CLAIMS

1. An apparatus for generating nitric oxide (NO), the apparatus comprising:

a reaction chamber having a liquid region and a gas region, the liquid region configured to contain a reaction medium, the gas region configured to contain a product gas comprising NO;

a plurality of electrodes disposed in the reaction medium, the plurality of electrodes comprising a cathode;

an energy source electrically connected to the plurality of electrodes and configured to apply a predetermined voltage or a predetermined current to the cathode to generate NO;

a sparger disposed in the reaction medium;

an inlet circuit in fluid communication with the sparger and configured to convey a carrier gas to the sparger; wherein the carrier gas preferably comprises nitrogen;

an outlet circuit in fluid communication with the gas region of the reaction chamber and configured to convey the product gas from the reaction chamber; and

(A) a pressure vessel in fluid communication with the outlet circuit, the pressure vessel configured to receive the product gas from the outlet circuit, store the received product gas at or below a predetermined pressure, and release the received product gas; and/or

(B) a recirculation circuit including:

a circulation inlet in fluid communication with the gas region of the reaction chamber configured to receive a fluid flow of the product gas from the gas region;

a circulation outlet in fluid communication with the sparger; and

a pump configured to create the fluid flow of the product gas from the circulation inlet to the sparger through the circulation outlet.

2. The apparatus of claim 1, wherein the fluid flow comprises a flow of the product gas.

3. The apparatus of claim 1, wherein the sparger is disposed adjacent the cathode and configured to emanate bubbles in the reaction medium to propagate along a surface of the cathode.

4. The apparatus of claim 1, wherein the reaction chamber comprises a first side and a second side opposite to the first side, and the cathode comprises an electrode plate positioned substantially perpendicular to the second side of the reaction chamber.

5. The apparatus of claim 4, wherein the electrode plate comprises a surface, a first edge, and a second edge opposite to the first edge, the first edge extending along the first side of the reaction chamber, the second edge extending along the second side of the reaction chamber.

6. The apparatus of claim 5, wherein the sparger is disposed between the second side of the reaction chamber and the second edge of the electrode plate and configured to emanate bubbles along a bubble path extending from the second edge to the first edge of the electrode plate.

7. The apparatus of claim 1, wherein the reaction medium comprises a buffer solution, a source of nitrite ions, and a catalyst.

8. The apparatus of claim 1, wherein the predetermined current is from about 0 mA to about 600 mA.

9. The apparatus of claim 1, wherein the pressure vessel comprises:

a body defining an interior cavity comprising a first region and a second region, the second region in fluid communication with and disposed downstream of the first region;

a gas inlet and a gas outlet in fluid communication with the first region;

and a plurality of baffles defining a circuitous flow path through the first region and the second region; and

a pressure relief valve disposed on the body and in fluid communication with the second region.

10. The apparatus of claim 1, further comprising a filtration device disposed downstream of the circulation inlet and upstream of the pump of the recirculation circuit, the

filtration device configured to reduce or remove one or more liquid and/or solid impurities in the first fluid flow.

11. The apparatus of claim 1, further comprising a carrier gas source disposed upstream of and in fluid communication with the inlet circuit, the carrier gas source configured to generate or supply the carrier gas to the inlet circuit.

12. The apparatus of claim 1, further comprising a ventilation circuit configured to connect to a respiratory device, the ventilation circuit comprising an inspiratory circuit disposed downstream of and in fluid communication with the respiratory device and the pressure vessel.

13. The apparatus of claim 12, wherein the inspiratory circuit comprises:

an inlet configured to receive an air flow or an oxygen flow from the respiratory device;

a port disposed downstream of the inlet, the port configured to receive the product gas from the pressure vessel;

a flow rate sensor disposed downstream of the inlet and configured to measure a flow rate of the air flow or the oxygen flow; and

an outlet configured to deliver a gas mixture comprising the product gas from the pressure vessel and the air or oxygen from the respiratory device.

14. The apparatus of claim 13, wherein the inspiratory circuit further comprises a sampling port disposed upstream of the outlet and configured to output a sample gas flow of the gas mixture.

15. The apparatus of claim 14, further comprising a gas monitoring device comprising one or more gas sensors configured to receive the sample gas flow and measure one or more concentrations of NO_2, NO, and O_2 of the sample gas flow.

16. The apparatus of claim 15, further comprising:

a flow control device configured to control a flow rate of the product gas entering the inspiratory circuit from the pressure vessel;

a control device in communication with the flow rate sensor, the flow control device, and the gas monitoring device, wherein the control device is configured to

receive one or more sensing signals or readings from the gas monitoring device and/or the flow rate sensor;

generate instructions based on the one or more sensing signals or readings; and

send the instructions to the flow control device to adjust the flow rate of the product gas entering the inspiratory circuit.

17. A method for generating nitric oxide (NO), the method comprising:

applying, by an energy source, a predetermined voltage or a predetermined current to one or more of electrodes disposed in a reaction medium contained in a reaction chamber to generate NO, the plurality of electrodes comprising a cathode, the reaction chamber comprising a gas region and a liquid region, the liquid region configured to contain the reaction medium, the gas region configured to contain a product gas comprising NO;

receiving a carrier gas through an inlet circuit in fluid communication with a sparger disposed in the reaction medium;

emanating, by the sparger, bubbles of the carrier gas in the reaction medium to sweep a surface of one or more of the plurality of electrodes; and

conveying the product gas from the reaction chamber through an outlet circuit, the outlet circuit in fluid communication with the gas region of the reaction chamber,

wherein (A) the product gas is further conveyed through a pressure vessel in fluid communication with the outlet circuit, or (B) at least a portion of the product gas is circulated, in a recirculation circuit, back to the sparger in the reaction chamber.

18. The method of claim 17, wherein the portion of the product gas is circulated from the gas region of the reaction chamber, by the pump in the recirculation circuit, to the sparger.

19. The method of claim 17, further comprising combining the circulated product gas with the carrier gas upstream of the sparger.

20. The method of claim 17, further comprising before applying the predetermined voltage or the predetermined current, applying a stimulation voltage or a stimulation current to at least one of the plurality of electrodes for a stimulation period.