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Review 2013-15
Hydrogen Peroxide

By Mike Kelly

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Abstract

Commercial production of hydrogen peroxide is dominated by the conventional anthraquinone process, which involves hydrogenation of alkylanthraquinones to the corresponding anthrahydroquinone, followed by oxidation to yield hydrogen peroxide and the original alkylanthraquinone. The direct reaction between hydrogen and oxygen, which is, in principal, the simplest pathway for producing hydrogen peroxide, has been of interest for many years because of its potential for capital savings, particularly when integrated with production of chemical intermediates like propylene oxide. However, the direct hydrogen peroxide process route is not without its challenges, namely low catalyst activity, poor product selectivity, and safety. For these reasons and others it has yet to be commercialized.

This review presents a conceptual direct synthesis process for hydrogen peroxide production, based largely on patents assigned to Headwaters Technology who, together in a joint venture with Evonik, showed early progress toward commercializing a direct process route. In this novel design, a 70 weight percent hydrogen peroxide product is produced by the direct catalytic reaction of hydrogen and oxygen in the presence of a liquid methanol reaction medium. The hydrogen is fed into the reactor at four serially connected stages or conversion zones, each with a uniform molar ratio of oxygen to hydrogen. Hydrogen conversion and selectivity to hydrogen peroxide are both 90%. The catalyst employed is a supported palladium-based nanocatalyst with a crystal face exposure of FCC 110 and coordination number of 2.

Variable and total fixed capital costs for the standalone 217 million lb/yr (~98,000 metric ton/yr) direct synthesis plant presented in this review are about 25% higher and 33% lower, respectively, when compared to the conventional anthraquinone-based plant presented in PEP Report 68B. However, the total fixed capital cost comparison is somewhat limited given that the size of the conventional plant at 45 million lb/yr (20,000 metric ton/yr) is outside typical scaling allowances. Compared to recent announcements for the conventional-based technology, total fixed capital costs for the standalone direct synthesis plant appear to be near or above the high end of the range.

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