fuel. Here, the preferred process is methane steam reforming (MSR): $CH_4 + H_2O \rightleftharpoons CO + 3\ H_2$. Again, the gas stream produced by MSR is typically treated by WGSR to increase the hydrogen content. However, rather than being converted to valuable chemicals, the CO from MSR is instead converted to CO_2 which is then released to the atmosphere.

The present invention provides solutions to these and related problems.

SUMMARY

Among other things, the present disclosure encompasses the applicant's recognition that epoxide carbonylation can be performed industrially utilizing syngas streams containing hydrogen, carbon monoxide and varying amounts carbon dioxide. Contrary to expectation, the epoxide carbonylation reaction proceeds selectively in the presence of these mixed gas streams and incorporates excess CO from the syngas stream into valuable chemical precursors. Where the goal of biomass gasification is to maximize the amount of biomass-derived carbon converted to valuable chemical products, the present disclosure has the advantage of incorporating the CO present in syngas into those products. This is economically and environmentally preferable to performing WSGR which converts that CO to CO_2, which is then lost to the atmosphere. The integrated processes herein therefore provide improved carbon efficiency for processes based on coal or biomass gasification or steam methane reforming.

The present disclosure provides an integrated process for the conversion of biomass or coal to FT products and commodity chemicals derived from epoxide carbonylation.

In one aspect of the present disclosure, there is provided a method for the integrated production of chemicals comprising:

a) in a first reaction zone, contacting an epoxide in the presence of a carbonylation catalyst with a syngas stream containing hydrogen and carbon monoxide to produce an epoxide carbonylation product,

b) removing an upgraded gas stream from the first reaction zone wherein the upgraded gas stream has a higher hydrogen to carbon monoxide ratio than the starting syngas stream.

In certain embodiments, such methods comprise the steps of:

a) in a first reaction zone, contacting syngas derived from gasification of biomass or coal with an epoxide in the presence of a carbonylation catalyst thereby consuming carbon monoxide from the syngas and producing an epoxide carbonylation product,

b) recovering an upgraded gas stream from the first reaction zone wherein the upgraded gas stream has a higher hydrogen to carbon monoxide ratio than the starting syngas stream,

CLAIMS

What is claimed is:

1. A method for the integrated production of chemicals comprising:

    a) in a first reaction zone, contacting an epoxide in the presence of a carbonylation catalyst with a syngas stream containing hydrogen and carbon monoxide to produce an epoxide carbonylation product,

    b) removing an upgraded gas stream from the first reaction zone wherein the upgraded gas stream has a higher hydrogen to carbon monoxide ratio than the starting syngas stream.

2. The method of claim 1, wherein the syngas stream has a molar hydrogen to carbon monoxide ratio between 0.5:1 and 1.2:1 and the upgraded gas stream has a hydrogen to carbon monoxide ratio of at least 1.9:1.

3. The method of claim 1, wherein the syngas stream contains CO_2.

4. The method of claim 1, wherein the syngas stream contains between about 1 mole percent and about 30 mole percent CO_2.

5. The method of claim 1, wherein the syngas stream contains little or no CO_2.

6. The method of claim 1, wherein the syngas stream contains less than about 2000 ppm, less than about 1000 ppm, less than about 500 ppm, less than about 200 ppm, less than about 100 ppm, less than about 50 ppm, less than about 25 ppm, or less than about 10 ppm CO_2.

7. The method of any of claims 1 to 6, wherein the syngas stream is produced by coal gasification.

8. The method of any of claims 1 to 6, wherein the syngas stream is produced by biomass gasification.

9. The method of any of claims 1 to 8, wherein in a second reaction zone, utilizing the upgraded gas stream to conduct a second chemical process requiring a hydrogen to carbon monoxide ratio higher than the ratio in the syngas stream utilized in step a).

10. The method of claim 9, wherein the second chemical process comprises Fischer Tropsch synthesis.

11. The method of claim 9, wherein the second chemical process comprises reaction on a fuel cell.

12. The method of claim 9, wherein the second chemical process comprises hydrogenation.

13. The method of any one of claims 1 to 8, wherein the epoxide carbonylation product is selected from the group consisting of: optionally substituted beta lactone, optionally substituted succinic anhydride, and a polyester resulting from alternating polymerization of carbon monoxide and the epoxide.

14. The method of any one of claims 1 to 8, wherein the epoxide is ethylene oxide.

15. The method of claim 13, wherein the epoxide carbonylation product is beta propiolactone.

16. The method of claim 13, wherein the epoxide carbonylation product is succinic anhydride and the upgraded gas stream has a molar hydrogen to carbon monoxide ratio greater than 5:1.

17. The method of any one of claims 1 to 16, wherein the upgraded gas stream has a hydrogen to carbon monoxide ratio greater than 10:1, greater than 20:1, greater than 50:1, greater than 100:1, or greater than 1,000:1.

18. The method of any one of claims 1 to 16, wherein the upgraded gas stream is free of carbon monoxide.