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Covalent Bonding of Polycations to Small Polymeric Particles

A newly developed process produces small spherical polymeric particles which have polycations bound to them. The particles are made by the copolymerization of vinyl monomers and 2-dimethylamino-ethylmethacrylate, and they are modified by means of a quaternization (Menshutkin) reaction. The addition of dihalides and diamines causes the formation of polycations containing positive charges in their backbones. The number of polycation chains and the number of positive charges present in each chain may be varied.

The particles can be utilized in medicine and biology. In an emulsion form, they present a large positively charged surface which is available to absorb polyanions. This property can be used in removing heparin, a polyanion, from the blood in patients with kidney malfunctions. [Also see NASA Tech Brief B75-10336 (NPO-13620)]. A similar technique can be used in removing bile acids from the digestive track. In addition, other anions, such as DNA and RNA, can also be removed from aqueous solutions.

An experiment was conducted to test the effectiveness of these particles in combining with heparin. The procedure was as follows: Spherical particles (1.66 μm in diameter) containing dimethylamino groups were stirred with 1,3-dibromopropane and 1,3-tetramethylaminopropane at room temperature in a dimethylformamide-methanol mixture (1:1 by volume for 24 hours). The reaction product after the addition of water was centrifuged. The centrifugation in the presence of water was repeated until the supernatant was free of bromide ions. An aqueous suspension of polycation spheres (1 cm^3 , 28 mg/cm^3) was added to 20 ml of a heparin solution (1 mg/cm^3). After stirring the mixture for 15 minutes and filtration, the filtrate contained 0.04 mg/cm^3 of heparin.

By repeating this experiment under identical conditions but using 2 cm^3 of suspended charged spheres, no heparin could be detected in the filtrate by

means of azure A dye. The presence of positive charges on the spherical particles was ascertained by reaction with eosin Y. The latter is acidic dye which combines with 3,3-ionene to form an insoluble red precipitate. The ionene spheres were stirred in an aqueous solution with eosin Y for 10 minutes and then were centrifuged in distilled water 10 times. The spheres remained dark red. Polyhydroxyethylmethacrylate spheres without dimethylamino groups served as control. After reaction with eosin Y and centrifugation, they were free of dye and appeared white.

Further studies have to be conducted to see if the polycations have any toxic effects on the human body. By themselves they do, but their effect is significantly diminished after they combine with the polyanions.

Notes:

1. Recent studies have shown that ionene spheres kill leukemic EL4 cells by contact.
2. Requests for further information may be directed to:

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Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)] to California Institute of Technology, Pasadena, California 91109.

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