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g_{cat}/hr ; partial pressures: glycerol=0.0593 atm; steam=0.7065 atm; nitrogen=0.2342 atm.

Catalyst can be regenerated again, and glycerol provided at GHSV=4,712/hr; WHSV=1.384 $g_{gly}/g_{cat}/hr$; partial pressures: glycerol=0.0593 atm; steam=0.7065 atm; nitrogen=0.2342 atm—rapid deactivation.

Upon loss of activity, glycerol flow can be stopped and the reactor containing the catalyst held in steam flow for 20 minutes, N_2 flow can be increased to 150 sccm for 10 minutes after water flow is turned off. Tributyl-phosphate can then be provided to the reactor at 1 mL/hr for 1 hr. The reactor can then be held in air flow (~250 sccm) overnight—~8 hrs, and steam flow provided for 20 minutes prior to starting glycerol feed. Catalyst activity can be recovered for ~1 hr prior to “normal deactivation pattern and may level out at ~20% conversion.

Referring to FIG. 21 provides data obtained while regenerating catalyst with rephosphating a 15 wt % PO_4 as $Co(H_2PO_4)_2/f$ -Silica (Slurry with P/Co~4). The reactor and catalyst loading is consistent with Co/P catalysts prepared herein as well as the reaction flows and conditions. Upon recognized loss of activity, the reactor and catalyst can be exposed to air at 600° C. for about 10 hrs, cooled to 280° C. in N_2 flow (150 sccm) and held for 1 hr. Tributyl-phosphate can then be exposed to the catalyst at 1 mL/hr for 1.75 hrs, then the catalyst can be held in air flow (~250 sccm) for 1 hr. Steam flow can be proved to the reactor and catalyst for 30 minutes prior to starting glycerol feed (or until tributyl-phosphate was no longer detected) exiting the reactor. Catalyst activity can be recovered with slightly improved selectivity (93% vs 91%).

Referring to FIG. 22 data obtained using a Rb-catalyst to perform dehydration is shown; 28% RbH_2PO_4 w/ excess H_3PO_4/f -Silica (HS-5). The reactor is 26.0 cm in length and has an ID=5.19 mm, 2.81 g catalyst (5.5 cm³ meas.) can be added having a 30-60 mesh ($D_p=0.595-0.25$ mm). Under the first condition, reaction can be performed under the following conditions: GHSV=9,451/hr (1 atm), WHSV=1.079 $g_{gly}/g_{cat}/hr$, superficial velocity=0.683 m/s, $P_{gly}=0.029$ atm, $PH_2O=0.855$ atm, $PN_2=0.117$ atm, Wt % gly=14.7%, and $DP=8.0$ psi. As noted a second condition can be provided and that condition can include the following: reactor at 290° C., GHSV=2766/hr (1 atm), WHSV=1.079 $g_{gly}/g_{cat}/hr$, superficial velocity=0.2 m/s, $P_{gly}=0.098$ atm, $PH_2O=0.503$ atm, $PN_2=0.399$ atm, Wt % gly=50%, and $DP=6.5$ psi (initial). Under the third condition noted, the reactor is maintained at 290° C., GHSV=6409/hr (1 atm), WHSV=1.079 $g_{gly}/g_{cat}/hr$, superficial velocity=0.463 m/s, $P_{gly}=0.042$ atm, $PH_2O=0.217$ atm, $PN_2=0.741$ atm, Wt % gly=50%, and $DP=6.5$ psi. The Rb-catalyst demonstrated substantial robustness.

Referring to FIG. 23, XRD data of unused Rb-catalyst is shown and in FIG. 24 XRD data of used Rb-catalyst is shown. This XRD demonstrate the lack of phosphate leaching occurring during dehydration and subsequent regeneration.

Referring to FIG. 25 data obtained using a Rb-catalyst to perform dehydration is shown; 28% RbH_2PO_4 w/ excess H_3PO_4/f -Silica (HS-5) and additional data obtained as the process continued is shown in FIG. 26. About 2.76 g catalyst (5.7 cm³ meas.) with 30-60 mesh ($D_p=0.595-0.25$ mm) can be loaded into a 27 cm long reactor have an ID=5.19 mm. The first condition noted can be performed with a reactor at 290° C. and: GHSV=4756/hr (1 atm), WHSV=1.80 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.09$ atm, $PH_2O=0.462$ atm, $PN_2=0.448$ atm, Wt % gly=30 wt %, and $DP=6.2$ psi.

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The second condition noted can be performed with a reactor at 300° C. and: GHSV=3734/hr (1 atm), WHSV=1.10 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.07$ atm, $PH_2O=0.36$ atm, $PN_2=0.57$ atm, Wt % gly=50 wt %, and $DP=4.5$ psi. Under condition 2a, the reactor can be 300° C. and GHSV=5886/hr (1 atm), WHSV=1.1 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.045$ atm, $PH_2O=0.228$ atm, $PN_2=0.728$ atm, and Wt % gly=50%.

The third condition noted can be performed with a reactor at 300° C. and: GHSV=5822/hr (1 atm), WHSV=1.1 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.045$ atm, $PH_2O=0.231$ atm, $PN_2=0.365$ atm, $PAir=0.359$ atm, and Wt % gly=50%.

The fourth condition noted can be performed with a reactor at 300° C. and: GHSV=5822/hr (1 atm), WHSV=1.1 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.045$ atm, $PH_2O=0.229$ atm, $PN_2=0.637$ atm, $PAir=0.089$ atm, and Wt % gly=50%.

The fifth condition noted can be performed with a reactor at 300° C. and: GHSV=9099/hr (1 atm), WHSV=1.1 $g_{gly}/g_{cat}/hr$, $P_{gly}=0.029$ atm, $PH_2O=0.856$ atm, $PAir=0.115$ atm, and Wt % gly=50%.

Referring to FIGS. 25 and 26, the dehydration process continued >60 hrs on stream before deactivation with 78% acrolein selectivity, 15% acetol selectivity. Addition of air improved conversion (100%) and selectivity (to 70%), and reduced acetol formation and dimer formation. Catalyst was regenerated.

In compliance with the statute, embodiments of the invention have been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the entire invention is not limited to the specific features and/or embodiments shown and/or described, since the disclosed embodiments comprise forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

What is claimed is:

1. A chemically synthetic dehydration process comprising exposing a multihydric compound to a Rb-phosphate catalyst to form a dehydration product of the multihydric compound.
2. The process of claim 1 wherein the multihydric compound comprises glycerol.
3. The process of claim 2 wherein the glycerol is a byproduct of a biofuel manufacturing process.
4. The process of claim 1 wherein the dehydration product of the multihydric compound comprises one or both of acrolein and acetol.
5. The process of claim 1 wherein the Rb-phosphate catalyst is supported by Si.
6. The process of claim 1 wherein the Rb-phosphate catalyst is supported by a fumed support.
7. The process of claim 1 wherein the Rb-phosphate catalyst is supported by a fumed Si support.
8. The process of claim 1 further comprising: ceasing exposing the multihydric compound to the catalyst; regenerating the catalyst; and again exposing the multihydric compound to the catalyst to form the dehydration product of the multihydric compound.
9. The process of claim 8 wherein the regenerating the catalyst comprises exposing the catalyst to a gas while heating the catalyst to a temperature sufficient to remove carbon byproducts.

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