

A COMPARATIVE STUDY OF THE GASEOUS OXIDATION OF VITREOUS
CARBON AND VARIOUS GRAPHITES AT 1500-3000°K

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ABSTRACT

Weight loss rates of various oxidation-resistant carbons were measured in a tubular flow reactor in carbon dioxide, oxygen-argon and hydrogen-argon mixtures, and nitrogen. The effects of gas stream velocity up to 3500 cm/sec, of pressure up to 100 p.s.i. absolute, and of carbon surface temperature up to 3000°K, were investigated.

Rate-temperature curves for reactions with CO_2 and O_2 exhibited a maximum and a minimum at temperatures which were markedly dependent on the type of carbon (Fig.1) and only slightly dependent on pressure (Fig.2). Specific rates below about 0.05 g/cm² min were almost independent of gas stream velocity at the highest velocities used, but higher rates were probably limited by boundary layer diffusion. Attempts are being made to remove this limitation by modifying the experimental procedure.

In order to investigate the possible contribution of thermal accommodation to the kinetics, a plasma pre-heater for reactant gases has been developed. Initial results with a CO_2 -Ar mixture at a fixed pre-heat temperature of about 2150°K (Fig.3) showed that the reaction rate was appreciably greater than for 'cold' gas; the general shape of the rate-temperature curve was similar, thus apparently eliminating the possibility that the rate maximum was due to a decrease in thermal accommodation efficiency with increase in temperature.

At temperatures near or above the rate minimum, the following effects occurred:

- (i) Vitreous carbon and the α -surface of pyrolytic graphite were found to undergo superficial recrystallisation to form a skin with strongly preferred orientation of basal planes parallel to the surface;
- (ii) The rate of weight loss in oxidising gases became comparable to the rate of evaporation of carbon in vacuo or in an inert gas stream;
- (iii) The apparent order of reaction with respect to pressure of CO_2 fell from about unity to almost zero.

The results suggest that the increase in weight loss rate at these temperatures may be due to evaporation followed by gas phase reaction, but there are still some unexplained discrepancies between the expected and observed shapes of the rate-temperature curve near the rate minimum.

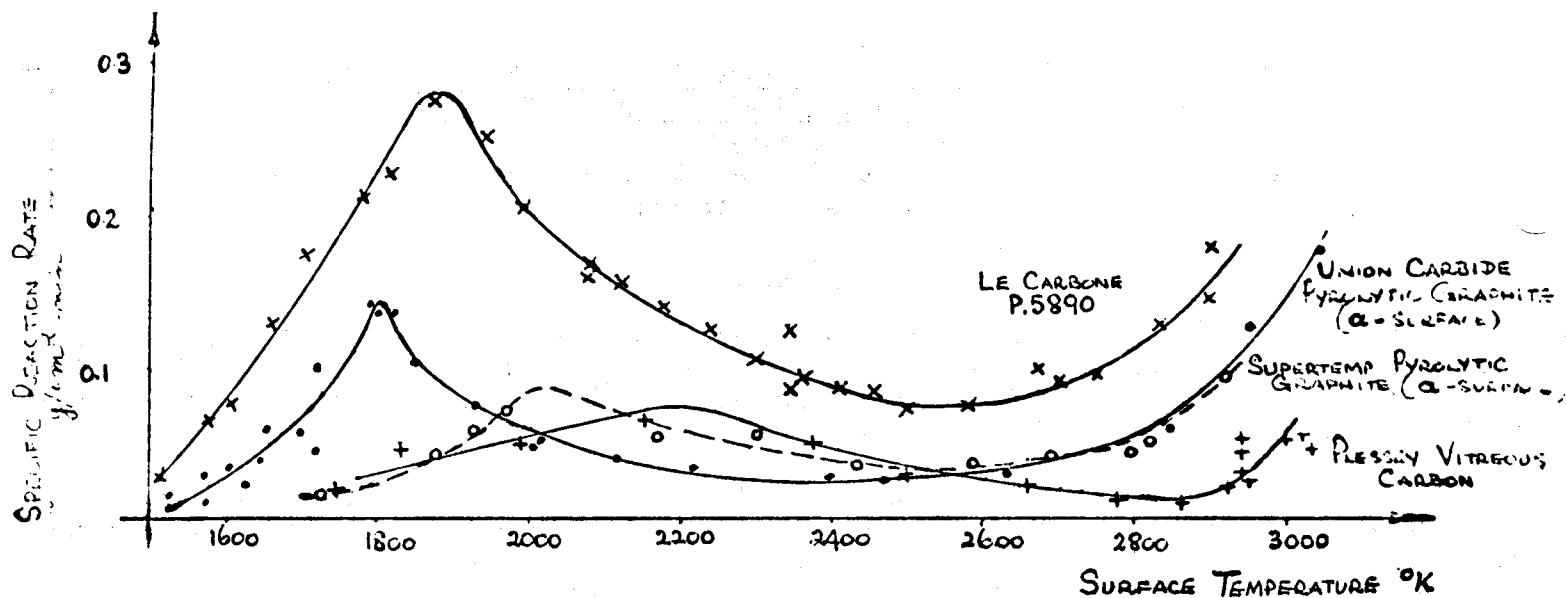


FIG. 1 Reactivity of various carbons with carbon dioxide (cold) at 19 p.s.i. pressure and gas velocity ~ 3000 cm/sec.

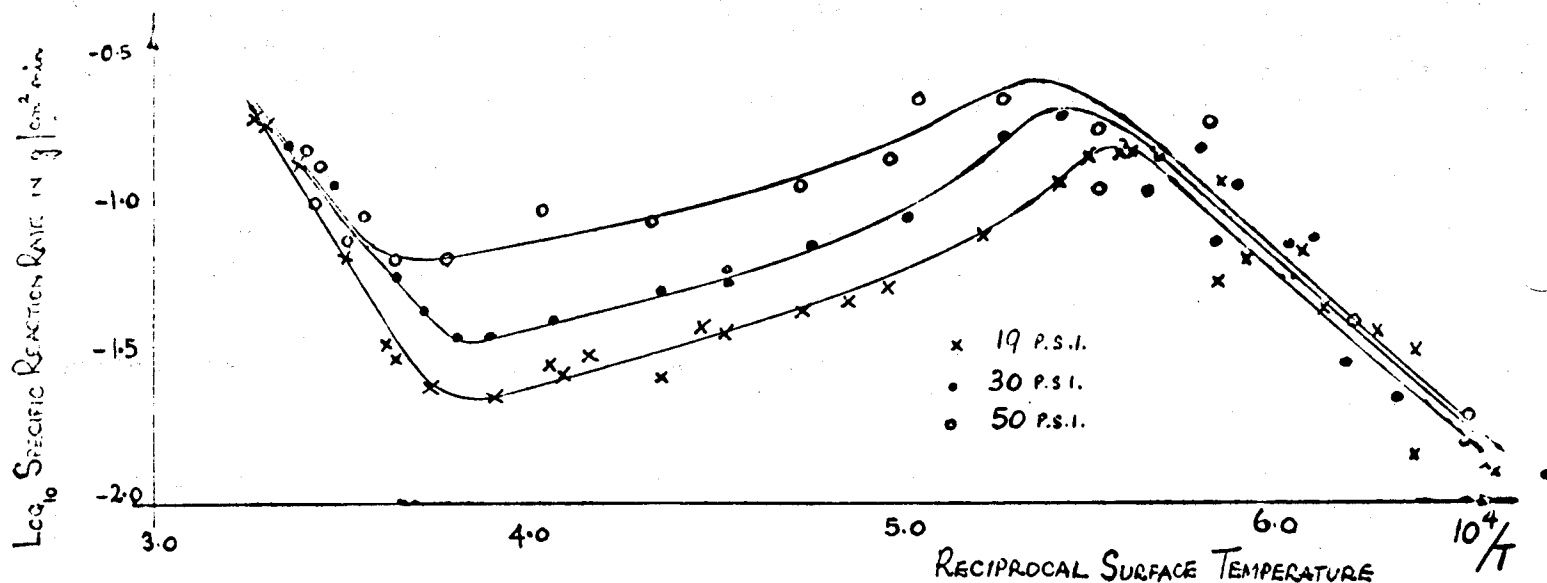


FIG. 2 Variation of reactivity of Union Carbide pyrolytic graphite with pressure of CO_2

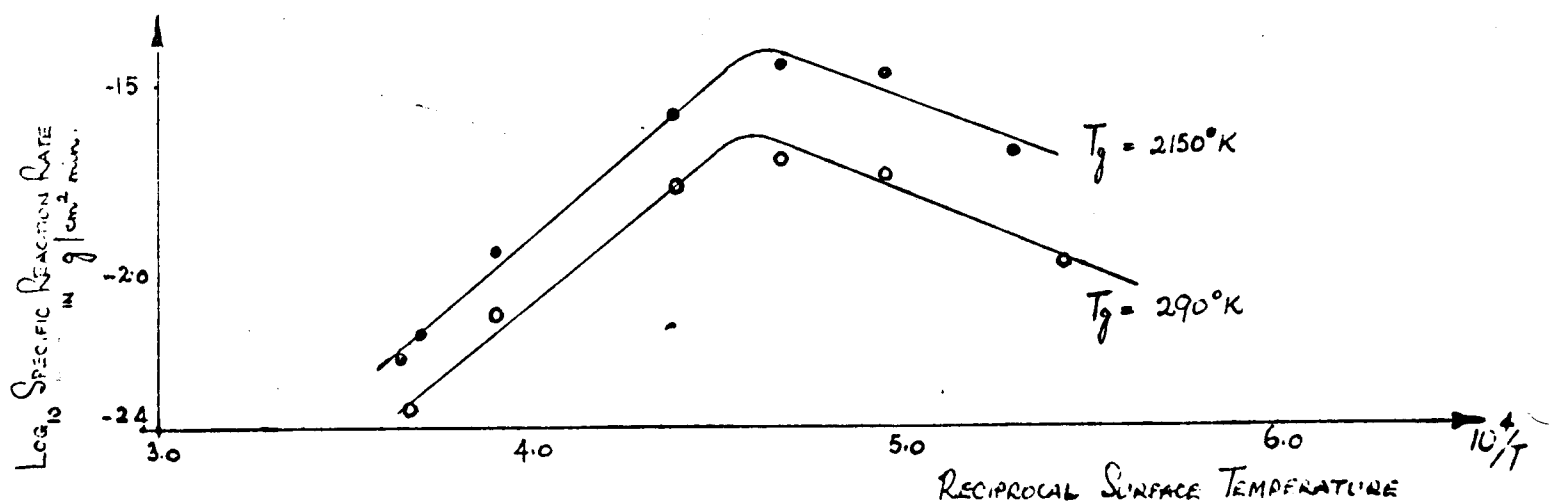


FIG. 3 Effect of gas feed temperature T_g on reactivity of vitreous carbon with 48% CO_2 , 52% Ar mixture