CO-ADSORPTION OF CYANOGEN CHLORIDE AND CHLOROPICRIN ON CU-CR-AG IMPREGNATED CARBON

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Introduction

A copper-chromium-silver impregnated carbon was challenged with a mixture containing cyanogen chloride (CK) and chloropicrin (PS) at equal concentrations. It is well known [1] that PS is retained on the carbon surface by physical adsorption, while CK is removed by adsorption, followed by chemical reaction with the metal impregnants. The objective of this project was to verify whether interference occurs, e.g., competition for adsorption sites, during the exposure of the carbon surface to these two different chemical vapours.

Experimental

The impregnated carbon employed was a Calgon 12x30 US mesh ASC/T carbon. Fresh sample of this carbon was loaded using the "snow-storm method" into a tube-tester 5 cm in diameter and 2 cm in height for each challenge. The challenges were carried out in an air flow set at 7.5 L/min, 30°C and 80% RH. A concentration of 4000 mg/m^3 was used for each gas in the challenge. Thus, in a combined (two-components) challenge, 4000 mg/m^3 each of CK and PS were present in the gas stream. The carbon was preconditioned at 30°C and 80% RH until constant weight was obtained before all challenge experiments. Breakthrough concentration was set at 2.5 mg/m^3 and 5 mg/m^3 for CK and PS respectively. Breakthrough times and penetration profiles were obtained for all challenges (single- and two-components).

Results and Discussions

Table 1 summarizes the breakthrough times obtained in these experiments. The bracket behind the breakthrough times indicates the number of data obtained. The breakthrough times measured for CK and PS were essentially the same whether it is a single-component or two-components challenge, within experimental standard deviations. Since the breakthrough occurred within 30-40 minutes of the initial introduction of the challenge gases, this indicates that there is no competition for adsorption sites between CK and PS at low dosage. This could also suggest that there are abundant non-discriminative sites for the initial adsorption for both CK and PS on the carbon surface.

The competition for adsorption sites in the two-components challenge is more apparent at higher concentrations as shown in Figures 1 and 2. The penetration profiles for both CK and PS shift to the left i.e., to higher concentrations at a shorter time period in the two-components challenge. The peaking of PS concentration in the penetration profile at about 180 minutes shown in Figure 2 was attributed to the desorption of PS from the carbon surface caused by the more "strongly-adsorbed" water molecules present in the challenge gas mixture.

Conclusion

At the low concentration (or dosage) regime, there is no observable interference on the carbon surface in the removal of CK and PS in a mixed challenge. This indicates that the current gas mask canister employing ASC/T carbon is capable of withstanding the challenge of a mixture of toxic gases which are removed by the carbon via different pathways. This finding contradicts those reported previously [2, 3] that the adsorption capacity for chloropicrin was reduced drastically when challenged in the presence of hydrogen cyanide and sulfur dioxide respectively. The presence of water on the carbon and inside the challenge gas mixture exhibit interference on the adsorption of PS, agreeing with previous results [3].

References

[1] Bansal RC, Donnet JB and Stoeckli F. Active carbon. Marcel Dekker Inc NY. 1988: 336.

[2] Barnardt CA and Dilebo N. The influence of binary exposure to trichloronitromethane (PS) and hydrogen cyanide on the capacity of ASC impregnated carbon. Extended abstracts, Carbon 96. University of Newcastle Upon Tyme (Newcastle, UK): European Carbon Society, 1996; 58-59.

[3] Anstice PJC and Alder JF. The effect of sulfur dioxide on the adsorption properties of activated carbon towards chloropicrin. Adsorpt Sci Technol 1997; 15(7): 541-550.

Table 1. Breakthrough Times (Minutes) of CK and PS Challenges

Gas	Single-Component	Two-Component
CK	25.4±3.6 (6)	25.1±5.4 (10)
PS	32.9±6.2 (5)	33.4±8.0 (10)

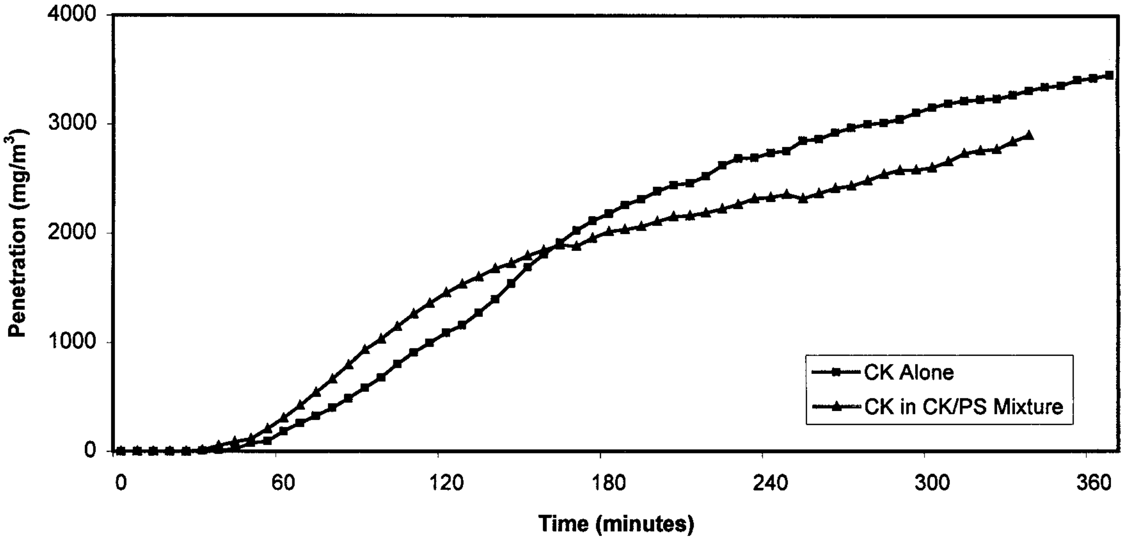

Figure 1. Penetration Profiles of CK on the Impregnated Carbon

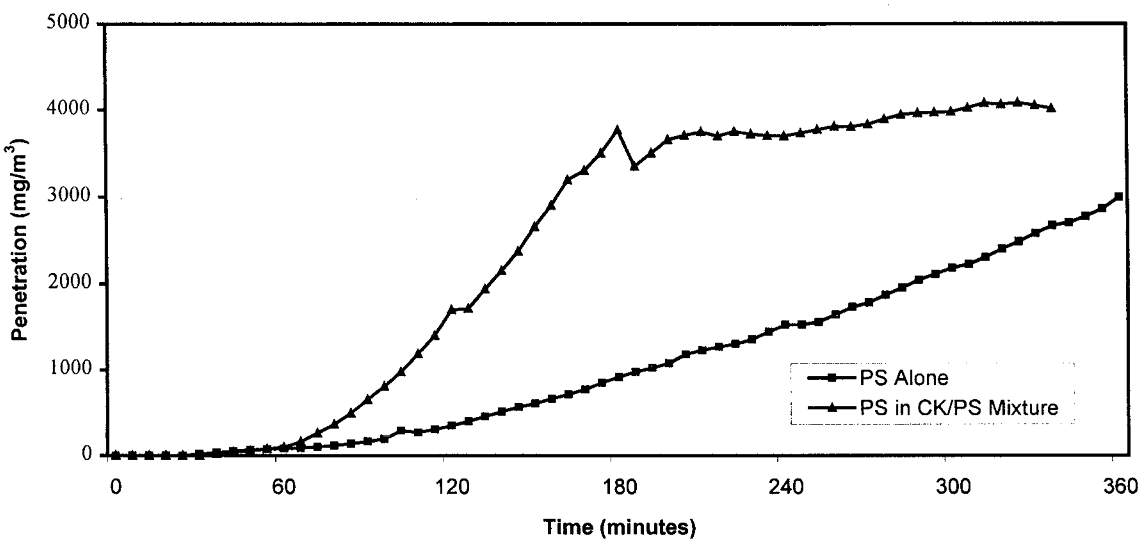

Figure 2. Penetration Profiles of PS on the Impregnated Carbon