

Effect of Pressure on the Joint Reduction of ZrO_2 and B_2O_3 with Calcium

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INTRODUCTION

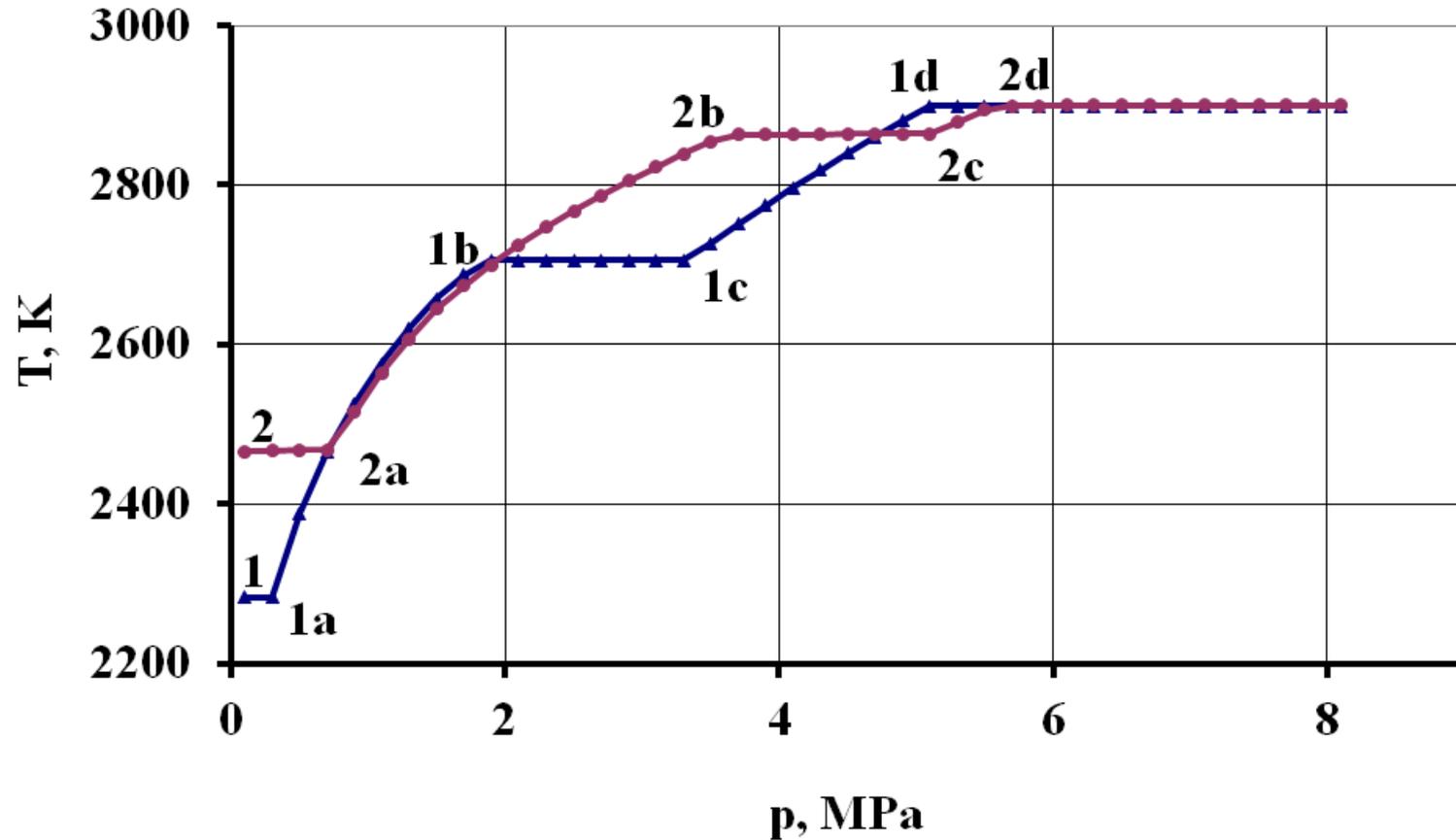
Calcium has found application as a reducing agent to obtain f-elements (uranium, rare-earth metals, their alloys, etc.). Calcium hydride is used to obtain the powders of metals, intermetallic compounds, refractory compounds and composite materials from oxides, where calcium is a reducing agent. To obtain powders of metals, intermetallic compounds, refractory compounds and composite materials from oxides, calcium hydride is used, where calcium is a reducing agent. The obtaining of refractory nitrides from oxides under nitrogen pressure using calcium as a reducing agent was implemented at the Tomsk Scientific Center of SB RAS. The previous studies showed that the pressure of the gaseous medium ambiguously affected the temperature and combustion rate of calciothermal systems. The goal of this work is to study the effect of pressure on the joint reduction of ZrO_2 and B_2O_3 with calcium.

Experimental procedure

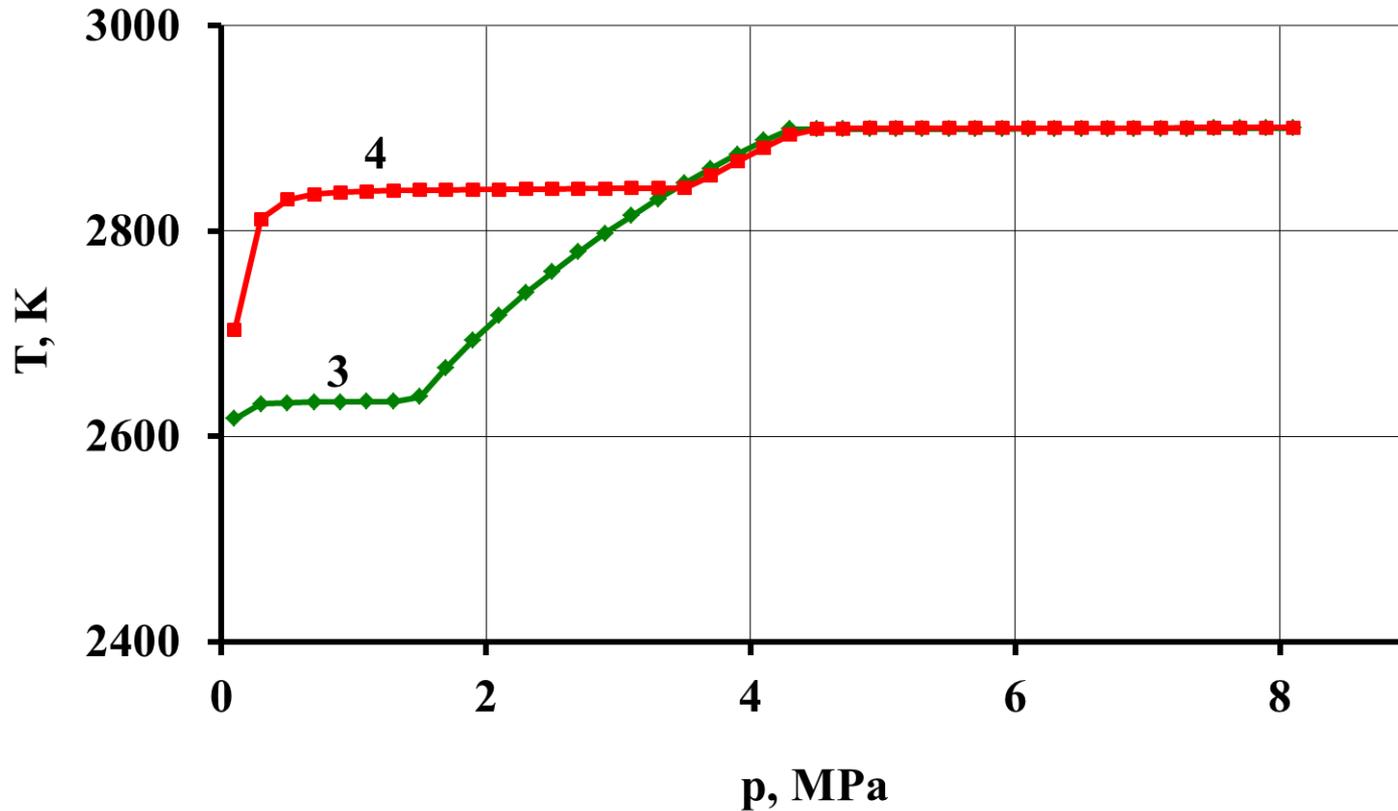
Table 1. Compositions of the starting mixtures

Composition #	Ca(IO ₃) ₂ , g	ZrO ₂ , g	B ₂ O ₃ , g	Ca, g
1	0	18.48	7.18	28.35
2	1.8	18.48	7.18	29.68
3	3.0	15.4	5.98	25.85
4	5.7	15.4	5.98	27.86

Results and Discussion



- Fig. 1 Adiabatic temperature during the combustion of mixtures 1 and 2 as a function of pressure



• Fig. 2. Adiabatic temperature during the combustion of mixtures 3 and 4 as a function of pressure

The difference between compositions 3 and 4 from compositions 1 and 2 is their higher thermal stability. This leads to the fact that the condensation stage of calcium vapors begins at a higher pressure. For this reason, T_{ad} reaches the melting point of CaO before calcium vapors begin to condense. The solid – liquid phase transition of CaO eliminates the effect of the vapor – liquid phase transition of metallic calcium on T_{ad} . Due to this, the curve in Figure 2 does not show an increase in T_{ad} caused by the condensation of calcium vapors. The temperature growth of compositions 3 and 4 is noticeably affected only by the displacements of the equilibrium $\text{CaZrO}_3 + \text{Ca} \leftrightarrow \text{Zr} + \text{CaO}$ to the right with increasing pressure. Fig. 2 also demonstrates, at pressures up to 0.5 MPa, an increase in T_{ad} caused by the suppression of the dissociation of calcium iodides in the vapor phase.

CONCLUSIONS

- The increase in pressure was shown to shift the equilibrium of $\text{CaZrO}_3 + \text{Ca} \leftrightarrow \text{Zr} + \text{CaO}$ to the right, which contributes to a more complete reduction of ZrO_2 and B_2O_3 oxides with calcium. The range in which zirconium is reduced depends on the thermal stability of the mixture. Higher thermal stability of mixtures requires higher pressures to achieve full reduction.

Acknowledgements

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