CLAIMS

1. An air treatment unit, comprising:

an air inlet to receive a flow of input air for treatment;

a reaction reservoir configured to hold an aqueous air treatment solution, wherein the reaction reservoir includes a first reagent inlet configured to allow into the reaction reservoir a supply of hydrogen peroxide, and wherein the reaction reservoir includes a second reagent inlet configured to allow into the reaction reservoir a supply of alkali hydroxide;

an air dispersing element flow connected with the air inlet, wherein the air dispersing element is configured to convert at least a portion of the flow of input air into a plurality of microbubbles for introduction into the aqueous air treatment solution, such that an amount of one or more target gas species contained within the plurality of microbubbles is reduced through reaction with the aqueous air treatment solution;

a pH sensor configured to generate an output indicative of a pH level of a solution in the reaction reservoir;

at least one controller programmed to, based on the output of the pH sensor, initiate transfer into the reaction reservoir of at least one of the supply of hydrogen peroxide via the first reagent inlet or the supply of alkali hydroxide via the second reagent inlet; and

an air outlet configured to output treated air from the reaction reservoir.

2. The air treatment unit of claim 1, wherein the air dispersing element includes a plurality of holes configured to emit the microbubbles.

3. The air treatment unit of claim 2, wherein the plurality of holes have an average diameter of between 0.5 microns and 500 microns.

4. The air treatment unit of claim 2, wherein the plurality of holes have an average diameter of between 10 microns and 100 microns.

5. The air treatment unit of claim 2, wherein the plurality of holes are distributed across at least a portion of the air dispersing element with a distribution density of between one and 100 holes per square centimeter.

6. The air treatment unit of claim 2, wherein the plurality of holes are distributed across at least a portion of the air dispersing element with a distribution density of between three and ten holes per square centimeter.

7. The air treatment unit of claim 1, wherein the air dispersing element is configured to generate microbubbles having an average diameter of less than 1 millimeter.

8. The air treatment unit of claim 1, wherein the air dispersing element is configured to generate microbubbles having an average diameter of between 1 and 100 microns.

9. The air treatment unit of claim 1, wherein the air dispersing element is configured to generate microbubbles of which at least 80% have an average diameter of between 10- 70 microns.

10. The air treatment unit of claim 1, wherein the microbubbles generated by the air dispersing element have a mean free path in the air treatment solution that ranges from 0.01 cm to 25 cm.

11. The air treatment unit of claim 1, wherein the at least 80% of the microbubbles generated by the air dispersing element have a mean free path of at least 1 mm.

12. The air treatment unit of claim 1, wherein the aqueous air treatment solution includes an oxidizing agent, wherein the oxidizing agent includes the hydrogen peroxide.

13. The air treatment unit of claim 12, wherein the oxidizing agent includes at least one of permanganate, persulfate, or combinations thereof.

14. The air treatment unit of claim 12, wherein the air treatment solution has an oxidizing agent to alkali hydroxide ratio of at least 1:1 and up to 1.6:1.

15. The air treatment unit of claim 12, wherein the air treatment solution has an oxidizing agent to alkali hydroxide ratio of at least 1:1 and up to 4:1.

16. The air treatment unit of claim 12, wherein the alkali hydroxide includes one or more of sodium hydroxide, calcium hydroxide, potassium hydroxide, lithium hydroxide, or combinations thereof.

17. The air treatment unit of claim 1, wherein the aqueous air treatment solution includes hydrogen peroxide having a molarity of between 5M and 50M.

18. The air treatment unit of claim 1, wherein the aqueous air treatment solution includes alkali hydroxide having a molarity of between 3M and 30M.

19. The air treatment unit of claim 1, wherein the aqueous air treatment solution has a pH of between 10 and 12.5.

20. The air treatment unit of claim 1, wherein the aqueous air treatment solution includes a superoxide anion formed by reaction of hydrogen peroxide with at least one alkali hydroxide.

21. The air treatment unit of claim 1, wherein the air treatment unit further includes:

an air quality sensor configured to generate an output indicative of a level of at least one constituent in air treatable by the air treatment unit; and

at least one controller programmed to:

monitor the output of the air quality sensor to determine the level of the at least one constituent;

determine whether the level of the at least one constituent exceeds a predetermined threshold; and

after determining that the level of the at least one constituent exceeds the predetermined threshold, initiate transfer into the reaction reservoir of the supply of hydrogen peroxide via the first reagent inlet, initiate transfer into the reaction reservoir of the supply of alkali hydroxide via the second reagent inlet, and cause at least some of the air treatable by the air treatment unit to enter the air inlet.

22. The air treatment unit of claim 21, wherein the air quality sensor is located remotely with respect to the air treatment unit.

23. The air treatment unit of claim 1, wherein the air treatment unit further includes:

an air quality sensor configured to generate an output indicative of a level of at least one constituent in treated air output by the air treatment unit; and

at least one controller programmed to:

monitor the output of the air quality sensor to determine the level of the at least one constituent;

determine whether the level of the at least one constituent exceeds a predetermined threshold; and

after determining that the level of the at least one constituent exceeds the predetermined threshold, initiate transfer into the reaction reservoir of a portion of the supply of hydrogen peroxide via the first reagent inlet.

24. The air treatment unit of claim 23, further comprising initiation of transfer into the reaction reservoir of a portion of the supply of alkali hydroxide via the second reagent inlet after a determination that the level of the at least one constituent exceeds the predetermined threshold.

25. The air treatment unit of claim 23, wherein the air quality sensor is positioned to interact with air in the air outlet.

26. The air treatment unit of claim 1, wherein the at least one controller is further programmed to:

monitor the output of the pH sensor to determine a pH level of the solution in the reaction reservoir;

determine how the pH level of the solution in the reaction reservoir compares to at least one of a target pH level or a target pH range; and

after a determination that the pH level of the solution in the reaction reservoir differs from the target pH level by more than a threshold difference or falls outside of the target pH range, initiate transfer into the reaction reservoir of at least one of the supply of hydrogen peroxide via the first reagent inlet or the supply of alkali hydroxide via the second reagent inlet.

27. The air treatment unit of claim 1, wherein the air treatment unit further includes:

a fluid level sensor configured to generate an output indicative of a fluid level of a solution in the reaction reservoir; and

at least one controller programmed to:

monitor the output of the fluid level sensor;

after a determination that a fluid level in the reaction reservoir has fallen below a target fluid level, initiate transfer into the reaction reservoir of at least one of the supply of hydrogen peroxide via the first reagent inlet, the supply of alkali hydroxide via the second reagent inlet, or a supply of water through a water inlet.

28. The air treatment unit of claim 1, further including one or more pumps for drawing air into the air inlet or for causing air to flow from the air outlet.

29. The air treatment unit of claim 1, further including a condenser unit downstream of the air outlet and configured to collect aqueous air treatment solution carried by treated air passing out of the air outlet.

30. The air treatment unit of claim 1, further including a thermocatalytic unit upstream from the air inlet, wherein the thermocatalytic unit includes:

a heater configured to heat air passing therethrough to a temperature in the range of 80 degrees Celsius to 500 degrees Celsius; and

a catalytic converter configured to receive the heated air.

31. The air treatment unit of claim 30, wherein the heater is powered by at least one of electric power or fuel gas combustion.

32. The air treatment unit of claim 1, further comprising one or more particulate filters.

33. The air treatment unit of claim 1, wherein the air treatment unit is configured to reduce an amount of carbon monoxide from the input air by at least a factor of 100.

34. The air treatment unit of claim 1, wherein the air treatment unit is configured to reduce a temperature of the input air by at least a factor of two.

35. The air treatment unit of claim 1, wherein the air treatment unit is configured to process the input air at a flow rate of between 300 liters per minute to 600 liters per minute.

36. An elevator fitted with the air treatment unit of claim 1, wherein the elevator includes a cabin, and treated air passing from the air outlet flows toward the cabin.

37. The elevator of claim 36, wherein the air treatment unit is configured to provide an overpressure in the cabin of at least 0.8 mbar.

38. The elevator of claim 36, wherein treated air provided to the cabin has a temperature of no more than 40 degrees Celsius.

39. A personal breathing apparatus including the air treatment unit of claim 1.

40. The personal breathing apparatus of claim 39, wherein the air treatment unit is configured to process the input air at a flow rate of least 10 liters per minute to 100 liters per minute.

41. The personal breathing apparatus of claim 39, further including a breathing interface flow connected to the air outlet and configured to provide at least a portion of the treated air to a user of the personal breathing apparatus.

42. The personal breathing apparatus of claim 41, wherein the breathing interface includes at least one of a mouthpiece or a mask.

43. The personal breathing apparatus of claim 39, further including two or more breathing interfaces flow connected to the air outlet and configured to provide at least a portion of the treated air to two or more users of the personal breathing apparatus.

44. The personal breathing apparatus of claim 41, further including a flow limiter to limit flow of the aqueous air treatment solution into the breathing interface.

45. The personal breathing apparatus of claim 39, further including a flow path configured to receive air exhaled by a user of the personal breathing apparatus and provide the exhaled air to the air inlet of the air treatment unit.

46. A method of treating air with an air treatment unit, the method comprising:

flowing air to be treated into an air inlet of a reaction reservoir, wherein the reaction reservoir includes an air treatment solution including a mixture of an oxidizing agent and alkali hydroxide;

converting at least a portion of the flow of air to be treated into a plurality of microbubbles using an air dispersing element;

introducing the microbubbles into the air treatment solution, such that an amount of one or more target gas species contained within the plurality of microbubbles is reduced through reaction with one or more constituents of the air treatment solution;

generating, by a sensor, an output indicative of a pH level of a solution in the reaction reservoir;

initiating, by at least one controller and based on the output of the sensor, transfer into the reaction reservoir of at least one of the supply of hydrogen peroxide via the first reagent inlet or the supply of alkali hydroxide via the second reagent inlet; and

outputting treated air from the reaction reservoir.

47. The method of claim 46, further comprising:

automatically determining, from an output of an air quality sensor, a level of at least one constituent in a volume of air;

automatically determining whether the level of the at least one constituent exceeds a predetermined threshold; and

after determining that the level of the at least one constituent exceeds the predetermined threshold, initiating transfer into the reaction reservoir of a supply of the oxidizing agent via a first reagent inlet.

48. The method of claim 47, further including initiating transfer into the reaction reservoir of a supply of the alkali hydroxide via a second reagent inlet.

49. The method of claim 47, wherein the oxidizing agent includes at least one of hydrogen peroxide, permanganate, persulfate, or combinations thereof.

50. The method of claim 47, wherein the air quality sensor is positioned downstream of the reaction reservoir.

51. The method of claim 47, wherein the air quality sensor is positioned upstream of the air inlet of the reaction reservoir.