

MONSANTO CHEMICAL COMPANY

MERRIMAC DIVISION

BOSTON, MASS.
EVERETT STATION

July 24, 1939

Dr. Leroy U. Gardner
Director
Saranac Laboratory
P.O. Box 551
7 Church Street,
Saranac Lake, N. Y.

51629

Dear Dr. Gardner:

In accordance with your letter of July 19th, I am sending a one pound sample of Santocel (trade name for the silica aerogel) for your examination of its capacity to induce fibrosis.

You may be interested to know that the National Institute of Public Health under the direction of Dr. Sayers, Chief Surgeon, has been investigating the characteristics of Santocel as a silicosis hazard. Up to the present time their results have not been very conclusive since one sample did induce prolific nodulation when injected into the peritoneum but another sample failed to duplicate this. I believe they are still actively engaged in further experiments with the material. Dr. Sayers is quite interested in the silica aerogel because, it being a new physical form of silica, it may offer a new means of attacking the problem of general research on silicosis.

For your information I am including a brief description of the process we use along with some theories pertinent to the subject. Some of these have been evolved by us and some have been taken from the literature.

Our starting material is a sodium silicate solution comprising of Na_2O , SiO_2 and water. In this solution the SiO_2 is partially colloidal and partially crystalloidal. This solution is neutralized with acid, converting nearly all of the SiO_2 to the colloidal form. While a liquid this mixture is referred to as a silica sol. After standing for some time (the time is

a function of the pH), the sol sets to a firm rigid transparent gel. No evidence can be obtained concerning the composition of the SiO_2 in a freshly prepared gel but the literature indicates that after an extended aging period an X-ray diffraction pattern for cristobalite, an anhydrous crystalline SiO_2 , can be obtained.

It is probable that the SiO_2 in a freshly prepared gel is cristobalite but the crystals are truly colloidal in size and are too small to give any pattern. These crystals orient themselves into long chains, setting up an interlocked fibrous mass that is the gel. The liquid phase present, a dilute water solution of Na_2SO_4 , is entrapped by these fibres.

Heating this gel will volatilize the water and, because of the surface tension forces set up at the gas-liquid interface, the fibres will be drawn into a more closely knit structure and shrinkage results. During this heating in the presence of water it is probable that there is some growth in the crystal size of the SiO_2 and hence it loses some of its colloidal properties. A material prepared by such treatment of an SiO_2 aqua gel is known as an xerogel or commercial silica gel.

In the aerogel process an SiO_2 aqua gel is formed but the water phase is replaced with alcohol by placing the aquagel in alcohol and allowing diffusion to take place. The alcohol is constantly renewed until the liquid phase is at least 90% EtOH. This composition is termed an SiO_2 alcogel. As far as is known the SiO_2 structure undergoes no change during this treatment.

This alcogel is heated in an autoclave to above the critical temperature of the alcohol while maintaining a pressure in excess of the critical pressure. When a temperature in excess of the critical is reached, the pressure is released and reduced to atmospheric.

This technique accomplishes two things. A gas-liquid interface is prevented for up to the critical temperature only the liquid phase is present and beyond this only the gas phase is present. This avoidance of the two phase interface prevents shrinkage. The heating of the SiO_2 in the presence of alcohol rather than water prevents any marked growth of the SiO_2 crystals. Therefore, the final aerogel comprises of the SiO_2 in colloidal size

Dr. Leroy U. Gardner

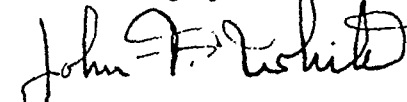
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crystals, the crystals oriented in chain-like groups to form a fibrous interlocked mass with air entrapped in place of the water in the original aquagel.

As you probably realize, we, as manufacturers of Santocel, are extremely interested in its capacity to induce silicosis and will be very anxious to learn of any results that you may attain.

Sincerely yours,



John F. White
SANTOCCEL RESEARCH

JFW:REC

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