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What is claimed is:

1. A glycerol dehydration method comprising exposing glycerol to a catalyst, the catalyst comprising a fumed support material, phosphate, and at least one or more metals from groups 2-12 of the periodic table or K, Cs, or Rb, the exposing forming one or both of acrolein and acetol.

2. The method of claim 1 wherein the glycerol is a co-product of biofuel production.

3. The method of claim 1 wherein the glycerol is comprised by a reactant mixture, the mixture comprising 3-70% (wt./wt.) glycerol.

4. The method of claim 3 wherein the mixture comprises at least about 30% (wt./wt.) glycerol.

5. The method of claim 3 wherein the reactant mixture further comprises one or more of N₂, CO₂ and H₂O.

6. The method of claim 5 wherein either or both of the N₂ and CO₂ is less than 1% (wt./wt.) of the reactant mixture.

7. The method of claim 3 wherein the reactant mixture has a temperature of at least about 100° C. prior to being exposed to the catalyst.

8. The method of claim 1 wherein the catalyst is maintained at a temperature of between 250° C. and 350° C. during the exposing.

9. The method of claim 1 wherein the fumed support material comprises Si.

10. The method of claim 1 wherein the one or more metals includes Co and the phosphate is in the form of dihydrogen phosphate.

11. A glycerol dehydration catalyst regeneration method comprising:

providing a used glycerol dehydration catalyst, the catalyst comprising a fumed support material, phosphate, and at least one or more metals from groups 2-12 of the periodic table and/or Rb, K, and Cs; and

exposing the used catalyst to either N₂ alone and/or air while maintaining a temperature of the catalyst above 200° C. to regenerate the catalyst.

12. The method claim 11 wherein the exposing comprises passing either N₂ alone and/or air over the catalyst while maintaining a temperature of the catalyst above 550° C.

13. The method claim 11 wherein the exposing comprises: passing N₂ alone over the used catalyst while maintaining a temperature of the catalyst above 200° C.; and passing air over the used catalyst while maintaining a temperature of the catalyst above 550° C.

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14. The method of claim 13 wherein the passing the N₂ alone over the used catalyst is performed prior to passing the air over the used catalyst.

15. The method of claim 11 further comprising monitoring CO₂ evolution from the catalyst.

16. A glycerol dehydration system comprising:

a reactor coupled to at least two conduits, one of the two conduits configured to convey reactants to the reactor, and the other of the two conduits configured to convey products from the reactor; and

a catalyst within the reactor, the catalyst comprising a fumed support material, phosphate, and at least one or more metals from groups 2-12 of the periodic table and/or Rb, K, and Cs.

17. The glycerol dehydration system of claim 16 wherein the catalyst comprises fumed Si, dihydrogen phosphate, and Co.

18. The glycerol dehydration system of claim 16 wherein the one conduit is configured to vaporize its contents prior to conveying same to the reactor.

19. The glycerol dehydration system of claim 16 wherein the reactor is configured to be programmably heated between the temperatures of 100° C. and 600° C.

20. A chemically synthetic dehydration process comprising:

exposing a multihydric reactant to a phosphorous comprising catalyst within a reactor to form a dehydration product, wherein the phosphorous comprising catalyst comprises a fumed support material, phosphate, and at least one or more metals from groups 2-12 of the periodic table and/or Rb, K, and Cs;

ceasing the providing of the reactant to the reactor; and after ceasing the providing of the reactant, providing a phosphorous comprising material to the reactor, the phosphorous comprising material increasing the amount of phosphorous in the dehydration catalyst; and after providing the phosphorous comprising material, again providing reactant to the reactor.

21. The process of claim 20 wherein the multihydric reactant comprises glycerol.

22. The process of claim 20 wherein the dehydration product comprises one or both of acrolein and acetol.

23. The process of claim 20 wherein the phosphorous comprising material comprises an organophosphate.

24. The process of claim 23 wherein the organophosphate comprises trimethylphosphate.

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