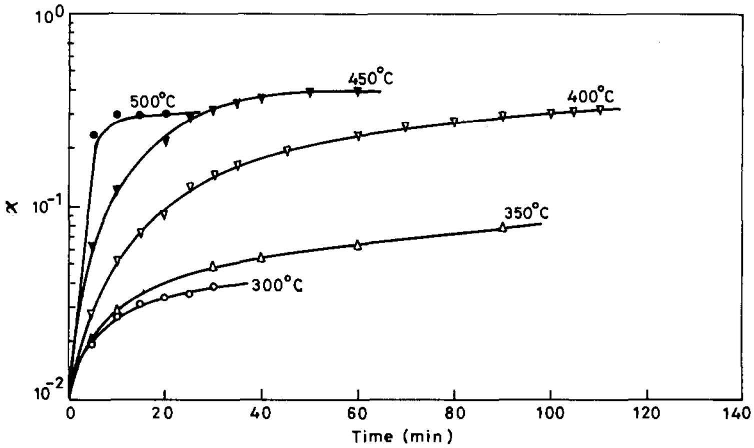

Fig. 1. Plots of $\alpha - t$ at five different temperatures.

The ln t_α vs. $1/T$ plot is linear and shows the effect of temperature on decomposition (Fig. 2). At lower temperatures, more time is required to get the same degree of decomposition. The activation energy calculated from ln t_α vs. $1/T$ plot is found to be 11.6 kcal mol^{-1}.

From the $\alpha - t$ dependence, the rate constants K for different temperatures were calculated using the general kinetic equation (Fig. 3). The Arrhenius plot (Fig. 4) was used to calculate the activation energy, which was found to be 16 kcal mol^{-1}.

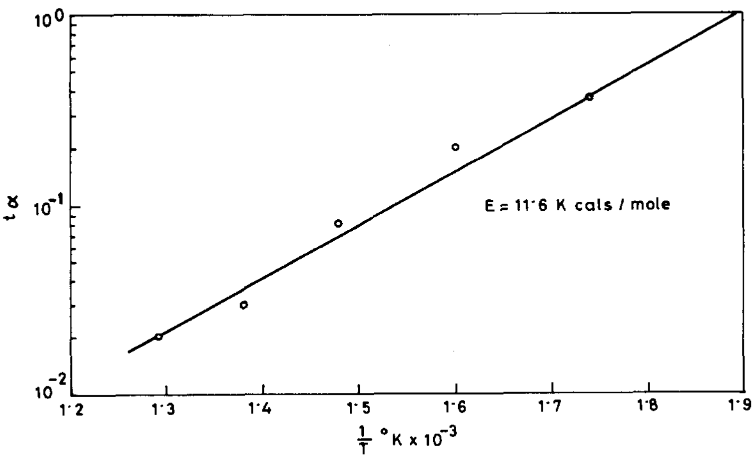

Fig. 2. Plot of ln t_α vs. $1/T$.

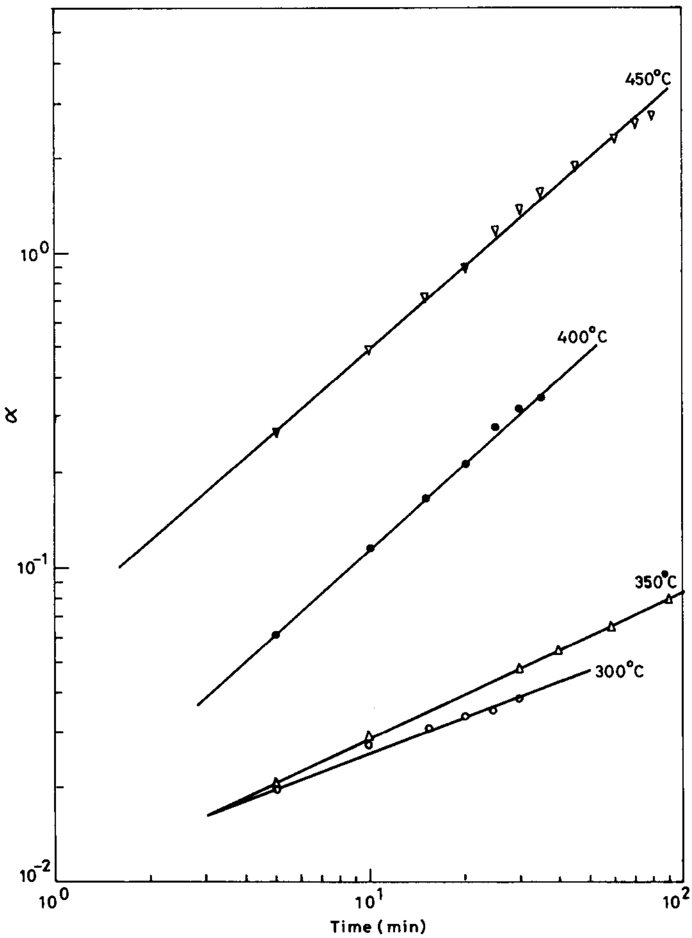

Fig. 3. Plots of $\alpha - t$ for different temperatures.

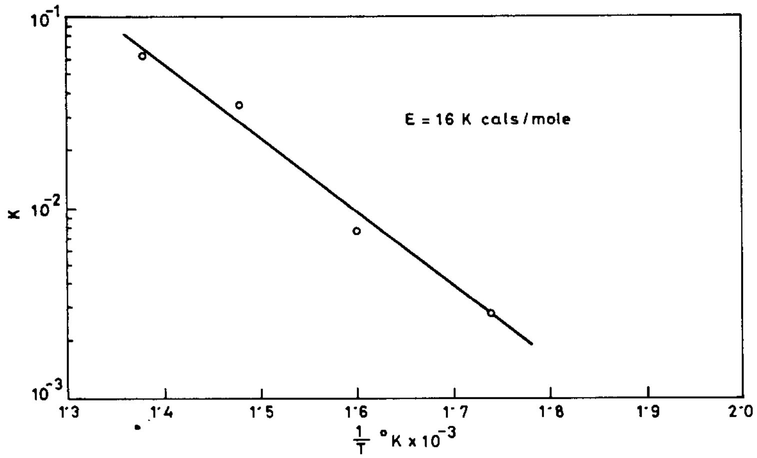

Fig. 4. Arrhenius type plot.

CONCLUSIONS

Activation energy of decomposition of Almora magnesite was found to be 11–16 kcal mol^{-1} by using α–t plots.