Description

Title of Invention : Method and System For Producing An Olefin

Technical Field

The present invention generally relates to the preparation of chemical compounds, and more specifically, the preparation of optionally substituted olefins.

Background Art

Developing chemical reactions or processes to transform renewable carbon-neutral feedstock such as biomass into valuable chemical commodities is one of the most pressing issues in the 21st century. Such reactions will reduce our dependence on fossil fuels, ultimately bringing about benefits to the environment and the economy.

1,3-butadiene (BD) is a high-value chemical monomer used for the production of commercial polymers such as styrene-butadiene rubbers. BD can be converted from ethanol either directly or via a two or more step process. In recent times, BD is extracted from oil via steam cracking of petroleum gas or naphtha. However, with the rising prices of crude oil and decreasing prices of chemicals derived from cheap biomass, reactions like ethanol-to-butadiene conversion have come to the fore again in recent years.

Several catalyst systems have been used in the conversion of ethanol to BD. However, percentage conversion of ethanol and selectivity of BD have not been satisfactory for practical industrial application.

There is therefore a need to provide a method and system that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

According to a first aspect, there is provided a method for producing an optionally substituted olefin, comprising the steps of: dehydrogenating an optionally substituted alcohol in a first reaction zone comprising a first catalyst supported on a porous silica-based particle to form an optionally substituted carbonyl at a first set of reaction conditions; converting the optionally substituted alcohol and the optionally substituted carbonyl from the first reaction zone in a second reaction zone at a second set of reaction conditions that is different to the first set of reaction conditions and is selected to form the optionally substituted olefin, wherein the second reaction zone comprises a second catalyst supported on a porous silica-based particle.

According to a second aspect, there is provided a system for producing an optionally substituted olefin, the system comprising: a first reaction zone having a first catalyst for dehydrogenating an optionally substituted alcohol to form an optionally substituted carbonyl; and a second reaction zone having a second catalyst for converting the optionally substituted alcohol and the optionally substituted carbonyl from the first reaction zone to

Claims

1. A method for producing an optionally substituted olefin, comprising the steps of: dehydrogenating an optionally substituted alcohol in a first reaction zone comprising a first catalyst supported on a porous silica-based particle to form an optionally substituted carbonyl at a first set of reaction conditions; converting the optionally substituted alcohol and the optionally substituted carbonyl from the first reaction zone in a second reaction zone at a second set of reaction conditions that is different to the first set of reaction conditions and is selected to form the optionally substituted olefin, wherein the second reaction zone comprises a second catalyst supported on a porous silica-based particle.

2. The method of claim 1, wherein the first set of reaction conditions comprises controlling the alcohol/carbonyl molar ratio provided to the second reaction zone.

3. The method of claim 1 or 2, wherein the controlling step comprises fixing the temperature in the second reaction zone, while controlling the temperature in the first reaction zone.

4. The method of any one of the preceding claims, wherein the first set of reaction conditions comprises conducting the dehydrogenating step at a temperature of between 100°C to 400°C, or
wherein the second set of reaction conditions comprises conducting the conversion step at a temperature of between 250°C to 550°C.

5. The method of any one of the preceding claims, wherein the first catalyst and the second catalyst are different metal catalysts composed of different metals independently selected from the group consisting of a single metal catalyst, binary metal catalyst, ternary metal catalyst and metal oxide catalysts thereof.

6. The method of claim 5, wherein the metal or metal oxide of the first catalyst is selected from the group consisting of silver, gold, copper, cobalt, zinc, aluminum, magnesium, manganese, zirconium, tantalum, titanium, vanadium and their combinations thereof; and the metal or metal oxide of the second catalyst is selected from the group consisting of silver, gold, copper, zinc, aluminum, magnesium, zirconium, tantalum, titanium, vanadium and their combinations thereof.

7. The method of any one of claims 5 or 6, wherein the first catalyst is copper supported on a mesoporous silica-based particle.

8. The method of any one of claims 5 or 6, wherein the second catalyst is zirconium supported on a mesoporous silica-based particle.

9. The method of any one of the preceding claims, wherein the optionally substituted olefin is an optionally substituted diene.

10. The method of any one of the preceding claims, wherein the optionally substituted olefin comprises 4 to 20 carbon atoms and the optionally substituted alcohol comprises 2 to 20 carbon atoms.

11. The method of any one of the preceding claims, wherein the converting step comprises a step of coupling the optionally substituted alcohol with the optionally substituted carbonyl, and a step of dehydrating the coupled optionally substituted alcohol and optionally substituted carbonyl to form the optionally substituted olefin.

12. A system for producing an optionally substituted olefin, the system comprising:
a first reaction zone having a first catalyst for dehydrogenating an optionally substituted alcohol to form an optionally substituted carbonyl; and
a second reaction zone having a second catalyst for converting the optionally substituted alcohol and the optionally substituted carbonyl from the first reaction zone to form the optionally substituted olefin;
wherein the first and second catalysts are supported on a porous silica-based particle.

13. The system of claim 12, wherein the silica-based particle is mesoporous.

14. The system of claim 13, wherein the mesoporous silica-based particle is a mesocellular siliceous foam with
a pore size in the range of 1 um to 100 um.

15. The system of any one of claims 12-14, wherein the porous silica-based particle has a surface area of at least 350 m^2/g.

16. The system of any one of claims 12-15, wherein the first catalyst and the second catalyst are independently selected from the group consisting of a single metal catalyst, binary metal catalyst, ternary metal catalyst and metal oxide catalysts thereof or
wherein the metal or metal oxide of the first catalyst is selected from the group consisting of silver, gold, copper, cobalt, zinc, aluminum, magnesium, manganese, zirconium, tantalum, titanium, vanadium and their combinations thereof; and the metal or metal oxide of the second catalyst is selected from the group consisting of silver, gold, copper, zinc,

aluminum, magnesium, zirconium, tantalum, titanium, vanadium and their combinations thereof.

17. The system of claims 16, wherein the first catalyst is copper supported on the porous silica-based particle.

18. The system of claims 16, wherein the second catalyst is zirconium supported on the porous silica-based particle.

19. The system of any one of claims 12-18, wherein the optionally substituted olefin is an optionally substituted diene further
comprising 4 to 20 carbon atoms.

20. The system of any one of claims 12-19, wherein the optionally substituted alcohol comprises 2 to 20 carbon atoms.