

## **BARIUM SULPHATE REDUCTION BY CARBON IN THE PRESENCE OF ADDITIVES**

*Y. Pelovski, Iv. Gruncharov and I. Dombalov*

HIGHER INSTITUTE OF CHEMICAL TECHNOLOGY, SOFIA 1156,  
BULGARIA

The results of a study of barium sulphate reduction by carbon in the presence of additives such as sodium carbonate, sodium chloride and calcium chloride are presented.

The reduction of barium sulphate by carbon-containing solid reducing agents to form water-soluble barium sulphide is a high-temperature process [1, 2]. The mechanism of interaction includes preliminary gasification of the solid reducing agent according to some studies [3, 4]. A few authors have proposed the introduction of activating additives [4] to intensify the process of reduction of barium sulphate.

The investigations were carried in a Shimadzu-31H thermogravimetric analyzer in nitrogen atmosphere at a gas flow rate of 115 cm<sup>3</sup>/min. The sample weight was 100 mg, while the mole ratio C:BaSO<sub>4</sub> was 2.5. The quantity of additives in the mixture did not exceed 1%. All initial substances were of reagent purity, with particle dimensions less than 0.1 mm. The carbon had an amorphous structure and consisted of 99.5% C. The degree of decomposition and the kinetic parameters of the process were determined on the basis of the weight losses from the thermogravimetric dependences.

The results of the experimental investigation of the effect of sodium carbonate on the reduction of barium sulphate by carbon are presented in Figs 1 and 2. The effect of sodium carbonate is exhibited to a great extent in the range of low sodium carbonate concentrations, up to 0.1% Na<sub>2</sub>CO<sub>3</sub>. An increase of the concentration brings about an increased activating effect of the additive, but some zones of melt and dross formation are observed in the solid product. This shows that sodium carbonate should be applied in quantities up to 0.3%. Higher sodium carbonate concentrations could be introduced into the initial mixture when the process is carried out in the melt state.

The dependences of the degree of reduction of barium sulphate by carbon promoted by 0.3% Na<sub>2</sub>CO<sub>3</sub> at different temperatures ranging from 786 to 871° are shown in Fig. 2. The reduction of barium sulphate is complete in 15–25 min in the

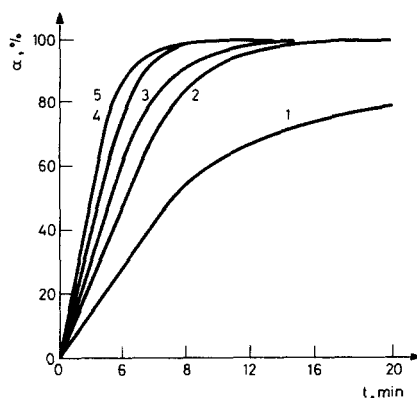


Fig. 1 The effect of  $\text{Na}_2\text{CO}_3$  quantity on  $\text{BaSO}_4$  reduction by 1 – 0%  $\text{Na}_2\text{CO}_3$ , 2 – 0.1%  $\text{Na}_2\text{CO}_3$ , 3 – 0.3%  $\text{Na}_2\text{CO}_3$ , 4 – 0.6%  $\text{Na}_2\text{CO}_3$ , 5 – 1%  $\text{Na}_2\text{CO}_3$

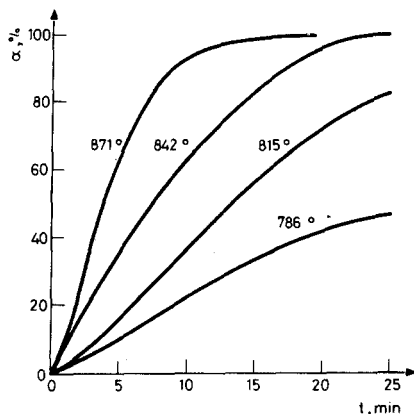


Fig. 2 The dependence of the degree of reduction of  $\text{BaSO}_4$  by carbon on time and temperature 0.3%  $\text{Na}_2\text{CO}_3$

presence of this additive at temperatures ranging from 842 to 871°. Such a degree of decomposition is achieved during 50–100 min under identical conditions but in the absence of an additive [3].

The experimental data shown in Fig. 2 are closely fitted by the equation of Erofeeff:  $\alpha = 1 - e^{-kt^n}$ . The values of  $-\ln k$  obtained for temperatures ranging from 786 to 871° vary from 5.15 to 3.37, respectively. The apparent energy of activation determined in the above range of temperatures amounts to 248.3 kJ/mol.

A similar activating action on the process of reduction of barium sulphate by carbon was found when sodium chloride and calcium chloride were used as additives. The observed activating action of the studied additives cannot be

ascribed to a given chemical component at this stage of the investigation. It is most probably determined by the appearance of microeutectic centres where the energy level and the crystal structure of the solid substances are changed.

The investigation that have been carried out confirm the possibility of decreasing the energy consumption during barium sulphate reduction by carbon through the introduction of a suitable additive into the initial mixture.

## References

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**Zusammenfassung** — Die Ergebnisse einer Untersuchung der Reduktion von Bariumsulfat mit Kohlenstoff in Gegenwart von Additiven wie z. B. Karbonat, Natriumchlorid und Kalziumchlorid werden dargelegt.

**Резюме** — Представлены результаты исследования реакции восстановления сульфата бария углеродом в присутствии таких добавок, как карбонаты и хлориды натрия и кальция.