CLAIMS

What is claimed is:

1. A mixed phosphate catalyst comprising at least two different phosphate salts selected from the group consisting of Formulas (I), (II), (III), and (IV):

ZH_2PO_4 (I)

$X_{2-a}HPO_4$, (II)

$X_3(PO_4)_{2-b}$ (III)

$X_{2+c}P_2O_7$, (IV)

wherein Z is a Group I metal, and wherein in each of Formulas (II) through (IV), each X is independently either a Group I or Group II metal, with the following provisos:

in Formula (II), when X is a Group I metal, a is 0, and when X is a Group II metal, a is 1;

in Formula (III), when X is a Group I metal, b is 1, and when X is a Group II metal, b is 0; and,

in Formula (IV), when X is a Group I metal, c is 2, and when X is a Group II metal, c is 0.

2. The mixed phosphate catalyst of claim 1, wherein the at least two different phosphate salts comprise K_2HPO_4 and $Ba_3(PO_4)_2$.

3. The mixed phosphate catalyst of claim 1, wherein the at least two different phosphate salts comprise K_2HPO_4, and $Ca_2P_2O_7$.

4. The mixed phosphate catalyst of claim 1, wherein the at least two different phosphate salts comprise two metals present in a molar ratio relative to each other of about 1:9 to about 9:1.

5. The mixed phosphate catalyst of claim 1, wherein the catalyst has been calcined at a temperature of about 250°C to about 450°C for about one hour to about four hours.

6. The mixed phosphate catalyst of claim 1 further comprising a carrier supporting the at least two different phosphate salts.

7. The mixed phosphate catalyst of claim 1 having a surface acidity density of about 0.35 millimoles per square meter (mmol/m^2) or less.

8. The mixed phosphate catalyst of claim 1 having a surface basicity density of at least about 2 mmol/m^2.

9. The mixed phosphate catalyst of claim 1, wherein one phosphate salt is a precipitation product of phosphoric acid (H_3PO_4) and a nitrate salt of Formula (V):

$$X(NO_3)_{2b} \quad (V),$$

and wherein another phosphate salt is selected from the group consisting of said Formulas (I), (II), (III), and (IV).

10. The mixed phosphate catalyst of claim 9, wherein the at least two different phosphate salts comprise K_2HPO_4 and the precipitation product of phosphoric acid and $Ba(NO_3)_2$.

11. The mixed phosphate catalyst of claim 9, wherein the at least two different phosphate salts comprise two metals present in a molar ratio relative to each other of about 1:9 to about 9:1.

12. The mixed phosphate catalyst of claim 9, wherein the catalyst has been calcined at a temperature of about 250°C to about 450°C for about one hour to about four hours.

13. The mixed phosphate catalyst of claim 9, further comprising a carrier supporting the at least two different phosphate salts.

14. The mixed phosphate catalyst of claim 9 having a surface acidity density of about 0.35 mmol/m^2 or less.

15. The mixed phosphate catalyst of claim 9 having a surface basicity density of at least about 2 mmol/m^2.

CLAIMS

1. A mixed phosphate catalyst comprising at least two different phosphate salts selected from the group consisting of Formulas (I), (II), (III), and (IV):

$$ZH_2PO_4 \quad (I)$$

$$X_{2-a}HPO_4, \quad (II)$$

$$X_3(PO_4)_{2-b} \quad (III)$$

$$X_{2+c}P_2O_7, \quad (IV)$$

wherein Z is a Group I metal, and wherein in each of Formulas (II) through (IV), each X is independently either a Group I or Group II metal, with the following provisos:

in Formula (II), when X is a Group I metal, a is 0, and when X is a Group II metal, a is 1;

in Formula (III), when X is a Group I metal, b is 1, and when X is a Group II metal, b is 0; and,

in Formula (IV), when X is a Group I metal, c is 2, and when X is a Group II metal, c is 0; and further, wherein the at least two different phosphate salts comprise two metals present in a molar ratio relative to each other of about 1:9 to about 9:1.

2. The mixed phosphate catalyst of claim 1, wherein the at least two different phosphate salts comprise K_2HPO_4 and $Ba_3(PO_4)_2$.

3. The mixed phosphate catalyst of claim 1, wherein the at least two different phosphate salts comprise K_2HPO_4, and $Ca_2P_2O_7$.

4. The mixed phosphate catalyst of any one of the previous claims, wherein the catalyst has been calcined at a temperature of about 250°C to about 450°C for about one hour to about four hours.

5. The mixed phosphate catalyst of any one of the previous claims further comprising a carrier supporting the at least two different phosphate salts.

6. The mixed phosphate catalyst of any one of the previous claims having a surface acidity density of about 0.35 millimoles per square meter ($mmol/m^2$) or less.

7. The mixed phosphate catalyst of any one of the previous claims having a surface basicity density of at least about 2 mmol/m^2.

8. The mixed phosphate catalyst of claim 1, wherein one phosphate salt is a precipitation product of phosphoric acid (H_3PO_4) and a nitrate salt of Formula (V):

$$X(NO_3)_{2-b} \qquad (V),$$

and wherein another phosphate salt is selected from the group consisting of said Formulas (I), (II), (III), and (IV).

9. The mixed phosphate catalyst of claim 8, wherein the at least two different phosphate salts comprise K_2HPO_4 and the precipitation product of phosphoric acid and $Ba(NO_3)_2$.

10. The mixed phosphate catalyst of claim 8 or 9, wherein the catalyst has been calcined at a temperature of about 250°C to about 450°C for about one hour to about four hours.

11. The mixed phosphate catalyst of any one of claims 8 to 10, further comprising a carrier supporting the at least two different phosphate salts.

12. The mixed phosphate catalyst of any one of claims 8 to 11 having a surface acidity density of about 0.35 mmol/m^2 or less.

13. The mixed phosphate catalyst of any one of claims 8 to 12 having a surface basicity density of at least about 2 mmol/m^2.