CLAIMS

1. An ammonia cracker comprising:

an anolyte chamber housing an anolyte, wherein the anolyte comprises alkali and ammonia;

a first catholyte chamber housing a first catholyte, wherein the first catholyte comprises alkali;

a second catholyte chamber housing a second catholyte, wherein the second catholyte comprises acid; and

an electrolysis cell, the electrolysis cell comprising:

an anode chamber housing an anode;

a cathode chamber housing a cathode; and

an ion exchange membrane separating the anode chamber and the cathode chamber.

2. The ammonia cracker of claim 1, wherein the first catholyte chamber and second catholyte chamber are fluidly connected to the cathode chamber, and wherein the ammonia cracker further comprises a catholyte management system for controlling flow of the first catholyte and second catholyte to the cathode chamber.

3. The ammonia cracker of claim 2, wherein the catholyte management system is programmed to switch flows from the first catholyte to the second catholyte after a predetermined period of time.

4. The ammonia cracker of any one of claims 1 to 3, wherein the anolyte and second catholyte have a pH difference of at least about 10.

5. An ammonia cracker comprising:

an anolyte chamber housing an anolyte, wherein the anolyte comprises alkali and ammonia;

a catholyte chamber housing an acid catholyte; and

an electrolysis cell, the electrolysis cell comprising:

an anode chamber housing an anode;

a cathode chamber housing a cathode; and

an ion exchange membrane separating the anode chamber and the cathode chamber.

6. An ammonia cracker comprising:

an anolyte chamber housing an anolyte, wherein the anolyte comprises alkali and ammonia;

a catholyte chamber housing an alkali catholyte; and

an electrolysis cell, the electrolysis cell comprising:

an anode chamber housing an anode;

a cathode chamber housing a cathode; and

an ion exchange membrane separating the anode chamber and the cathode chamber.

7. The ammonia cracker of any one of claims 1 to 4 and 6, wherein the alkali of the first catholyte or alkali catholyte is selected from the group consisting of KOH, NaOH, LiOH, CsOH, and combinations thereof.

8. The ammonia cracker of any one of claims 1 to 5, wherein the acid of the second catholyte or acid catholyte is selected from the group consisting of H_2SO_4, HCl, HNO_3, and combinations thereof.

9. The ammonia cracker of any one of claims 1 to 8, comprising at least one of:

a) wherein the anolyte comprises KOH, NaOH, LiOH, CsOH, or combinations thereof;

b) wherein the anode and/or cathode comprises a Pt-based catalyst;

c) wherein the Pt-based catalyst is 40 wt% Pt/C or Pt-black;

d) wherein the anode further comprises Ni felt or Pt-coated Ti felt as Gas Diffusion Layers (GDLs);

e) wherein the ammonia cracker comprises separate outlets for anodic product and cathodic product; and

f) wherein the cathodic product comprises hydrogen.

10. A method of producing hydrogen, the method comprising:
(i) feeding an anolyte comprising ammonia and alkali to an anode chamber housing an anode;
(ii) feeding a first catholyte to a cathode chamber housing a cathode, wherein the first catholyte comprises alkali;
(iii) applying an electric potential between the anode and the cathode to activate electrolysis; and
(iv) switching from feeding a first catholyte to the cathode chamber to feeding a second catholyte to the cathode chamber after a predetermined period of time, wherein the second catholyte comprises acid,
wherein an ion exchange membrane separates the anode chamber and the cathode chamber.

11. A method of producing hydrogen, the method comprising:
(i) feeding an anolyte comprising ammonia and alkali to an anode chamber housing an anode;
(ii) feeding an alkali catholyte to a cathode chamber housing a cathode; and
(iii) applying an electric potential between the anode and the cathode to activate electrolysis,
wherein an ion exchange membrane separates the anode chamber and the cathode chamber.

12. A method of producing hydrogen, the method comprising:
(i) feeding an anolyte comprising ammonia and alkali to an anode chamber housing an anode; and
(ii) feeding an acid catholyte to a cathode chamber housing a cathode,
wherein an ion exchange membrane separates the anode chamber and the cathode chamber.

13. The method of claim 10 or 12, comprising at least one of:

a) wherein an electric potential is generated when feeding the second catholyte or the acid catholyte to the cathode chamber; and

b) further comprising applying a pulsed electric potential between the anode and the cathode.

14. The method of any one of claims 10 to 13, comprising at least one of:

a) wherein the method is performed at a temperature of about room temperature to about 90 °C; and

b) wherein the method produces an anodic product comprising nitrogen, and a cathodic product comprising hydrogen, from separate outlets.

15. Hydrogen produced by the method of any one of claims 10 to 14.