CLAIMS

What is claimed is:

1. A divertless, gas-dosing system comprising:

a process gas inlet pneumatically coupled to an inlet valve;

a flow controller pneumatically coupled to the inlet valve;

a line charge-volume (LCV) pneumatically coupled to be downstream of the inlet valve and the flow controller, the LCV being configured to receive an initial single-dose of a process gas;

a pressure sensor coupled to the LCV to determine a pressure level within the LCV; and

an outlet valve pneumatically coupled to be downstream of the LCV, the outlet valve configured to be coupled pneumatically to a process chamber on a downstream side of the outlet valve, the flow controller being configured to control a flow of the process gas to the process chamber independently of the inlet valve and substantially to maintain the flow at a pre-determined set point when the outlet valve is opened, the divertless, gas-dosing system being time independent with regard to a magnitude of the initial single-dose of the process gas.

2. The system of claim 1, wherein no divert valve and no diversion of precursor gases to a foreline is used within the gas-dosing system.

3. The system of claim 1, wherein:

a determination of the initial single-dose of the process gas is based solely on the determined pressure level within the LCV; and

a determination of the initial single-dose of the process gas is not to be based on a time required to charge the LCV to a level of the initial single-dose of the process gas.

4. The system of claim 1, wherein a ramp-up speed and a ramp-down speed of the flow controller is to be compensated by the determined pressure level within the LCV.

5. The system of claim 1, wherein the flow controller is configured to operate in at least one of three modes that is selected from modes including:

a flow control mode, wherein the flow controller is configured to control a flowrate of the process gas;

a pressure control mode, wherein the flow controller is configured to control the LCV up to and including a determined pressure within the LCV based on a feedback loop from the pressure sensor; and

a hold mode, wherein the flow controller is configured to hold a control valve within the flow controller based on a positional feedback of the control valve.

6. The system of claim 1, wherein the outlet valve is configured to remain closed until after the pressure sensor indicates that the pressure level within the LCV is at a predetermined level.

7. The system of claim 1, further comprising:

a self-calibrating flow meter including:

a flow-control valve; and

a second pressure sensor located upstream of the flow-control valve, the flow-control valve and the second pressure sensor both located downstream from the flow controller.

8. The self-calibrating flow meter of claim 7, further comprising a third pressure sensor located downstream of the flow-control valve and upstream of the LCV, wherein the self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the second pressure sensor and the third pressure sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.

9. The system of claim 1, further comprising:

a self-calibrating flow meter including:

a flow-control valve;

a differential-pressure sensor coupled across the flow-control valve, the differential-pressure sensor having a first leg coupled upstream of the flow-control valve and a second leg coupled downstream of the flow-control valve; and

a temperature sensor coupled proximate to the flow-control valve and upstream of the LCV, wherein the self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the differential-pressure sensor and the temperature sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.

10. An apparatus to supply precursor gas, the apparatus comprising:

a precursor gas inlet pneumatically coupled to an inlet valve;

a flow controller pneumatically coupled to be downstream of the inlet valve;

a line charge-volume (LCV) pneumatically coupled to be downstream of the flow controller, the LCV to be charged with an initial single-dose of the precursor gas;

a pressure sensor coupled to the LCV to determine a pressure level within the LCV, the initial single-dose of the precursor gas to be determined based on a pressure level within the LCV; and

an outlet valve pneumatically coupled to be downstream of the LCV, the outlet valve configured to be coupled pneumatically on a downstream side of the outlet valve to a process chamber, the outlet valve configured to be opened to release the initial single-dose of the precursor gas to the process chamber after the pressure level of the LCV reaches a predetermined value, the flow controller being configured to control a flow of the precursor gas to the process chamber independently of the inlet valve and substantially to maintain the flow at a pre-determined set point when the outlet valve is opened, the apparatus being time independent with regard to a magnitude of the initial single-dose of the process gas.

11. The apparatus of claim 10, wherein no divert valve and no diversion of precursor gases to a foreline is used within the gas-dosing apparatus.

12. The apparatus of claim 10, wherein the flow controller is configured to operate in at least one of three modes that is selected from modes including:

a flow control mode, wherein the flow controller is configured to control a flowrate of the precursor gas;

a pressure control mode, wherein the flow controller is configured to control the LCV up to and including a determined pressure within the LCV based on a feedback loop from the pressure sensor; and

a hold mode, wherein the flow controller is configured to hold a control valve within the flow controller based on a positional feedback of the control valve.

13. The apparatus of claim 10, further comprising:

a self-calibrating flow meter including:

a flow-control valve;

a second pressure sensor located upstream of the flow-control valve, the flow-control valve and the second pressure sensor both located downstream from the flow controller; and

a third pressure sensor located downstream of the flow-control valve and upstream of the LCV, wherein the self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the second pressure sensor and the third pressure sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.

14. The apparatus of claim 10, further comprising:

a self-calibrating flow meter including:

a flow-control valve;

a differential-pressure sensor coupled across the flow-control valve, the differential-pressure sensor having a first leg coupled upstream of the flow-control valve and a second leg coupled downstream of the flow-control valve;

a temperature sensor coupled proximate to the flow-control valve and upstream of the LCV, wherein the self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the differential-pressure sensor and the temperature sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.

15. A divertless, gas-dosing system comprising:

a first process gas inlet pneumatically coupled to a first inlet valve to receive a first process gas;

a second process gas inlet pneumatically coupled to a second inlet valve to receive a second process gas;

a first flow controller and a second flow controller pneumatically coupled separately to be downstream of the first inlet valve and the second inlet valve, respectively;

at least one, line charge-volume (LCV) pneumatically coupled to be downstream of first flow controller and the second flow controller, the at least one LCV being configured to receive an initial single-dose of at least one of a mixture of the first process gas and the second process gas and separate initial single-doses of the first process gas and the second process gas;

at least one pressure sensor coupled separately to respective ones of the at least one LCV to determine a pressure level within each of the at least one LCVs; and

an outlet valve pneumatically coupled to be downstream of the at least one LCV, the outlet valve configured to be coupled pneumatically on a downstream side of the outlet valve to a process chamber, the divertless, gas-dosing system being time independent with regard to a magnitude of the initial single-dose of the process gas.

16. The system of claim 15, wherein the first process gas inlet and the second process gas inlet are configured to be coupled to process gas supplies comprising different precursor gases.

17. The system of claim 15, further comprising:

a first self-calibrating flow meter and a second self-calibrating flow meter located downstream from the first flow controller and the second flow controller, respectively, each of the first self-calibrating flow meter and the second self-calibrating flow meter including:

a flow-control valve; and

a second pressure sensor located upstream of the flow-control valve.

18. The first self-calibrating flow meter and the second self-calibrating flow meter of claim 17, each further comprising a third pressure sensor located downstream of the respective flow-control valve and upstream of the at least one LCV.

19. The first self-calibrating flow meter and the second self-calibrating flow meter of claim 18, wherein each of first self-calibrating flow meter and the second self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the second pressure sensor and the third pressure sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.

20. The system of claim 15, further comprising:

a first self-calibrating flow meter and a second self-calibrating flow meter located downstream from the first flow controller and the second flow controller, respectively, each of the first self-calibrating flow meter and the second self-calibrating flow meter including:

a flow-control valve;

a differential-pressure sensor coupled across the respective flow-control valve, the differential-pressure sensor having a first leg coupled upstream of the flow-control valve and a second leg coupled downstream of the flow-control valve; and

a temperature sensor coupled proximate to the respective flow-control valve and upstream of the at least one LCV, wherein each of first self-calibrating flow meter and the second self-calibrating flow meter is configured to operate in at least one of two modes that is selected from modes including:

a first mode in which a position of the flow-control valve is to be based on readings from the pressure sensor, at least one of the differential-pressure sensor and the temperature sensor, and calibration data of the flow controller, the first mode being configured to provide a faster response time than a second mode; and

the second mode in which control of the flow-control valve is to be based on feedback received from the flow controller, the second mode being configured to provide at least one of a higher accuracy and a higher precision than the first mode.