Abstract

PEP Review 2012-10

ETHYLENE GLYCOL PRODUCTION FROM COAL-BASED SYNTHESIS GAS

By

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(October 2012)

ABSTRACT

This review presents a technoeconomic evaluation of a newly commercialized monoethylene glycol (MEG) production route, which, if it successfully meets the desired level of product purity and catalyst stability, could revolutionize the MEG industry with the possibilities of switching its production from the current ethylene-based source to a new coal-based source. At the moment, this route is only commercialized in China, mainly because of its rich coal resources and high ethylene prices.

The technical review presented here is based on a study of about twenty-seven patents of Chinese companies and institutes (listed inside). The process design and plant economics worked out therefrom are, however, based upon the information provided by the Fujian Institute of Research on the Structure of Matter (Chinese Academy of Sciences) in its patents (CN1054765A, CN1148589A, and CN102247847A). Six plants based on Fujian technology, each at 200 thousand t/yr capacity, are under construction. The owners of these six plants are Henan Coal Chemical Group Co. Ltd. and Tongliao GEM Chemical Co. Ltd.

The process essentially consists of several stages of reaction and resulting products separation. In the initial step, CO and methyl nitrite (CH_3ONO) react in the gaseous phase in the presence of a proprietary Pd 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, leave the scrubbing column in gaseous form.

In the second step, nitric oxide formed in the first step is converted back to methyl nitrite by reacting 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 the column from the top. The light gases (mainly unconverted NO), unconverted O_2, CO, CO_2, N_2, etc., leaving from the top of the column are cooled, and after purging a small portion thereof, recycled to the first-stage dimethyl oxalate reactor. An aqueous solution of methanol is removed from the bottom of the column.

The third reaction step consists of converting dimethyl oxalate to ethylene glycol (EG) in an excess of H_2. Methanol for producing methyl nitrite is also regenerated in this reaction. This is a vapor-phase process in which a proprietary type of copper-zinc chromite is used as a catalyst. 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 serious difficulties, 1,2-butanediol is likely to pose a problem for producing fiber-grade EG.

Product separation and refining (of EG) is done through a series of distillation columns.

The process economics of a stand-alone as well as an integrated (with coal gasification/syngas) EG plant are presented in this review.

A private report by the

Process Economics Program

Review No. 2012-10

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