

SARAN CARBON--A SUPERIOR ADSORBENT  
FOR VOLATILE COMPOUNDS

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Introduction

Saran carbon has been described in the literature for more than 25 years. It is a pure, high surface area carbon made by pyrolysis of poly(vinylidene chloride) or vinylidene chloride copolymers (Sarans). Saran degrades and crosslinks by evolving hydrochloric acid at temperatures well below its melting point. Crosslinked polymer can then be heated above the original melting point without fusion. Since the Saran never melts, the Saran carbon produced has the same shape as the Saran starting material.

Potential commercial applications of Saran carbon as an adsorbent have been explored at The Dow Chemical Company, the sole producer of Saran polymers in the United States. Saran carbon beads as large as 10 mesh and as small as 150 mesh have been made and studied on the laboratory scale. These beads have been labeled Dow Developmental Adsorbent with experimental designation number XF-4175L for sampling purposes.

Saran suspension beads were made by modification of the polymerization technique described by Meeks.<sup>1</sup> These Saran beads were then carbonized by pyrolysis methods similar to those described by Dacey and Thomas<sup>2</sup> and many others.

Physical Properties

The Saran carbon beads are very hard and non-dusting. They will not mark paper. They are easy to handle in analytical applications in which quantitative transfer is important. The measured Moh hardness of Saran carbon is about 4.5. Its CWS hardness number is 97. No measureable attrition was observed in a Saran carbon fluidized bed after 200 hours.

Saran polymer as the starting material for carbon affords processing options that coal or coconut shells cannot give. Control of granule shape is the prime example. In addition to beads, Saran carbon can be made into pellets or tablets by compacting Saran into these shapes. The crosslinking of the polymer during carbonization acts as a strong carbon binder. Therefore, the Saran carbon granules do not lose their strength or integrity in acidic and basic media.

The macroporosity of Saran carbon can also be controlled. Saran suspension beads have a porosity of 25-30%, with about one micron pores throughout the beads. This macroporosity is retained upon carbonization. Mercury intrusion curves show that Saran carbon has much more interconnected pore volume in the macropore range (greater than 300 Angstroms) than coconut shell carbon. *These macropores are important* for access of fluids to the micropores where nearly all the adsorption takes place. The macropore volume of Saran beads (and, consequently, of Saran carbon) can be increased by adding organic solvents such as methylene chloride or heptane to vinylidene chloride before suspension polymerization.

The molecular sieve properties of Saran carbon have been widely discussed in the literature.<sup>2-5</sup> The amount of adsorption of molecules of different molecular cross-sections has established the size of micropores. They have been described at various times as 5 to 12 Angstroms in diameter, depending on the initial Saran polymer composition and heat treatment temperatures.

Air Sampling Tubes

Saran carbon has been evaluated as an adsorbent in our laboratory under dynamic flow through packed beds. These are the types of adsorption conditions encountered industrially. Its use in air sampling tubes for industrial hygiene samples was studied because of its ease of handling. Saran carbon beads packed in 4 mm i.d. tubes were found to give longer than normal breakthrough times with volatile compounds such as vinyl chloride, methyl chloride, methylene chloride, and acrylonitrile. For example, with one gram samples of Saran carbon and Pittsburgh Activated Carbon PCB (coconut shell carbon) packed in tubes, methyl chloride broke through the Saran carbon tube three times longer than the coconut shell carbon tube. Air contaminated with 50 ppm methyl chloride flowed through the tubes at 50 ml/min. One percent breakthrough of methyl chloride occurred in 2.5 minutes with the coconut carbon tube and 7.5 minutes with the Saran carbon tube.

Volatile adsorbents on Saran carbon gave in nearly every case 100% recovery factors when desorbed in carbon disulfide or when desorbed by heating to 200°C in nitrogen. Thus, the Saran carbon not only adsorbs and retains volatile organic compounds much better than the best commercial carbon for this use, but also desorbs quantitatively. For example, Saran carbon in air sampling tubes was used to adsorb vinyl chloride, methyl chloride, dimethyl ether, ethyl chloride, and vinylidene chloride from air downwind of a chemical plant. The compounds concentrated in this way were desorbed thermally directly in a gas chromatograph. Concentrations in the 1 to 100 parts per billion range were obtained. The thermal desorption was quantitative so the Saran carbon air sampling tubes were re-used several times.

#### Gas Mask Canisters

These unexpectedly long breakthrough times with volatile compounds were also found for Saran carbon in gas mask cartridges. Ten ppm vinyl chloride in 85% relative humidity air was pumped through twin chemical cartridge respirators at 64 liters per minute. The concentration of vinyl chloride in the effluent stream was analyzed as a function of time. The Saran carbon cartridges broke through to 1 ppm vinyl chloride after two hours. The cartridges packed with coconut shell carbon broke through in less than 15 minutes.

In addition to prolonged breakthrough times, Saran carbon in gas masks might allow simpler canister design. Saran carbon beads pack well without channeling and are not dusty. Thus, it might be possible to remove some of the partitions, screens, and filters from present canister design.

#### Economic Considerations

Saran as a raw material for carbon is both more expensive and more corrosive upon carbonization than coconut shells or coal. Consequently, Saran carbon will be several times more expensive. Specialty adsorption uses that can afford a higher carbon cost have to be found for Saran carbon if it is to become a commercial adsorbent.

#### References

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