What is claimed is:

1. A mass flow controller for controlling a flow of gas from a source to a target, the mass flow controller comprising:

a first flow meter, wherein the first flow meter is a thermal mass flow meter constructed and arranged to measure the flow rate of the mass of a gas through the mass flow controller as a function of thermal sensing mass flow;

a second flow meter including a pressure sensor and a structure defining a predefined volume for receiving gas flowing through the mass flow controller, the second flow meter being constructed and arranged to measure flow rate of the mass of the gas through the mass flow controller as a function of measured rate of decay of the pressure of the gas when allowed to flow from a predefined volume;

an upstream control valve constructed and arranged to selectively control the rate of flow of gas into the mass flow controller;

a downstream control valve constructed and arranged so as to control the flow rate of the mass of the gas from the mass flow controller in response to a control signal generated as a function of a set point and the flow rate as measured by one of the flow meters; and

a system controller constructed and arranged to generate the control signal, and to provide an indication when a difference between the flow rate of mass of the gas as measured by the first flow meter and the flow rate of the mass of the gas as measured by the second flow meter exceeds a threshold;

wherein the pressure sensor, upstream flow control valve and system controller are further constructed and arranged so as to form a closed-loop pressure controller configured to regulate the pressure inside the predefined volume.

2. The mass flow controller according to claim 1, wherein the closed-loop pressure controller is further constructed and arranged so that the upstream control valve can be adjusted so as to let an inside pressure of the predefined volume rise to an upstream pressure of inlet gas sufficiently slow so as to avoid in-rush gas.

3. The mass flow controller according to claim 2, wherein the closed-loop pressure controller is further constructed and arranged so that if there is an upstream pressure disturbance during flow control when the mass flow controller is controlling the flow of gas from the source to the target, the closed-loop pressure controller will automatically adjust the openness of the

upstream control valve so as to regulate the pressure within the predetermined volume such that the inlet pressure disturbance effect on the output flow control of the mass flow controller is minimized and the pressure insensitivity performance of the flow control of mass flow controller is improved.

4. The mass flow controller according to claim 1, wherein the closed-loop pressure controller is constructed and arranged so that if there is an upstream pressure disturbance during flow control when the mass flow controller is controlling the flow of gas from the source to the target, the closed-loop pressure controller will automatically adjust the openness of the upstream control valve so as to regulate the pressure within the predetermined volume such that the inlet pressure disturbance effect on the output flow control of the mass flow controller is minimized and the pressure insensitivity performance of the flow control of mass flow controller is improved.

5. The mass flow controller according to claim 1, wherein the structure defining the predefined volume supports one or more of the first flow meter, the second flow meter, the upstream control valve and the downstream control valve.

6. The mass flow controller according to claim 1, wherein the first mass flow meter comprises a thermal mass flow meter, and the downstream control valve is positioned downstream from the thermal mass flow meter.

7. The mass flow controller according to claim 1, wherein the upstream control valve is positioned upstream from the downstream control valve, the predefined volume is positioned between the downstream control valve and the upstream control valve through which gas can flow; and wherein the pressure sensor and temperature sensor are configured, respectively to generate a pressure signal and a temperature signal representing the temperature and pressure of gas in the predefined volume.

8. The mass flow controller according to claim 7, wherein the predefined volume is within the mass flow controller between the downstream and upstream control valves, and the closed-loop pressure controller is constructed and arranged so that (1) the upstream control valve can be controlled so as to slowly let the inside pressure of the mass flow controller rise to the upstream pressure of inlet gas in order to avoid in-rush gas; and (2) if there is an upstream pressure

disturbance during the flow control period, the closed-loop pressure controller will automatically adjust the openness of the upstream control valve so as to regulate the pressure within the predetermined volume such that the inlet pressure disturbance effect on the output flow control of the mass flow controller is minimized, so as to improve the pressure insensitivity performance of the flow control of the mass flow controller.

9. The mass flow controller according to claim 1, wherein the mass flow controller and the system controller are configured and arranged to operate as follows:

(a) when the set point is at zero, the downstream control valve is closed, and the upstream control valve is opened to allow the gas from the source to fill the predefined volume then the upstream control valve is closed;

(b) when the flow set point is changed from zero to a non-zero value, the second control valve is kept closed and the flow control valve is opened to regulate the flow Q_t measured by the first flow meter to the flow set point;

(c) for a predetermined period of time, the mass flow controller verifies the flow rate based on the rate of decay of a pressure signal in accordance with the following relationship:

$$Q_v=-V[d(P/T)]/dt$$

wherein Q_v is a verified flow rate as determined by the second flow meter;

V is the predetermined volume;

P is a pressure as measured by the pressure signal;

T is a temperature as measured by a temperature signal; and

d(P/T)/dt is a first derivative of a ratio P/T; and

(d) after the flow verification, the second control valve is opened to let the mass flow controller continue the flow control.

10. The mass flow controller according to claim 9, wherein the predetermined period of time is between about 50 ms and 1000 ms.

11. The mass flow controller according to claim 9, wherein the mass flow controller is further configured to compare the verified flow rate Q_v, with the flow rate measured by the first flow meter Q_t, and wherein a flow error alarm signal is provided if a deviation between Q_t and Q_v exceeds the threshold.

12. The mass flow controller according to claim 11, wherein the mass flow controller is

configured to perform self-calibration based on measured values of Q_v and Q_t.

13. The mass flow controller according to claim 1, wherein the downstream control valve is controlled allowing gas to flow through the mass flow controller as a function of the flow set point flow rate of mass through the mass flow controller so long as the flow set point is non-zero.

14. The mass flow controller according to claim 1, wherein following the setting of the flow set point to zero, the mass flow controller is configured to immediately close the upstream flow control valve.

15. The mass flow controller according to claim 1, wherein the threshold is user set.

16. The mass flow controller according to claim 1, wherein the threshold is factory set.

17. The mass flow controller according to claim 1, wherein the threshold is set as a function of permissible tolerance in mass flow for a process with which the controller is used to deliver gas.

18. A pressure insensitive mass flow controller for controlling the flow of gas from a source to a target, the mass flow controller comprising:

a first flow meter, wherein the first flow meter is a thermal mass flow meter constructed and arranged to provide a mass flow signal as a function of a set point and a measured flow of gas through the mass flow controller;

a first control valve constructed and arranged to control the flow of gas through the mass flow controller in response to a valve control signal;

a system controller constructed and arranged to generate the valve control signal as a function of a set point signal and mass flow signal;

a second flow meter including a pressure sensor constructed and arranged to provide a pressure measurement signal representing the measured pressure of the gas flowing through the mass flow controller, the second flow meter being constructed and arranged to provide a second mass flow signal as a function of the measured pressure of the gas;

a second control valve constructed and arranged upstream from the pressure sensor to selectively control the rate of flow of gas into the mass flow controller as a function of the second mass flow signal;

wherein the pressure sensor, second control valve and system controller are further constructed and arranged so as to form a closed-loop pressure controller configured to regulate a pressure flow into the mass flow controller.

19. A mass flow controller for controlling the flow rate of gas from a source to a target, the mass flow controller comprising:

a first flow meter, wherein the first flow meter is a thermal mass flow meter constructed and arranged to measure the flow rate of a mass of a gas through the mass flow controller as a function of sensing mass flow;

a second flow meter including a pressure sensor and a structure defining a predefined volume for receiving gas flowing through the mass flow controller, the second flow meter being constructed and arranged to measure and verify the flow rate of the mass of the gas through the mass flow controller as a function of measured pressure rate of decay of the gas when allowed to flow from the predefined volume;

an upstream control valve constructed and arranged to selectively control the flow rate of gas into the mass flow controller;

a downstream control valve constructed and arranged so as to control the flow rate of the mass of the gas from the mass flow controller in response to a control signal generated as a function of a set point and the flow rate as measured by the first flow meter; and

a system controller constructed and arranged to generate the control signal and verify the accuracy of the mass flow control of the mass flow controller as a function of the measured pressure rate of decay of the gas allowed to flow from the predetermined volume;

wherein the structure defining the predefined volume is a mounting block for supporting at least the second flow meter and the upstream control valve.