CATALYTIC COMBUSTION OF GRAPHITE BLOCK USING KOH

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Introduction

Japanese nuclear reactor is currently considered to be out of operation in near future. A huge quantify of nuclear graphite blocks which form the inner wall of the reactor must be stored because of radio-active ^{14}C included in the graphite. It is necessary to minimize its quantity by concentrating ^{14}C in a small volume. Safe combustion of the block is proposed to concentrate $^{14}CO_2$ by selective pressure swing adsorption.

Catalytic combustion of graphite block was studied of around 500 in the present study, using potassium chemicals to low the temperature of combustion for the inreactive graphite.

Experimental

The combustion of graphite cube (0.4×0.4×0.4) was followed by TGA. The cube was heated from 30 to 900 in air flow by the heating rate of 5 /min. Another program to heat the cube to 500 , 600 , and 700 by 5 /min was also applied. The temperature was kept for 10hr to measure the weight loss.

Graphite samples examined were IG-20 typical nuclear graphite, electrode graphite and graphite for special purpose. Aq. KOH was put on one face of graphite cube and dried before the combustion.

Results

Non-Catalytic Combustion Reactivity of Graphite Cubes

Figure 1 Shows the reactivity of three graphite cubes at 700 in N_2/O_2=7/3. The weight loss of all cubes became significant when the temperature reached 700 . The reactivity order of graphite was IG-20 > Electrode Graphite > Special Graphite, reflecting their graphitization extent. IG-20 lost its whole weight by 200 minute while other two cubes did by 600 and 800 minute, respectively. It must be noted that IG-20 hardly lost its weight at 500 .

Catalytic Combustion

Figure 2 shows weight losses of IG-20 cube by the combustion in N_2/O_2=1 at 550 when KOH was place on the top or bottom face of the cube. The cube lost its weight only within an initial 100 minute by 10% when KOH was put on the top face. Longer holding time caused no weight loss at all. In contrast, KOH on the bottom face continued the linear weight loss, which reached 60% by 300 minute. Steady combustion by KOH on the bottom face must be noted.

Figure 3 shows the catalytic combustion when the KOH amount was varied. Large amount of KOH(1.16×10^{-4}g) accelerated the combustion with the weight loss being 82% at 300 minute.

Discussion

KOH has been recognized to catalyze the combustion of carbon materials. The species produced from KOH certainly accelerates the combustion of graphite at 550 . It is interesting to note that the catalyst put on the top or bottom faces on cube showed very different activity. KOH has been believed to accelerate the combustion through the cycle of KOH K, although some part of is converted into K_2CO_3. Metallic potassium can be vaporized to be removed from the cube. When KOH is put on the to face, its escape from the cube must be rapid while it penetrates into the cube to help the combustion of whole volume when KOH is put on the bottom face. When two cubes were placed in layer and one cube carries KOH, two cubes are catalytically combusted.

These results indicate that K species moves around the cube, accelerating the combustion. Hence moving bed furnace for graphite cubes can allow the continue combustion when the temperature distribution in the furnace is adequately designed.

Conclusions

KOH displayed catalytic effect in combustion of graphite as expected. It attracts attention that progress of combustion considerably varies by application of graphite materials on the top and bottom side of the cube. It is thought that during combustion of KOH, the reduction to K and the oxidation to K_2CO_3 are repeated. Scattering occurs in a state of K. Accordingly for real graphite combustion, it is necessary to produce design a reactor which continues catalytic combustion by K_2CO_3 into K which disperses to be captured by graphite materials, and recharging the material to combustion.

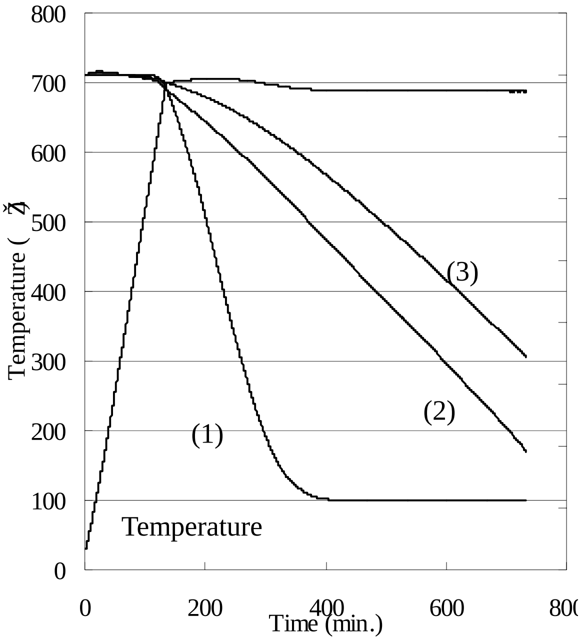

Fig.1 Non-Catalytic Isothermal Combustion of 3 kinds of Graphite Materials in N_2/O_2=7/3 at 700

(1) IG-20 for a Nuclear Reactor

(2) Graphite for an Electrode

(3)Special Carbon Graphite

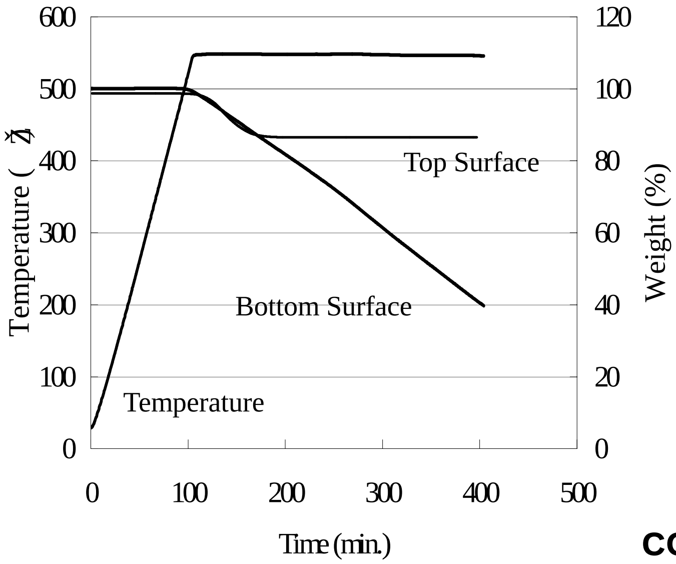

Fig.2 Catalytic Combustion of IG-20 in N_2/O_2=1 due to the Catalyst Location at 550 .

KOH (2.65×10^{-4}g) was placed on the top or bottom surfaces of IG-20 Cube.

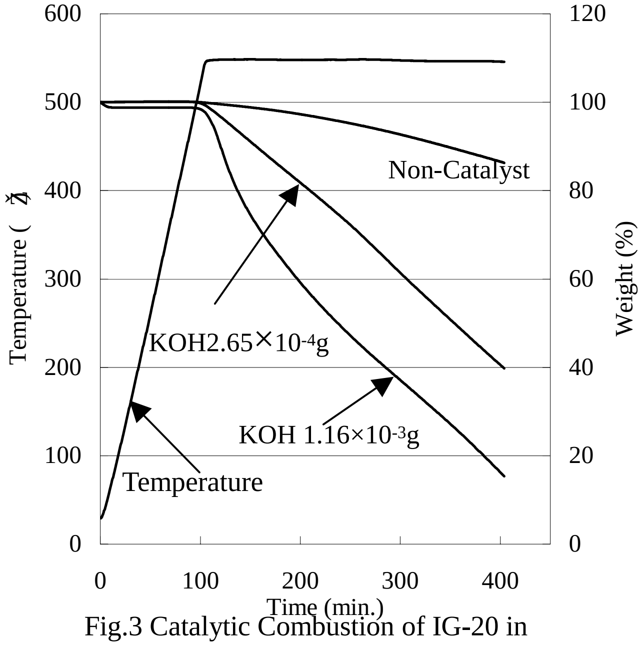

Fig.3 Catalytic Combustion of IG-20 in N_2/O_2=1 at 550 .

KOH on Bottom Surface

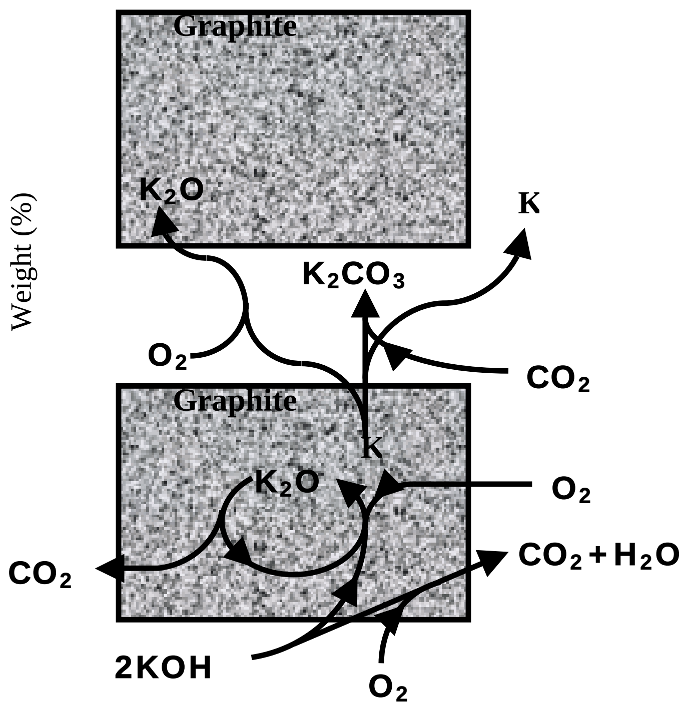

Fig.4 The Mechanism of the Catalytic Combustion of Graphite