CATALYSTS AND METHODS FOR PRODUCING PROPYLENE FROM ETHYLENE AND BUTENE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is filed under the Patent Corporation Treaty, which claims the benefit of priority to U.S. Provisional Application No. 62/288,954, filed on January 29, 2016, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present disclosure relates to chemical catalysts and methods that may be used for the production and/or interconversion of olefins.

BACKGROUND OF THE INVENTION

[0003] Propylene (propene) is a commercially important olefin product and a byproduct of oil refining and natural gas processing. Propylene is also produced by on-purpose production methods, such as butene isomerization combined with olefin metathesis chemistry (see, for example, FIG. 1). Olefin metatheses, which are also known as disproportionation, are reversible reactions in which double bonds of, for example, ethylene and 2-butene (B2) are broken and then reformed as propylene. WO_3 supported on SiO_2 is one type of disproportionation catalyst that has been used, and MgO is one type of isomerization catalyst that has been used. The chemistry involves many side reactions in the disproportionation (DP) reactors (FIG. 2), including, *e.g.*, the half productive route for propylene via butene (B) self-metathesis and undesirable consumption of product propylene with 1-butene (B1) to produce higher olefins (C_{5+} olefins) and ethylene. Current methods are energy intensive, relying on high heat (*e.g.*, 650 °F), and significant quantities of isomerization catalyst, i.e. a high weight ratio of isomerization catalyst to the disproportionation catalyst (see, *e.g.*, FIG. 3).

SUMMARY OF THE INVENTION

[0004] In one aspect, the present disclosure provides methods comprising:

(a) obtaining a catalyst composition comprising an isomerization catalyst and a disproportionation catalyst, wherein the weight ratio of the isomerization catalyst to the disproportionation catalyst is from 10:1 to 1:10; and

CLAIMS

1. A method for producing propylene comprising:

   (a) obtaining a catalyst composition comprising an isomerization catalyst comprising MgO and a disproportionation catalyst comprising a transition metal oxide deposited on a solid support, wherein the weight ratio of the isomerization catalyst to the disproportionation catalyst is from 10:1 to 1:10; and

   (b) reacting butene with ethylene at a temperature from about 500 °F (260 °C) to about 650 °F (350 °C) in the presence of the catalyst composition under conditions sufficient to produce propylene;

   wherein the temperature is optionally decreased for increasing propylene production and reducing catalyst compositional decay.

2. The method of claim 1, wherein the ethylene and the butene are reacted at a temperature from about 500 °F (260 °C) to about 550 °F (288 °C).

3. The method of claim 1, wherein the weight ratio of the isomerization catalyst to the disproportionation catalyst is from about 4:1 to about 1:4.

4. The method of claim 1, wherein the weight ratio of the isomerization catalyst to the disproportionation catalyst is about 1:1.

5. The method of claim 1, wherein the isomerization catalyst is a zeolite, alumina, or a basic metal oxide selected from the group consisting of an alkali metal oxide, an alkaline earth metal oxide and a rare earth metal oxide.

6. The method of claim 1, wherein the transition metal oxide is an oxide of molybdenum, tungsten, cobalt, ruthenium, rhenium or a mixture thereof.

7. The method of claim 6, wherein the transition metal oxide is WO_3.

8. The method of claim 7, wherein the solid support is silica.

9. The method of claim 1, wherein the ethylene and the butene are reacted at a pressure from about 5 psig (0.14 MPa) to about 600 psig (4.24 MPa).

10. The method of claim 1, wherein the mole ratio of ethylene to butene is from about 0.5:1 to about 5:1.

11. The method of claim 1, wherein the weight hourly space velocity of the reaction is from about 1 hr^{-1} to 100 hr^{-1}.

12. The method of claim 1, wherein the method results in:

(a) a butene conversion percentage of greater than 55% relative to the amount of butene;

(b) a propylene selectivity percentage of greater than 85% relative to the total reaction products; or

(c) a propylene yield of greater than 50% based on the amount of butene.