REACTOR WITH IMPROVED RESISTANCE TO FOULING

Field of the Invention

The invention pertains to shell and tube oxidation reactors and processes for making acrylic acid through the oxidation of propylene.

Discussion of the Related Art

The production of acrylic acid by fixed-bed catalytic oxidation of propylene is widely practiced and involves oxidizing propylene to the intermediate acrolein and then further oxidizing acrolein to acrylic acid. Numerous solid particulate-type catalysts have been developed to facilitate this two-stage oxidation process and methods for preparing these catalysts are well documented in the literature.

In general, commercial-scale manufacturing facilities utilize two compositionally distinct catalysts, a first stage catalyst and a second stage catalyst, in the production of acrylic acid. First stage catalysts (referred to herein as "R1 catalysts") are mixed metal oxide ("MMO") catalysts generally comprising molybdenum, bismuth, and optionally iron, and are used to promote the conversion of propylene to acrolein. Second stage catalysts (referred to herein as "R2 catalysts") are also mixed metal oxide (MMO) catalysts, but these generally comprise molybdenum and vanadium, and are used to promote the conversion of acrolein to acrylic acid.

Current commercial-scale processes for the production of acrylic acid often utilize reactors modeled on shell-and-tube heat exchangers. Typically, such commercial reactors comprise from about 12,000 up to about 22,000 tubes in a single reaction vessel and may have acrylic acid production capacities of up to 100 kT/year (220,000,000 pounds/year) operating with a 93% onstream factor. Large-scale commercial reactors, though less common, may comprise 25,000 up to about 50,000 tubes in a single reaction vessel, with production capacities of up to 225 kT/year (500,000,000 pounds/year). In such shell-and-tube type reactors, a fixed catalyst bed can be assembled by loading particulate-type MMO catalysts into the tubes of the reactor. Process gases may flow through the tubes, in direct contact with the catalyst particles, while coolant can be passed through the vessel shell to remove the heat of reaction. Typical coolants include molten nitrate salts and organic heat transfer fluids, such as Dowtherm™. The resulting product gas from the reactor can be collected and purified in additional downstream equipment, such as one or more of quench