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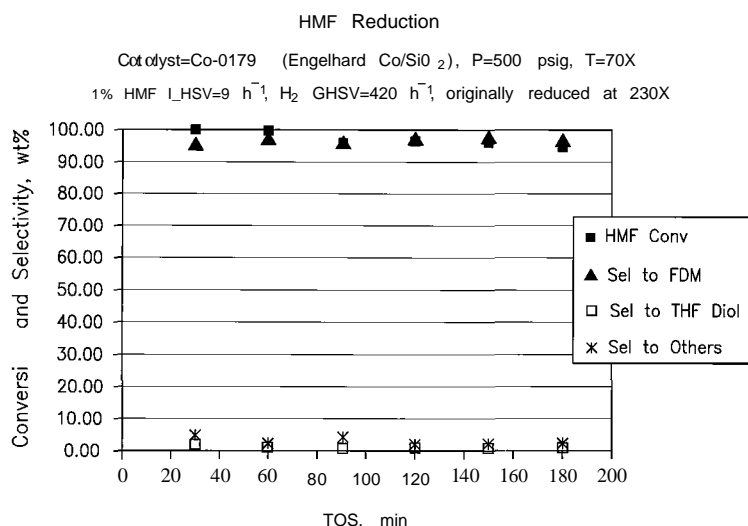
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(54) **Title:** HYDROXYMETHYLFURFURAL REDUCTION METHODS AND METHODS OF PRODUCING FURANDIMETHANOL



(57) **Abstract:** A method of reducing hydroxymethylfurfural (HMF) where a starting material containing HMF in a solvent comprising water is provided. H<sub>2</sub> is provided into the reactor and the starting material is contacted with a catalyst containing at least one metal selected from Ni, Co, Cu, Pd, Pt, Ru, Ir, Re and Rh, at a temperature of less than or equal to 250°C. A method of hydrogenating HMF includes providing an aqueous solution containing HMF and fructose. H<sub>2</sub> and a hydrogenation catalyst are provided. The HMF is selectively hydrogenated relative to the fructose at a temperature at or above 30°C. A method of producing tetrahydrofuran dimethanol (THFDM) includes providing a continuous flow reactor having first and second catalysts and providing a feed comprising HMF into the reactor. The feed is contacted with the first catalyst to produce furan dimethanol (FDM) which is contacted with the second catalyst to produce THFDM.

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**AMENDED CLAIMS**

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The invention claimed is:

1. A method of reducing hydroxymethylfurfural (HMF), comprising:  
providing a starting material comprising HMF in a solvent comprising water into a reactor;  
providing H<sub>2</sub> into the reactor; and  
contacting the starting material with a catalyst comprising at least one metal selected from Ni, Co<sub>1</sub>Cu, Pd, Pt, Ru, Ir, Re and Rh, the contacting being conducted at a reactor temperature of less than or equal to 100<sup>0</sup>C.
2. Canceled.
3. The method of claim 1 wherein the contacting is conducted at a temperature of less than or equal to 70<sup>0</sup>C.
4. The method of claim 1 wherein the contacting is conducted at a reactor temperature of less than or equal to 60<sup>0</sup>C.
5. The method of claim 1 wherein the catalyst further comprises one or more metal selected from the group consisting of Ni, Rh, Cu, Ca, Cr<sub>1</sub> Ru<sub>1</sub> Mn, Ag<sub>1</sub> Au<sub>1</sub> In, S, Fe, Re, Sn, Ge, Ir<sub>1</sub> Pd, Pt<sub>1</sub> Cd<sub>1</sub> Qa<sub>1</sub> Mo, Zn, Al<sub>1</sub> and Bi.
6. The method of claim 1 wherein the reactor is a continuous flow reactor, and wherein providing the starting material comprises flowing the starting material as a feed stream into the reactor.
7. The method of claim 6 further comprising purging the starting material with inert gas.
8. The method of claim 7 wherein the catalyst comprises Cu-chromite.
9. The method of claim 1 wherein the reaction results in production of tetrahydrofuran dimethanol.
10. The method of claim 1 wherein the reaction results in production of furandimethanol.

11. The method of claim 10 wherein the converting produces FDM as the major product.
12. The method of claim 1 wherein the catalyst comprises Pd on a carbon support material.
13. The method of claim 1 wherein the catalyst comprises Pt on an inorganic support material.
14. The method of claim 1 wherein the catalyst comprises Co on an inorganic support material.
15. The method of claim 1 wherein the catalyst comprises Cu-chromite.
16. A method of hydrogenating hydroxymethyl furfural (HMF)<sub>1</sub> comprising:  
providing an aqueous solution containing HMF and fructose into a reactor;  
providing H<sub>2</sub> into the reactor;  
providing a hydrogenation catalyst in the reactor comprising at least one metal selected from the group consisting of Co, Ni, Rh, Cu, Ca, Cr, Ru, Mn, Ag, Au, In, S, Fe, Re, Sn, Ge, Ir, Pd, Pt, Cd, Ga, Mo, Zn, Al, and Bi;  
at a temperature of at or above 30°C, selectively hydrogenating the HMF relative to the fructose.
17. The method of claim 16 wherein the temperature is greater than or equal to 60°C.
18. The method of claim 16 wherein the catalyst comprises Pt and Ge.
19. The method of claim 16 wherein the catalyst comprises Co.

20. A method of producing tetrahydrofuran dimethanol (THFDM), comprising:  
providing a continuous flow reactor having a first catalyst and a second catalyst, each of the first and second catalysts independently comprising at least one metal selected from the group consisting of Co, Ni, Rh, Cu, Ca, Cr, Ru, Mn, Ag, Au, In, S<sub>1</sub>Fe, Re, Sn, Ge, Ir, Pd, Pt, Cd, Ga, Mo, Zn, Al, and Bi;  
providing a feed comprising hydroxymethyl furfural (HMF) and water into the reactor;  
contacting the feed with the first catalyst to produce furan dimethanol (FDM); and  
contacting the FDM with the second catalyst to produce THFDM.
21. The method of claim 20 wherein the first catalyst is segregated from the second catalyst within the same reactor bed.
22. The method of claim 20 wherein the feed comprises from 1% to 6% HMF.
23. The method of claim 20 wherein the THFDM is the majority product.
24. The method of claim 20 wherein the first catalyst comprises Co.
25. The method of claim 22 wherein the second catalyst comprises Ni.
26. A method of producing tetrahydrofuran dimethanol (THFDM), comprising:  
providing a starting material comprising furan dimethanol (FDM) in a solvent comprising water into a reactor;  
providing H<sub>2</sub> into the reactor;  
contacting the starting material with a catalyst comprising at least one metal selected from the group consisting of Ni, Ir, Co, Rh, Pt, Pd, and Ru, the contacting being conducted at a temperature of less than or equal to 250°C; and  
wherein THFDM is the major product.
27. The method of claim 26 wherein the contacting occurs at a temperature of less than or equal to 180°C.
28. The method of claim 26 wherein the catalyst comprises Ni.
29. Canceled.