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Coal-Based MEG Production by Sinopec SRIPT Process

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Abstract

This review presents a technoeconomic evaluation of a grassroots monoethylene glycol (MEG) plant built on the basis of patented R&D work of the Shanghai Research Institute of Petrochemical Technology (SRIPT), Sinopec. The route or chemistry of this production process is the same as that of Fujian or Ube MEG technologies. The analysis of these two technologies was presented in PEP reviews 2012-10 and 2013-09, respectively. However, based on information in the respective patents of these two companies, some differences are noted in the SRIPT technology, especially in the operational arrangement of the coupling and hydrogenation reactors with respect to their feed entry. Conversions of reactants and selectivities to products—dimethyl oxalate (DMO) from the coupling reactor and MEG from the hydrogenation reactor—are equal to or slightly higher than those for the Fujian or Ube processes as depicted in some of the examples. The base metal concentration of catalysts used in those examples is comparatively higher. Product workup or purification details are not provided in SRIPT patents. So, for this evaluation, we have followed the same workup methodology that we used for the Ube process in PEP Review 2013-09.

The SRIPT process, like the Ube process, consists of two main steps: 1) DMO production and 2) MEG production. Overall, the process may be described as consisting of several stages of reaction and reaction products separation. In the initial step, CO (imported or produced onsite) and methyl nitrite (CH_3ONO) react in a gaseous phase in the presence of a proprietary palladium catalyst producing a mixture of dimethyl oxalate ($CH_3COOCOOCH_3$) and nitric oxide (NO). The two reaction products are separated from each other by condensing dimethyl oxalate in a methanol-scrubbed column. Nitric oxide, along with unconverted CO and other associated light gases, leaves the scrubber column from the top in a gaseous stream.

In the second step, nitric oxide formed in the first step, is reconverted back to methyl nitrite by reacting it with methanol and oxygen. Water is also formed in this reaction. The reaction takes place in a countercurrent gas-liquid column with nitric oxide and oxygen entering from the bottom and methanol spraying down from the top. The light gases (mainly unconverted NO, CO, CO_2, and N_2) leaving from the top of the column are cooled and, after purging, a small portion is recycled to the first-stage coupling reactor along with regenerated methyl nitrite. An aqueous solution of methanol is removed from the bottom of the regeneration column. Small amounts of higher oxides of nitrogen are also formed in the reaction resulting in the loss of NO. A means is provided to produce nitric oxide to make up for that loss.

The third reaction step consists of DMO conversion to ethylene glycol (EG) in a hydrogenation step in the presence of excess of H_2. Methanol is regenerated in this reaction. This is a vapor-phase process in which a Cu-Cr-Ba- or Cu-Cr-Zn-based catalyst is used. Some impurities/by-products such as methyl glycolate, dimethyl carbonate, methyl formate, 1,2-butanediol, etc. are also produced in small amounts. While most of the impurities are removed from the EG without a problem, 1,2-butanediol (BDO) separation may pose a problem in producing a fiber-grade EG due to the closeness their boiling points.

Process economics of a standalone, as well as integrated (with coal gasification/syngas), EG plants are presented in this review. Comparative economics of the Fujian, Ube, and Sinopec processes are also given.

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Contents

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Figures

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Tables

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