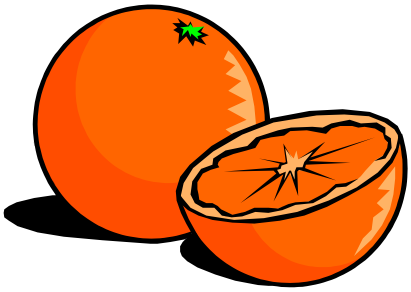
Polymers from Oranges:

Design and Feasibility of Polymer Production from Orange Oil Derivatives



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May 2, 2005

Executive Summary

This project presents the design and economic feasibility of a plant to produce a novel polymer made from orange oil derivatives and carbon dioxide. This new technology is desirable because of its use of carbon dioxide that would normally be emitted into the atmosphere and its use of renewable resources that reduce dependence on foreign oil. The polymer produced has properties similar to polystyrene, but the exact properties have not yet been determined experimentally. The feed products for the process are orange oil, tert-butyl hydroperoxide, and carbon dioxide. Carbon dioxide is a cheap feedstock because of its availability from power plants that wish to reduce emissions. The products of the process are the polymer polylimonene carbonate and tert-butyl alcohol. The process involves two main sub-processes, the production of limonene oxide from the orange oil and the production of the polymer from limonene oxide. Because of the large dependence of the process on the orange oil supply, this process should be approached as an addition to an orange processing plant in Florida. Florida also offers access to a carbon dioxide supplier and a styrofoam processing plant, making it an ideal location for the plant. A pilot plant should be constructed to insure the reliability of the product and to confirm reaction rates, which are based on limited lab-scale experiments using 30mL reactors. The equipment cost for the process was approximately $1 million, resulting in a total capital investment estimate of approximately $7.3 million. The product price necessary to achieve a ten percent return on investment is approximately $1.18/lb. This corresponds to a Net Present Worth of $1.1 million. This product price is not an unreasonable, but it is significantly higher than the current polystyrene price of $0.90/lb. The largest risk to the process is the orange oil supply, which can have large fluctuations after natural disasters affecting the orange crop. Because of orange oil price risks, there is a 27% chance that at least a ten percent return on investment will be realized with a product price of $1.18/lb. This was determined by creating a probability distribution for the price of orange oil with @Risk add-in for Excel. If further analysis of the properties of the novel polymer reveals advantages over conventional polystyrene, it is likely that this process will be able to compete with oil-derived polymers with current oil conditions. However, orange processors and the plastics industry should be aware of this technology and its developments as an alternative to oil-derived polymers.