METHOD FOR THE PRODUCTION OF ETHYLENE OXIDE

Field

The present invention relates to a method for the production of an ethylene oxide, an ethylene glycol, an ethylene glycol ether, an ethylene carbonate or an ethanol amine.

Introduction

Vapor phase water is introduced into the ethylene oxide reactor in a typical commercial reactor in the feed gas at the inlet of the reactor as well as by generation within the reactor due to the complete combustion of a portion of the ethylene fed to the reactor to carbon dioxide and water.

US Pat. No. 8,546,592 states that it is "well known that low CO_2 levels are useful in improving the selectivity of high selectivity catalysts. See, e.g., US Pat. No. 7,237,677; US Pat. No. 7, 193,094; US 2007/0129557; WO 2004/07873; WO 2004/07874; and EP 2,155,708. These patents also disclose that water concentrations in the reactor feed should be maintained at a level of at most 0.35 mole percent, preferably less than 0.2 mole percent." Col. 1, lines 53-60. To provide these low levels of water concentration, US Pat. No. 8,546,592 teaches controlling presence of the water vapor in the catalyst bed such that the ratio of the partial pressure of water (PPH2O) divided by the vapor pressure of water (VPH2O) is less than 0.006, preferably less than 0.004. US Pat. No. 8,546,592 describes a number of ways by which the ratio of the partial pressure of water (PPH2O) divided by the vapor pressure of water (VPH2O) can be reduced. One or more of the methods described in US Pat. No. 8,546,592requires additional capital and/or energy costs for the plant operation (e.g., increasing the cooling of the overhead streams coming from the ethylene oxide removal and/or carbon dioxide removal sections of the plant that return to the ethylene oxide reactor, operation of the reactor at a higher temperature than required) or other undesirable consequences (e.g., reduction in work rate).

It is desirable to provide a method for the production of ethylene oxide without having to expend the capital and/or energy needed to keep, or incur other undesirable consequences of keeping, the inlet water concentration at such low levels.

Summary

In one aspect, there is provided a method of producing ethylene oxide comprising:

a) providing to a reactor a reactor inlet gas mixture comprising ethylene, oxygen, one or more gas phase promoters, water and carbon dioxide, wherein the one or more gas phase promoters are organic chlorides, the components of the gas mixture subsequently being contacted within the reactor under epoxidation reaction conditions with a catalyst comprising

a catalytically effective amount of silver supported on a high purity carrier, a promoting amount of at least one Group IA metal, and a promoting amount of rhenium;

b) yielding from the reactor a reactor outlet gas mixture comprising ethylene oxide, ethylene, oxygen, water and carbon dioxide;

c) providing at least a portion of the reactor outlet gas mixture to an ethylene oxide absorber to produce an ethylene oxide stream and a treated gas stream comprising water and carbon dioxide;

d) providing at least a portion of the treated gas stream to a carbon dioxide absorber unit;

e) operating the carbon dioxide absorber unit to produce a recycle gas stream comprising carbon dioxide and water; and

f) combining at least a portion of the recycle gas stream from the carbon dioxide absorber unit with fresh feeds comprising oxygen and ethylene and at least a portion of a remaining portion, if any, of the treated gas stream, to form the reactor inlet gas mixture, wherein:

(i) a partial pressure of water vapor at the reactor inlet is at least about 8 kPa; and

(ii) the partial pressure of water vapor at the reactor inlet is continuously maintained at at least about 8 kPa over a period corresponding to the production of at least 250 kmole of ethylene oxide per cubic meter of catalyst.

In another aspect, there is provided a method of producing ethylene oxide comprising:

a) providing to a reactor a reactor inlet gas mixture comprising ethylene, an oxygen-containing gas, one or more gas phase promoters, water and carbon dioxide, wherein the one or more gas phase promoters are organic chlorides, the components of the gas mixture subsequently being contacted within the reactor under epoxidation reaction conditions with a catalyst comprising a catalytically effective amount of silver supported on a high purity carrier, a promoting amount of at least one Group IA metal, and a promoting amount of rhenium;

b) yielding from the reactor a reactor outlet gas mixture comprising ethylene oxide, ethylene, oxygen, water and carbon dioxide;

c) providing at least a portion of the reactor outlet gas mixture to an ethylene oxide absorber to produce an ethylene oxide stream and a treated gas stream comprising water and carbon dioxide;

d) combining at least a portion of the treated gas stream with fresh feeds comprising ethylene and providing at least a portion of the combined stream to a carbon dioxide absorber unit;

e) operating the carbon dioxide absorber unit to produce a recycle gas stream comprising carbon dioxide and water; and

f) combining at least a portion of the recycle gas stream from the carbon dioxide absorber unit with fresh feeds comprising oxygen and at least a portion of a remaining portion, if any, of the treated gas stream, to form the reactor inlet gas mixture,

wherein:

(i) a partial pressure of water vapor at the reactor inlet is at least about 8 kPa; and

(ii) the partial pressure of water vapor at the reactor inlet is continuously maintained at at least about 8 kPa over a period corresponding to the production of at least 250 kmole of ethylene oxide per cubic meter of catalyst.

In another aspect, there is provided a method for making an ethylene glycol, an ethylene glycol ether, an ethylene carbonate or an ethanolamine comprising:

obtaining an ethylene oxide by a method for the production of ethylene oxide as disclosed above; and

converting the ethylene oxide into an ethylene glycol, an ethylene glycol ether or an ethanolamine.

We have found a method for the production of ethylene oxide wherein the partial pressure of water vapor at the inlet of the reactor is at least about 8 kPa. The method comprises providing to a reactor a reactor inlet gas mixture comprising ethylene, oxygen,