CLAIMS

1. A dehydration catalyst consisting essentially of:

a. one or more amorphous phosphate salts consisting essentially of:

i) one or more monovalent cations, and

ii) one or more phosphate anions selected from the group represented by empirical formula (I):

$$\left[\mathrm{H}_{2(1-\mathrm{x})}\mathrm{PO}_{(4-\mathrm{x})}\right]^{-} \qquad \text{(I)};$$

wherein x is any real number equal to or greater than 0 and equal to or less than 1; wherein said one or more amorphous phosphate salts are neutrally charged;

b. one or more crystalline phosphate salts consisting essentially of:

i) one or more polyvalent cations, and

ii) one or more phosphate anions selected from the group represented by molecular formula (II):

$$\left[H_{(f-2g-h)}P_fO_{(4f-g)}\right]^{(2f+h)-} \qquad \text{(II)};$$

wherein f is a positive integer; wherein g is a positive integer or zero; wherein h is an integer; wherein (f-2g-h) is equal to or greater than zero; wherein (4f-g) is greater than zero; wherein (2f+h) is greater than zero; wherein (4h/f) is equal to or greater than -2 and equal to or less than 1; wherein said one or more crystalline phosphate salts are neutrally charged; and

c. one or more non-phosphate salts consisting essentially of:

i) one or more polyvalent cations, and

ii) one or more non-phosphate anions selected from the group represented by molecular formulae (III) and (IV):

$$\left[H_{(a-2b)}S_cO_{(4c-b)}\right]^{(2c-a)-} \qquad \text{(III)}$$
$$\left[Ta_{2d}O_{(5d+e)}\right]^{2e-} \qquad \text{(IV)};$$

wherein a and b are positive integers or zero; wherein c, d, and e are positive integers; wherein (a-2b) is equal to or greater than zero; wherein (2c-a) is greater than zero; wherein said one or more non-phosphate salts are neutrally charged;

wherein said one or more crystalline phosphate salts and said one or more non-phosphate salts are substantially chemically inert to said one or more amorphous phosphate salts.

2. The dehydration catalyst of claim 1, wherein said one or more monovalent cations are selected from the group consisting of K^+, Rb^+, Cs^+, and mixtures thereof.

3. The dehydration catalyst of claim 1, wherein at least one of said one or more amorphous phosphate salts consists of two or more different monovalent cations selected from the group consisting of K^+, Rb^+, and Cs^+.

4. The dehydration catalyst of claim 1, wherein said one or more amorphous phosphate salts are selected from the group represented by empirical formula (Ia):

$$M^I H_{2(1-x)} PO_{(4-x)} \qquad \text{(Ia)};$$

wherein M^I is a monovalent cation; wherein x is any real number equal to or greater than 0 and equal to or less than 1.

5. The dehydration catalyst of claim 4, wherein said one or more amorphous phosphate salts are selected from the group consisting of $KH_{2(1-x)}PO_{(4-x)}$, $RbH_{2(1-x)}PO_{(4-x)}$, $CsH_{2(1-x)}PO_{(4-x)}$, any of their hydrated forms, and mixtures thereof; wherein x is any real number equal to or greater than 0 and equal to or less than 1.

6. The dehydration catalyst of claim 5, wherein said one or more amorphous phosphate salts is $KH_{2(1-x)}PO_{(4-x)}$; wherein x is any real number equal to or greater than 0 and equal to or less than 1.

7. The dehydration catalyst of claim 1, wherein said one or more amorphous phosphate salts are selected from the group represented by empirical formula (Ib):

$$M_w^I N_{(1-w)}^I H_{2(1-x)} PO_{(4-x)} \qquad \text{(Ib)};$$

wherein M^I and N^I are two different monovalent cations; wherein x is any real number equal to or greater than 0 and equal to or less than 1; wherein w is any real number greater than 0 and less than 1.

8. The dehydration catalyst of claim 7, wherein said one or more amorphous phosphate salts are selected from the group consisting of $KH_{2(1-x)}PO_{(4-x)}$, $RbH_{2(1-x)}PO_{(4-x)}$,

$CsH_{2(1-x)}PO_{(4-x)}$, any of their hydrated forms, and mixtures thereof; wherein x is any real number equal to or greater than 0 and equal to or less than 1.

9. The dehydration catalyst of claim 1, wherein said one or more polyvalent cations of said one or more crystalline phosphate salts and wherein said one or more polyvalent cations of said one or more non-phosphate salts are selected from the group consisting of the cations of the metals Be, Mg, Ca, Sr, Ba, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Re, Al, Ga, In, Tl, Si, Ge, Sn, Pb, Sb, Bi, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and mixtures thereof.

10. The dehydration catalyst of claim 1, wherein said one or more amorphous phosphate salts is $KH_{2(1-x)}PO_{(4-x)}$; wherein x is any real number equal to or greater than 0 and equal to or less than 1.

11. The dehydration catalyst of claim 1, wherein said one or more polyvalent cations of said one or more crystalline phosphate salts and wherein said one or more polyvalent cations of said one or more non-phosphate salts are Ba^{2+}.

12. The dehydration catalyst of claim 1, wherein said one or more phosphate anions of said one or more crystalline phosphate salts are selected from the group represented by molecular formulae (IIa) to (IIg), and mixtures thereof:

$[HPO_4]^{2-}$ (IIa)
$[P_2O_7]^{4-}$ (IIb)
$[P_3O_{10}]^{5-}$ (IIc)
$[P_4O_{13}]^{6-}$ (IId)
$[HP_2O_7]^{3-}$ (IIe)
$[HPO_4]^{2-} \cdot [H_2PO_4]^{-}$ (IIf)
$[P_2O_7]^{4-} \cdot [H_2PO_4]^{-}$ (IIg).

13. The dehydration catalyst of claim 12, wherein said one or more phosphate anions of said one or more crystalline phosphate salts are selected from the group represented by molecular formulae (IIa), (IIb), and mixtures thereof:

$[HPO_4]^{2-}$ (IIa)
$[P_2O_7]^{4-}$ (IIb).

14. The dehydration catalyst of claim 1, wherein said one or more crystalline phosphate salts are selected from the group consisting of $BeHPO_4$, $MgHPO_4$, $CaHPO_4$, $SrHPO_4$, $BaHPO_4$, $BeNH_4PO_4$, $Be_2P_2O_7$, $Mg_2P_2O_7$, $MgK_2P_2O_7$, $Mg_3K_2(P_2O_7)_2$, $Ca_2P_2O_7$, $CaK_2P_2O_7$, $Ca_3K_2(P_2O_7)_2$, $Ca_5K_2(P_2O_7)_3$, $CaRb_2P_2O_7$, $CaCs_2P_2O_7$, $CaMgP_2O_7$, $Ca_3(NH_4)_2(P_2O_7)_2$, $Ca_5(NH_4)_2(P_2O_7)_3$, $Sr_2P_2O_7$, $SrK_2P_2O_7$, $SrRb_2P_2O_7$, $SrCs_2P_2O_7$, $SrMgP_2O_7$, $Ba_2P_2O_7$, $BaMgP_2O_7$, $BaCaP_2O_7$, $Sc_4(P_2O_7)_3$, $ScKP_2O_7$, $ScRbP_2O_7$, $ScCsP_2O_7$, YKP_2O_7, $YRbP_2O_7$, $YCsP_2O_7$, TiP_2O_7, $Ti_2Ba(P_2O_7)_2$, ZrP_2O_7, $ZrMgP_2O_7$, HfP_2O_7, $V_4(P_2O_7)_3$, VKP_2O_7, $VRbP_2O_7$, $VCsP_2O_7$, $V_2Sr(P_2O_7)_2$, $V_2Ba(P_2O_7)_2$, $Nb_2Mg(P_2O_7)_2$, $Cr_4(P_2O_7)_3$, $CrHP_2O_7$, $CrNH_4P_2O_7$, $CrKP_2O_7$, $CrRbP_2O_7$, $CrCsP_2O_7$, $Cr_2Mg(P_2O_7)_2$, $CrCaP_2O_7$, $Cr_2Ca(P_2O_7)_2$, $Cr_2Sr(P_2O_7)_2$, $CrBaP_2O_7$, $Cr_2Ba(P_2O_7)_2$, MoP_2O_7, $MoKP_2O_7$, $MoRbP_2O_7$, $MoCsP_2O_7$, $Mo_2Ba(P_2O_7)_2$, $Mn_2P_2O_7$, $MnHP_2O_7$, $MnK_2P_2O_7$, $MnKP_2O_7$, $2Mn_2P_2O_7 \cdot Mn_2KP_3O_{10}$, $MnRb_2P_2O_7$, $MnRbP_2O_7$, $MnCsP_2O_7$, $MnCaP_2O_7$, $MnSrP_2O_7$, $MnBaP_2O_7$, ReP_2O_7, $AlNH_4P_2O_7$, $AlKP_2O_7$, $AlRbP_2O_7$, $GaNH_4P_2O_7$, $GaKP_2O_7$, $GaRbP_2O_7$, $InKP_2O_7$, $InRbP_2O_7$, $InCsP_2O_7$, $In_2Ca(P_2O_7)_2$, $In_2Sr(P_2O_7)_2$, $In_2Ba(P_2O_7)_2$, SiP_2O_7, GeP_2O_7, SnP_2O_7, PbP_2O_7, $Sb^{V}Sb^{III}(P_2O_7)_2$, $Bi_4(P_2O_7)_3$, $BiHP_2O_7$, $La_4(P_2O_7)_3$, $LaHP_2O_7$, $LaKP_2O_7$, CeP_2O_7, $Gd_4(P_2O_7)_3$, $GdKP_2O_7$, $GdRbP_2O_7$, $GdCsP_2O_7$, $TbKP_2O_7$, $TbRbP_2O_7$, $TbCsP_2O_7$, $DyKP_2O_7$, $DyRbP_2O_7$, $DyCsP_2O_7$, $HoKP_2O_7$, $HoRbP_2O_7$, $HoCsP_2O_7$, $ErKP_2O_7$, $ErRbP_2O_7$, $ErCsP_2O_7$, $TmKP_2O_7$, $TmRbP_2O_7$, $TmCsP_2O_7$, $YbHP_2O_7$, $YbKP_2O_7$, $YbRbP_2O_7$, $YbCsP_2O_7$, $LuKP_2O_7$, $LuRbP_2O_7$, $LuCsP_2O_7$, $Be_2RbP_3O_{10}$, $Ca_2KP_3O_{10}$, $Ca_2RbP_3O_{10}$, $Ca_2CsP_3O_{10}$, $Sr_2KP_3O_{10}$, $Sr_2RbP_3O_{10}$, $Sr_2CsP_3O_{10}$, $Ba_2KP_3O_{10}$, $Ba_2RbP_3O_{10}$, $Ba_2CsP_3O_{10}$, $Y_5(P_3O_{10})_3$, $VCsP_3O_{10}$, $CrCs_2P_3O_{10}$, $Cr_3K(P_3O_{10})_2$, $Cr_3Rb(P_3O_{10})_2$, $Cr_3Cs(P_3O_{10})_2$, $MnCs_2P_3O_{10}$, $AlCs_2P_3O_{10}$, $Al_3Cs(P_3O_{10})_2$, $GaCs_2P_3O_{10}$, $In_5(P_3O_{10})_3$, $La_5(P_3O_{10})_3$, $Pr_5(P_3O_{10})_3$, $Nd_5(P_3O_{10})_3$, $Sm_5(P_3O_{10})_3$, $Gd_5(P_3O_{10})_3$, $Er_5(P_3O_{10})_3$, $Yb_5(P_3O_{10})_3$, $Ca_3P_4O_{13}$, $Sr_3P_4O_{13}$, $Ba_3P_4O_{13}$, $Ba_2MgP_4O_{13}$, $Y_2P_4O_{13}$, $Cr_2P_4O_{13}$, $Mn_2P_4O_{13}$, $Gd_2P_4O_{13}$, $Pb_3P_4O_{13}$, $Bi_2P_4O_{13}$, $La_2P_4O_{13}$, any of their hydrated forms, and mixtures thereof.

15. The dehydration catalyst of claim 14, wherein said one or more crystalline phosphate salts are selected from the group consisting of $MgHPO_4$, $CaHPO_4$, $SrHPO_4$, $BaHPO_4$, $Mg_2P_2O_7$, $Ca_2P_2O_7$, $Sr_2P_2O_7$, $Ba_2P_2O_7$, YKP_2O_7, $Mn_2P_2O_7$, $MnKP_2O_7$, $AlKP_2O_7$, $ErKP_2O_7$, $Ca_3P_4O_{13}$, $Sr_3P_4O_{13}$, $Ba_3P_4O_{13}$, any of their hydrated forms, and mixtures thereof.

16. The dehydration catalyst of claim 1, wherein said one or more non-phosphate anions are selected from the group represented by molecular formulae (IIIa) to (IIId), (IVa) to (IVg), and mixtures thereof:

$[SO_4]^{2-}$	(IIIa)
$[S_2O_7]^{2-}$	(IIIb)
$[HSO_4]^{1-}$	(IIIc)
$[SO_4]^{2-} \cdot [HSO_4]^{-}$	(IIId)
$[Ta_2O_6]^{2-}$	(IVa)
$[Ta_2O_7]^{4-}$	(IVb)
$[Ta_2O_9]^{8-}$	(IVc)
$[Ta_2O_{10}]^{10-}$	(IVd)
$[Ta_2O_{11}]^{12-}$	(IVe)
$[Ta_4O_{11}]^{2-}$	(IVf)
$[Ta_4O_{15}]^{10-}$	(IVg).

17. The dehydration catalyst of claim 16, wherein said one or more non-phosphate anions are selected from the group represented by molecular formulae (IIIa), (IVa), and mixtures thereof:

$[SO_4]^{2-}$	(IIIa)
$[Ta_2O_6]^{2-}$	(IVa).

18. The dehydration catalyst of claim 1, wherein said one or more non-phosphate salts are selected from the group consisting of $CaSO_4$, $SrSO_4$, $BaSO_4$, $SrK_2(SO_4)_2$, $SrRb_2(SO_4)_2$, $Ca_2K_2(SO_4)_3$, $Ca_2Rb_2(SO_4)_3$, $Ca_2Cs_2(SO_4)_3$, $CaTa_4O_{11}$, $SrTa_4O_{11}$, $BaTa_4O_{11}$, $MgTa_2O_6$, $CaTa_2O_6$, $SrTa_2O_6$, $BaTa_2O_6$, $Mg_2Ta_2O_7$, $Ca_2Ta_2O_7$, $Sr_2Ta_2O_7$, $SrK_2Ta_2O_7$, $Ba_2Ta_2O_7$, $Ba_3Ta_2O_8$, $Mg_4Ta_2O_9$, $Ca_4Ta_2O_9$, $Sr_4Ta_2O_9$, $Ba_4Ta_2O_9$, $Ca_5Ta_2O_{10}$, $Ca_2KTa_3O_{10}$, $Ca_2RbTa_3O_{10}$, $Ca_2CsTa_3O_{10}$, $Sr_2KTa_3O_{10}$, $Sr_2RbTa_3O_{10}$, $Sr_2CsTa_3O_{10}$, $Mg_5Ta_4O_{15}$, $Sr_5Ta_4O_{15}$, $Ba_5Ta_4O_{15}$, $Sr_2KTa_5O_{15}$, $Ba_2KTa_5O_{15}$, $Sr_6Ta_2O_{11}$, $Ba_6Ta_2O_{11}$, any of their hydrated forms, and mixtures thereof.

19. The dehydration catalyst of claim 18, wherein said one or more non-phosphate salts are selected from the group consisting of $CaSO_4$, $CaTa_2O_6$, $SrSO_4$, $SrTa_2O_6$, $BaSO_4$, $BaTa_2O_6$, any of their hydrated forms, and mixtures thereof.

20. The dehydration catalyst of claim 1, wherein said one or more amorphous phosphate salts are selected from the group consisting of $KH_{2(1-x)}PO_{(4-x)}$, $RbH_{2(1-x)}PO_{(4-x)}$,

$CsH_{2(1-x)}PO_{(4-x)}$, $K_wRb_{(1-w)}H_{2(1-x)}PO_{(4-x)}$, $K_wCs_{(1-w)}H_{2(1-x)}PO_{(4-x)}$, $Rb_wCs_{(1-w)}H_{2(1-x)}PO_{(4-x)}$, any of their hydrated forms, and mixtures thereof; wherein x is any real number equal to or greater than 0 and equal to or less than 1 and wherein w is any real number greater than 0 and less than 1;

wherein said one or more crystalline phosphate salts are selected from the group consisting of $Ca_2P_2O_7$, $CaHPO_4$, $Sr_2P_2O_7$, $SrHPO_4$, $Ba_2P_2O_7$, $BaHPO_4$, any of their hydrated forms, and mixtures thereof; and

wherein said one or more non-phosphate salts are selected from the group consisting of $CaSO_4$,

21. The dehydration catalyst of claim 20, wherein said one or more amorphous phosphate salts is $KH_{2(1-x)}PO_{(4-x)}$; wherein x is any real number equal to or greater than 0 and equal to or less than 1;

wherein said one or more crystalline phosphate salts is $Ba_2P_2O_7$; and

wherein said one or more non-phosphate salts is $BaSO_4$.

22. The dehydration catalyst of claim 1, wherein the weight fraction of said one or more amorphous phosphate salts in said dehydration catalyst is between about 0.1 and about 0.8.

23. A dehydration catalyst consisting essentially of:

a. one or more amorphous phosphate salts consisting essentially of:

i) one or more monovalent cations, and

ii) one or more phosphate anions selected from the group represented by empirical formula (I):

$$\left[H_{2(1-x)}PO_{(4-x)}\right]^- \qquad \text{(I)};$$

wherein x is any real number equal to or greater than 0 and equal to or less than 1; wherein said one or more amorphous phosphate salts are neutrally charged;

b. one or more crystalline phosphate salts consisting essentially of:

i) one or more polyvalent cations, and

ii) one or more phosphate anions selected from the group represented by molecular formula (II):

$$\left[H_{(f-2g-h)}P_fO_{(4f-g)}\right]^{(2f+h)-} \qquad \text{(II);}$$

wherein f is a positive integer; wherein g is a positive integer or zero; wherein h is an integer; wherein (f-2g-h) is equal to or greater than zero; wherein (4f-g) is greater than zero; wherein (2f+h) is greater than zero; wherein (4h/f) is equal to or greater than -2 and equal to or less than 1; wherein said one or more crystalline phosphate salts are neutrally charged; and

c. one or more non-phosphate salts consisting essentially of:

i) one or more polyvalent cations, and

ii) one or more non-phosphate anions selected from the group represented by molecular formulae (III) and (IV):

$$\left[H_{(a-2b)}S_cO_{(4c-b)}\right]^{(2c-a)-} \qquad \text{(III)}$$

$$\left[Ta_{2d}O_{(5d+e)}\right]^{2e-} \qquad \text{(IV);}$$

wherein a and b are positive integers or zero; wherein c, d, and e are positive integers; wherein (a-2b) is equal to or greater than zero; wherein (2c-a) is greater than zero; wherein said one or more non-phosphate salts are neutrally charged; and

d. silicon oxide (SiO_2);

wherein said one or more crystalline phosphate salts and said one or more non-phosphate salts are substantially chemically inert to said one or more amorphous phosphate salts.

24. The dehydration catalyst of claim 23, wherein said silicon oxide is selected from the group consisting of amorphous silica, quartz, tridymite, cristobalite, moganite, coesite, and mixtures thereof.

25. The dehydration catalyst of claim 24, wherein said dehydration catalyst consists essentially of $KH_{2(1-x)}PO_{(4-x)}$, $BaSO_4$, $Ba_2P_2O_7$, and amorphous silica; wherein x is any real number equal to or greater than 0 and equal to or less than 1.