CLAIMS

What is claimed is:

1. A liquid-free trap for trace levels of an acidic or basic airborne molecular contaminant in a gas, comprising:

a housing, comprising an inlet and an outlet;

a flow path between the inlet and the outlet; and

a porous solid mass of rigid sintered hydrophilic material situated in the flow path between the inlet and the outlet and sealed in the housing, the rigid sintered hydrophilic material functionalized with ~~from about 0.05 molar milliequivalents to about 10 molar milliequivalents of~~ a basic species for trapping an acidic airborne molecular contaminant in the gas or ~~from about 0.05 molar milliequivalents to about 10 molar milliequivalents of~~ an acidic species for trapping a basic airborne molecular contaminant in the gas.

~~2. A liquid-free trap for trace levels of an acidic or basic airborne molecular contaminant in a gas, comprising:~~

~~a housing, comprising an inlet and an outlet;~~

~~a flow path between the inlet and the outlet; and~~

~~a rigid sintered hydrophilic material situated in the flow path between the inlet and the outlet and sealed in the housing, the rigid sintered hydrophilic material functionalized with from about 0.05 molar milliequivalents to about 10 molar milliequivalents of a basic species that forms a solvent soluble reaction product with an acidic airborne molecular contaminant in the gas or from about 0.05 molar milliequivalents to about 10 molar milliequivalents of an acidic species that forms a solvent soluble reaction product with a basic airborne molecular contaminant in the gas.~~

~~3. The liquid-free trap of claim 2, wherein the solvent is water.~~

~~4. The liquid-free trap of claim 1, 2 or 3, wherein the rigid sintered hydrophilic material is functionalized with from about 0.05 molar milliequivalents to about 5 molar milliequivalents of a basic species for trapping an acidic airborne molecular~~

~~contaminant in the gas or from about 0.05 molar milliequivalents to about 5 molar milliequivalents of an acidic species for trapping a basic airborne molecular contaminant in the gas.~~

~~5. The liquid-free trap of claim 1, 2 or 3, wherein the rigid sintered hydrophilic material is functionalized with from about 0.1 molar milliequivalents to about 10 molar milliequivalents of a basic species for trapping an acidic airborne molecular contaminant in the gas or from about 0.1 molar milliequivalents to about 10 molar milliequivalents of an acidic species for trapping a basic airborne molecular contaminant in the gas.~~

~~6. The liquid-free trap of claim 1, 2 or 3, wherein the rigid sintered hydrophilic material is functionalized with from about 1 molar milliequivalents to about 10 molar milliequivalents of a basic species for trapping an acidic airborne molecular contaminant in the gas or from about 1 molar milliequivalents to about 10 molar milliequivalents of an acidic species for trapping a basic airborne molecular contaminant in the gas.~~

~~7. The liquid-free trap of claim 1, 2 or 3, wherein the rigid sintered hydrophilic material is functionalized with about 5 molar milliequivalents of a basic species for trapping an acidic airborne molecular contaminant in the gas or about 5 molar milliequivalents of an acidic species for trapping a basic airborne molecular contaminant in the gas.~~

~~8.~~2. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~–7~~, wherein the average pore size of the rigid sintered hydrophilic material is from about 1 micron to about 100 microns.

~~9. The liquid-free trap of claim 8, wherein the average pore size of the rigid sintered hydrophilic material is from about 2 microns to about 50 microns.~~

~~10. The liquid-free trap of claim 9, wherein the average pore size of the rigid sintered hydrophilic material is from about 5 microns to about 50 microns.~~

~~11.~~3. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~–10~~, wherein the rigid sintered hydrophilic material is sintered metal.

~~12. The liquid-free trap of claim 11, wherein the rigid sintered hydrophilic material is sintered type 316L stainless steel.~~

~~13. The liquid-free trap of any one of claims 1-10, wherein the rigid sintered hydrophilic material is polymeric.~~

~~14.~~4. The liquid-free trap of claim ~~13~~1, wherein the rigid sintered hydrophilic material is sintered hydrophilic polyethylene, sintered hydrophilic ultrahigh molecular weight polyethylene, sintered hydrophilic polytetrafluoroethylene, sintered hydrophilic polyethersulfone or sintered hydrophilic nylon.

~~15. The liquid-free trap of claim 14, wherein the rigid sintered hydrophilic material is sintered hydrophilic ultrahigh molecular weight polyethylene.~~

~~16.~~5. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~-15~~, wherein the ~~rigid sintered hydrophilic material is functionalized with a~~ basic species is selected from an alkali or alkaline earth metal salt of bicarbonate, carbonate or hydroxide, or a combination ~~of the foregoing~~ thereof.

~~17. The liquid-free trap of claim 16, wherein the rigid sintered hydrophilic material is functionalized with an alkali earth metal salt of a carbonate.~~

~~18.~~6. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~-15~~, wherein the rigid sintered hydrophilic material is functionalized with a polyprotic acid.

~~19. The liquid-free trap of claim 18, wherein the rigid sintered hydrophilic material is functionalized with phosphoric acid or citric acid.~~

~~20. The liquid-free trap of any one of claims 1-19, wherein the housing is a polymeric material.~~

~~21. The liquid-free trap of claim 20, wherein the housing is polyether ether ketone (PEEK).~~

~~22.~~7. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~-21~~, wherein the housing further comprises an upstream component including the inlet, a downstream component including the

outlet and a locking nut to secure the upstream component to the downstream component and the housing is polyether ether ketone (PEEK).

~~23. The liquid-free trap of any one of claims 1-22, wherein the housing is chemically clean.~~

~~24.~~8. The liquid-free trap of ~~any one of~~ claim~~s~~ 1~~-23~~, wherein the rigid sintered hydrophilic material is chemically clean.

9. The liquid-free trap of claim 1, wherein the housing comprises:

a hollow, substantially cylindrical upstream component having a longitudinal axis comprising an inner surface, an outer surface, the inlet and an upstream surface, the inner surface having a tapered portion terminating at the upstream surface, the inner surface tapering from the upstream surface to the inlet;

a hollow, substantially cylindrical downstream component comprising the outlet and a downstream surface; and

a locking nut to secure the upstream component to the downstream component without causing the upstream and downstream components to rotate with respect to one another, the upstream surface and the downstream surface together creating a space that is sealed from the environment and situated in a flow path between the inlet and the outlet.

10. The liquid-free trap of claim 9, wherein the rigid sintered hydrophilic material is sealed in the housing and situated in the flow path in the space created by the upstream component and the downstream component between the inlet and the outlet.

11. The liquid-free trap of claim 1, wherein the rigid sintered hydrophilic material has a thickness of from about 0.1 centimeters to about 0.65 centimeters.

~~25.~~12. A liquid-free trap for trace levels of a basic airborne molecular contaminant in a gas, comprising:

a housing, comprising an inlet and an outlet;

a flow path between the inlet and the outlet; and

a porous solid mass of rigid sintered hydrophilic material situated in the flow path between the inlet and the outlet and sealed in the housing, wherein the rigid sintered hydrophilic material is hydrophilic ultrahigh molecular weight polyethylene having an average pore size of from about 5 microns to about 50 microns and is functionalized with phosphoric acid.

~~26. The liquid-free trap of claim 25, wherein the basic airborne molecular contaminant is ammonia.~~

~~27. The liquid-free trap of claim 25 or 26, wherein the rigid sintered hydrophilic material is functionalized with from about 1 molar milliequivalents to about 10 molar milliequivalents of phosphoric acid.~~

~~28.~~13. A liquid-free trap for trace levels of an acidic airborne molecular contaminant in a gas, comprising:

a housing, comprising an inlet and an outlet;

a flow path between the inlet and the outlet; and

a porous solid mass of rigid sintered hydrophilic material situated in the flow path between the inlet and the outlet and sealed in the housing, wherein the rigid sintered hydrophilic material is sintered stainless steel having an average pore size of from about 5 microns to about 50 microns and is functionalized with an alkali metal carbonate or bicarbonate.

~~29.~~14. The liquid-free trap of claim ~~28~~13, wherein the rigid sintered hydrophilic material is functionalized with sodium carbonate or sodium bicarbonate or potassium hydroxide.

~~30. The liquid-free trap of claim 28, wherein the rigid sintered hydrophilic material is functionalized with sodium bicarbonate.~~

~~31. The liquid-free trap of claim 28, 29 or 30, wherein the rigid sintered hydrophilic material is functionalized with from about 1 molar milliequivalents to about 10 molar milliequivalents of the alkali metal carbonate or bicarbonate.~~

~~32. The liquid-free trap of any one of claims 28-31, wherein the acidic airborne molecular contaminant is sulfur dioxide, hydrogen fluoride or acetic acid, or a combination of the foregoing.~~

~~33.~~15. A method for trapping trace levels of an acidic or basic airborne molecular contaminant in a gas stream, comprising:

passing a gas stream into the inlet through the flow path and out of the outlet of the liquid-free trap of ~~any one of~~ claim~~s~~ 1~~-32~~ at a flow rate and for a period of time sufficient to trap a detectable quantity of the acidic or basic airborne molecular contaminant with the rigid sintered hydrophilic material.

~~34. A method for detecting or measuring trace levels of an acidic or basic airborne molecular contaminant in a gas stream, comprising:~~

~~passing a gas stream into the inlet through the flow path and out of the outlet of the liquid-free trap of any one of claims 1-32 at a flow rate and for a period of time sufficient to trap a detectable quantity of the acidic or basic airborne molecular contaminant with the rigid sintered hydrophilic material;~~

~~desorbing the trapped acidic or basic airborne molecular contaminant from the rigid sintered hydrophilic material, thereby providing a sample; and~~

~~analyzing the sample for trace levels of the acidic or basic airborne molecular contaminant, thereby detecting or measuring trace levels of an acidic or basic airborne molecular contaminant in the gas stream.~~

~~35.~~16. The method of claim ~~33 or 34~~ 15, wherein the period of time is from about ~~2~~0.5 to about 8 hours.

~~36. The method of claim 35, wherein the period of time is from about 4 hours to about 6 hours.~~

~~37.~~17. The method of ~~any one of~~ claim~~s 33-36~~ 15, wherein the flow rate is greater than zero and less than about 10 liters per minute.

~~38. The method of claim 37, wherein the flow rate is less than about 5 liters per minute.~~

18. The method of claim 15, wherein the gas stream is humidified prior to passing into the inlet of the liquid-free trap.

19. A method for detecting or measuring trace levels of an acidic or basic airborne molecular contaminant in a gas stream, comprising:

passing a gas stream into the inlet through the flow path and out of the outlet of the liquid-free trap of claim 1 at a flow rate and for a period of time sufficient to trap a detectable quantity of the acidic or basic airborne molecular contaminant with the rigid sintered hydrophilic material;

desorbing the trapped acidic or basic airborne molecular contaminant from the rigid sintered hydrophilic material, thereby providing a sample; and

analyzing the sample for trace levels of the acidic or basic airborne molecular contaminant, thereby detecting or measuring trace levels of an acidic or basic airborne molecular contaminant in the gas stream.

~~39.~~20. The method of ~~any one of~~ claim~~s 34-38~~19, wherein analyzing the sample comprises analyzing the sample using ion chromatography.

~~40. The method of any one of claims 33-39, wherein the basic airborne molecular contaminant is ammonia.~~

~~41. The method of any one of claims 33-39, wherein the acidic airborne molecular contaminant is sulfur dioxide, hydrogen fluoride or acetic acid, or a combination of the foregoing.~~

~~42.~~21. The method of ~~any one of~~ claim~~s 34-41~~ 19, wherein desorbing the trapped acidic or basic airborne molecular contaminant from the rigid sintered hydrophilic material comprises extracting the trapped acidic or basic airborne molecular contaminant from the rigid sintered hydrophilic material using a solvent.

~~43.~~22. The method of claim ~~42~~21, wherein extracting the trapped acidic or basic airborne molecular contaminant using a solvent comprises ultrasonically treating a mixture of the rigid sintered hydrophilic material and the solvent.

44. The method of any one of claims 33-43, wherein a pump is used to draw the gas stream into the inlet through the flow path and out of the outlet of the liquid-free trap.

45. The method of any one of claims 33-44, wherein the gas stream is humidified prior to passing into the inlet of the liquid-free trap.

46. A system, comprising a liquid-free trap of any one of claims 1-32; and a pump or a gas humidifier, or a combination of the foregoing.

47. A housing for a liquid-free trap for trace levels of an acidic or basic airborne molecular contaminant in a gas, comprising:

a hollow, substantially cylindrical upstream component having a longitudinal axis comprising an inner surface, an outer surface, an inlet and an upstream surface, the inner surface having a tapered portion tapering outwardly from the inlet to the upstream surface and terminating at the upstream surface;

a hollow, substantially cylindrical downstream component comprising an outlet and a downstream surface; and

a locking nut to secure the upstream component to the downstream component without causing the upstream and downstream components to rotate with respect to one another,

liquid-free trap the upstream surface and the downstream surface together creating a space that is sealed from the environment and situated in a flow path between the inlet and the outlet.

48. The housing of claim 47, wherein the upstream component, the downstream component and the locking nut are polyether ether ketone (PEEK).

49. The housing of claim 47 or 48, wherein the upstream component or the downstream component further comprises a grip to facilitate sealing and unsealing of the locking nut.

50. The housing of claim 47, 48 or 49, wherein the upstream component or the downstream component further comprises threads on an exterior surface thereof and the locking nut comprises threads on an interior surface thereof that mate with the threads of the upstream component or the downstream component.

51. The housing of any one of claims 47-50, further comprising a spring ring for preventing the locking nut from disengaging from the upstream component or the downstream component.

52. The housing of any one of claims 47-51, wherein the upstream component further comprises a stop for preventing the locking nut from disengaging from the upstream component and to secure the upstream component in the locking nut upon assembly of the housing.

53. The housing of any one of claims 47-52, wherein the tapered portion tapers outwardly at an angle of from about 5° to about 45 ° from the longitudinal axis of the upstream component.

54. A liquid-free trap for trace levels of an acidic or basic airborne molecular contaminant in a gas, comprising:

a housing of any one of claims 47-52; and

a rigid sintered hydrophilic material situated in the flow path in the space created by the upstream component and the downstream component between the inlet and the outlet and sealed in the housing.