

CLAIMS:

1. A respiratory humidification system for providing humidification to gases that pass through a gases passage way before being provided to an airway of a patient, the respiratory humidification system comprising:

a liquid flow controller for providing a controlled flow of liquid;

a heating system including a heating surface configured to be located in a gases passage way and provide humidification to gases passing through the passage way, wherein the heating system receives the controlled flow of liquid, the heating system configured to maintain the heating surface at a temperature of between 30 °C and 99.9 °C; and

one or more hardware processors providing deterministic control of a humidity level of gases passing through the gases passage way by instructing the liquid flow controller to adjust the controlled flow of liquid received at the heating system based on a flow rate of gases through the gases passage way, and an evaporation rate of said controlled flow of liquid from the heating surface.

2. The respiratory humidification system of Claim 1, wherein the deterministic control of the humidity level of gases is based on one or more of:

control of a temperature of the heating surface,

control of an evaporative area of the heating surface,

the flow of liquid received at the heating system.

3. The respiratory humidification system of Claim 1 or 2, wherein the controlled flow of liquid is configured to be provided to the heating surface so as to cover the heating surface as a film.

4. The respiratory humidification system of any one of Claim 1-3, wherein the liquid flow controller comprises a metering system.

5. The respiratory humidification system of any one of Claims 1-4, wherein the liquid flow controller comprises a pump, optionally the pump is a positive displacement pump, or a gravity feed and a control valve.

6. The respiratory humidification system of any one of Claims 1-5, wherein the liquid flow controller comprises a non-return valve.

7. The respiratory humidification system of any one of Claims 1-6, further comprising a liquid reservoir.

8. The respiratory humidification system of any one of Claims 1-7, wherein the liquid flow controller is a pump in an open loop configuration.

9. The respiratory humidification system of any one of Claims 1-8, further comprising a flow sensor, wherein the flow sensor is configured to measure the controlled flow of liquid.

10. The respiratory humidification system of Claim 9, wherein the liquid flow controller is a pump or flow actuator in series with the flow sensor in a closed loop configuration.

11. The respiratory humidification system of any one of Claims 1 to 10, wherein the one or more hardware processors provides deterministic control of the humidity level based on one or more of:

- a relative humidity level of the gases prior to interaction with the heating system;

- a temperature of the gases prior to interaction with the heating system;

- an absolute or barometric pressure of gases at the inlet.

12. The respiratory humidification system of any one of Claims 1-11, wherein the one or more hardware processors provides deterministic control of the humidity level based on one or more of the following:

- a humidity level based on the dew point temperature of the gases at the inlet;

- a humidity level based on enthalpy provided by the heating surface;

- a pressure of the gases;

- a function of gas velocity; and/or

- a temperature of the liquid in the controlled flow of liquid.

13. The respiratory humidification system of any one of Claims 1-12, further comprising one or more of the following: a water temperature sensor, a gas flow rate sensor at an outlet of the gases passage way, and a gas flow rate sensor at an inlet of the gases passage way.

14. The respiratory humidification system of any one of Claims 1-13, further comprising a gases pre-heater.

15. The respiratory humidification system of Claim 14, wherein the gases pre-heater is controlled to heat the gases to a desired downstream temperature after the pre-heater, the desired downstream temperature set to be between 0 °C and 5 °C above a gases output temperature.

16. The respiratory humidification system of any one of Claims 1-15, further comprising one or more of the following:

an ambient pressure sensor;

a pressure sensor positioned at or near the heater surface;

a heating surface temperature sensor;

an ambient dew point temperature sensor or ambient humidity sensor positioned upstream of a humidification region;

an ambient dew point temperature sensor positioned upstream from a gases pre-heater;

an ambient dew point temperature sensor positioned downstream from a gases pre-heater; and/or

an ambient dew point temperature sensor positioned downstream from the gases pre-heater and combined with a temperature sensor at a gases passage way inlet.

17. The respiratory humidification system of any one of Claims 1-16, further comprising at least one temperature sensor forming part of the heating system, optionally said at least one temperature sensor is in thermal contact with the heating surface.

18. The respiratory humidification system of Claim 17, wherein the at least one temperature sensor is utilized to determine a proportion of the heater that is saturated with a liquid.

19. The respiratory humidification system of any one of Claims 1-18, further comprising a liquid pre-heater.

20. The respiratory humidification system of any one of Claims 1-19, wherein the heating surface comprises a wicking surface.