# ROLES OF DILUENT IN THE CATALYTIC COMBUSTION OF GRAPHITE BLOCK WITH $O_2$ IN THE PRESENCE OF KOH

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## Introduction

Catalytic combustion of graphite was proved to complete at 550℃ within an acceptable time scale when KOH was applied as the catalyst. The oxidant gas can influence the rate of combustion and the concentration of $^{14}CO_2$ in the combustion gas to be separated.

In this study, the combustion of nuclear graphite IG-20 cube was examined in $O_2$/He, $O_2/N_2$ and $O_2/CO_2$, using KOH as the catalyst.

## 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 $O_2$/He, $O_2/N_2$ and $O_2/CO_2$ flow by the heating rate of 5℃/min. Another program to heat the cube to 550℃ by 5℃/min was also applied. The temperature was kept for 5hr to measure the weight loss.

Graphite samples examined were IG-20 typical nuclear graphite and chars obtained from Yallourn, Tanito Harum and South Banko Coals. Aq. KOH was put on the bottom face of graphite cube and dried before combustion.

## Results

Figure 1 compares the non-catalytic combustion reactivity of IG-20 cube in $O_2$/He, $O_2/N_2$ and $O_2/CO_2$ of 7/3 volume ratio at room temperature to 900℃. The combustion in He was most rapid. It started at 500℃ and finished at 800℃. $O_2/CO_2$ followed, starting at 700℃ and completing at 850℃. $O_2/N_2$ was least reactive, removing 50% by 900℃.

Figure 2 compares the reactivity of cube at 550℃ in $O_2/N_2$ and $O_2/CO_2$ of variable concentration. $O_2/CO_2$ was always more active, although the combustion was rather slow at this temperature. More $O_2$ accelerated the combustion in both $N_2$ and $CO_2$.

Figure 3 compares the combustion reactivity of cube in $O_2$/He, $O_2/N_2$ and $O_2/CO_2$ (=1) at 550℃ where KOH of $2.65\times10^{-4}$g was put on the bottom face of the cube. The reactivity order was He ≥ $CO_2$ > $N_2$ at this temperature. He accelerated the combustion very markedly in initial 150 minute however the combustion became slow beyond 150 minute. 90% of cube was combusted in both $O_2$/He and $CO_2/O_2$ by 300 minute while 60% was in $O_2/N_2$.

Figure 4 compared the reactivity of coal char in $CO_2/O_2$ and $O_2/N_2$ without catalyst. It is interesting to note that the combustion was more rapid in $O_2/N_2$ than in $CO_2/O_2$.

Table 1 summeryzes some properties of He, $N_2$ and $CO_2$ which may be related to the combustion.

So far no single parameter explains the roles of diluents in the combustion. Oxygen diffusion in the diluent gas to the cube must be considered. Low reactivity of graphite may prefer $CO_2$ than $N_2$ for its combustion

## Conclusion

The diluent was found very influential on the rate of combustion. CO2 is much more helpful for the combustion of graphite than N2. In contrast, the combustion of char in $N_2/O_2$ was rapider than that in $CO_2/O_2$. $CO_2/O_2$ combination is favorable for $^{14}CO_2$ separation, because this may produce only $CO_2$.

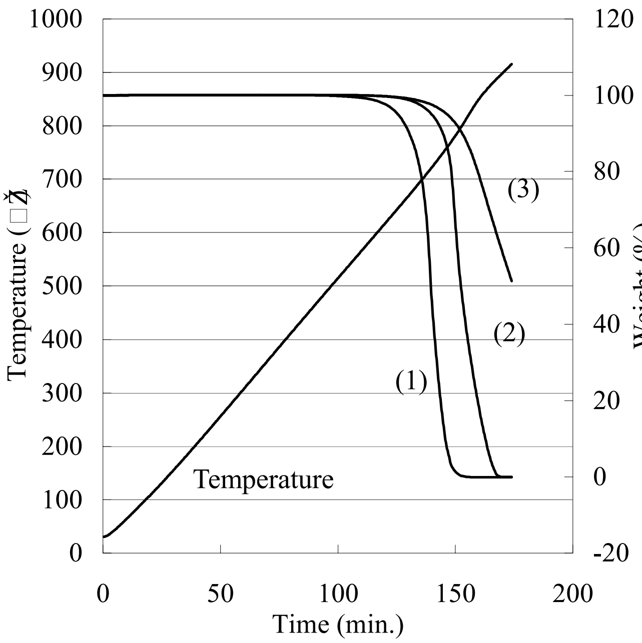


Fig.1 Non-Catalytic Combustion of IG-20 in He/ $O_2$ ,$N_2/O_2$ and $CO_2/O_2$ up to 900□.
(1)He /$O_2$=7/3, (2) $CO_2/O_2$= 7/3,(3) $N_2$ /$O_2$= 7/3

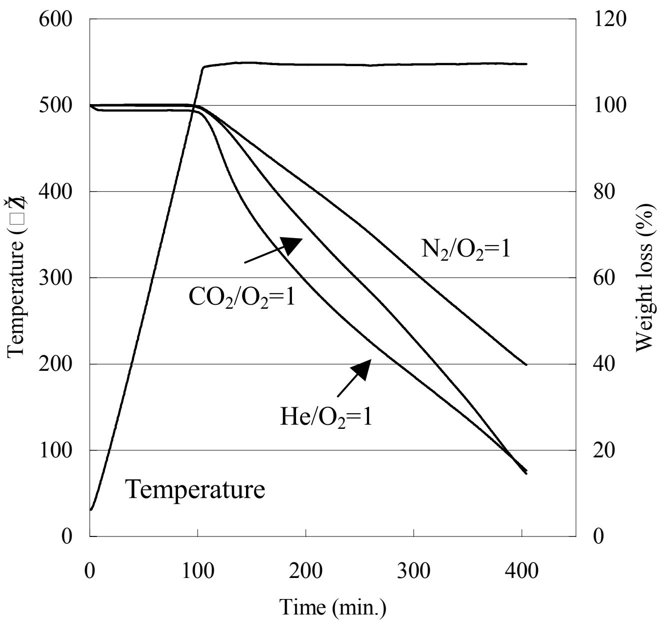


Fig.3 Catalytic Combustion of IG-20 in He/$O_2$=1, $N_2/O_2$=1 and $CO_2/O_2$=1 at 550 .
KOH(2.65×$10^{-4}$g) was placed on the Bottom

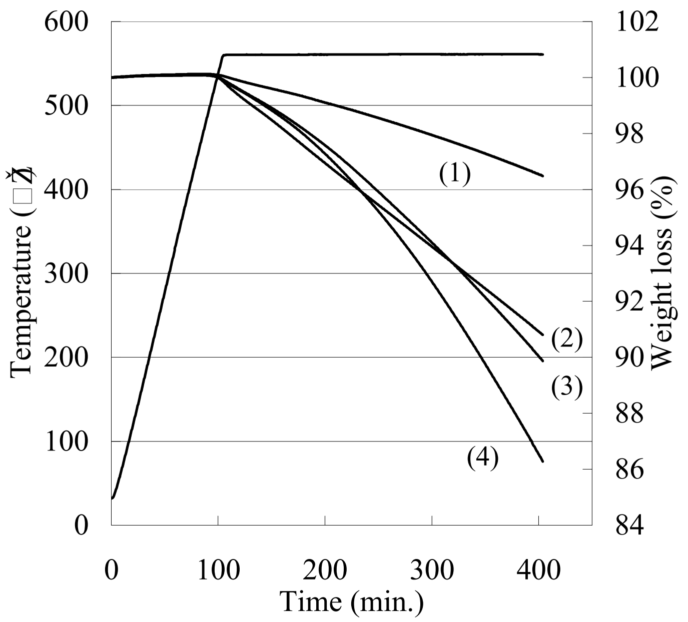


Fig.2 Non-Catalytic Isothermal Combustion of $N_2/O_2$ and $CO_2/O_2$ at 550□
(1) $N_2/O_2$=7/2, (2) $CO_2/O_2$=7/3, (3) $N_2/O_2$=1, (4) $CO_2/O_2$=1

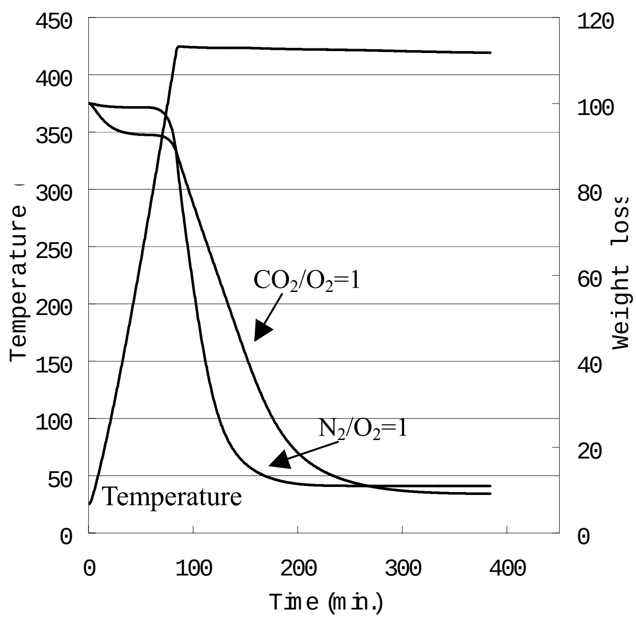


Fig.4 Combustion of char in $N_2/O_2$=1 and $CO_2/O_2$=1 at 550 .

Heat Capacity($JK^{-1}mol^{-1}$)
$CO_2$(37.11) > $N_2$(29.12) > He(20.79)
Thermal Conductivity($10^{-4}Jm^{-1}s^{-1}K^{-1}$)
He(1499) > $N_2$(259.8) > $CO_2$(166.2)
Competitive Adsorption
$CO_2$ > $N_2$ > He

Table 1