CLAIMS

What is claimed is:

1. A volumetric standard cassette for calibration of a cassette based pumping system, the volumetric standard cassette comprising:

a rigid body configured to be sealingly installed within the cassette based pumping system and having a midbody and a number of solid pump chambers regions each having a predefined geometry defining a known volume of the pump chamber region, the rigid body being flow path and orifice free.

2. The volumetric standard cassette of claim 1, wherein the volumetric standard cassette is metal.

3. The volumetric standard cassette of claim 1, wherein the volumetric standard cassette is machined.

4. The volumetric standard cassette of claim 1, wherein the volumetric standard cassette is made from a list of materials consisting of aluminum, steel, and plastic.

5. The volumetric standard cassette of claim 1, wherein the volumetric standard cassette is constructed via a material additive process.

6. The volumetric standard cassette of claim 1, wherein the midbody has a thickness equivalent to at least half that of the thickest portion of the rigid body.

7. The volumetric standard cassette of claim 1, wherein the midbody has a thickness equivalent to at least 60% that of the thickest portion of the rigid body.

8. The volumetric standard cassette of claim 1, wherein the midbody has a thickness equivalent to a range of one half to three fourths that of the thickest portion of the rigid body.

9. The volumetric standard cassette of claim 1, wherein the volumetric standard cassette includes no cassette sheeting.

10. A volumetric standard cassette for calibration of a cassette based pumping system, the volumetric standard cassette comprising:

a midbody which is completely solid and includes a first face and opposing second face;

a number of walls extending from at least the first face of the midbody and including a peripheral wall located at a peripheral edge of the midbody as well as a number of interior walls; and

a number of solid pump chambers regions each having a predefined geometry defining a known volume of the pump chamber region;

wherein the volumetric standard cassette is incapable of pumping fluid.

11. The volumetric standard cassette of claim 10, wherein no sheeting is coupled to any of the number of walls of the volumetric standard cassette.

12. The volumetric standard cassette of claim 10, wherein the first face of the midbody is uncovered by cassette sheeting and includes the pump chamber regions.

13. The volumetric standard cassette of claim 10, wherein both the first and opposing face of the midbody are uncovered by cassette sheeting.

14. The volumetric standard cassette of claim 10, wherein the volumetric standard cassette is made from a list of processes consisting of a material additive process, machining, and molding.

15. The volumetric standard cassette of claim 10, wherein the volumetric standard cassette is made from a list of materials consisting of aluminum, steel, and plastic.

16. The volumetric standard cassette of claim 10, wherein the opposing face of the volumetric standard cassette is flat.

17. The volumetric standard cassette of claim 10, wherein the first face of the volumetric standard cassette includes a number of projections which are surrounded by the walls of the interior walls.

18. The volumetric standard cassette of claim 10, wherein the walls are draft free.

19. A cassette analog of a disposable pumping cassette for calibration of a cassette based pumping system, the cassette analog comprising:

a midbody having a first face and opposing second face;

a number of sealing ribs on at least the first face; and

a first pump chamber region and a second pump chamber region, each of the first and second pump chamber region having a defined dimensionally stable geometry representative of a selected fill volume of corresponding pump chambers in the disposable pumping cassette;

wherein the first face and opposing face are open faced and the cassette analog is incapable of pumping fluid.

20. The cassette analog of claim 19, wherein the cassette analog is formed of metal.

21. The cassette analog of claim 19, wherein the midbody is completely solid.

22. The cassette analog of claim 19, wherein the midbody is devoid of any pass-throughs.

23. The cassette analog of claim 19, wherein the selected fill volume is a full pump chamber volume of the corresponding pump chambers in the disposable pumping cassette.

24. The cassette analog of claim 19, wherein the selected fill volume is an empty pump chamber volume of the corresponding pump chambers in the disposable pumping cassette.

25. The cassette analog of claim 19, wherein the selected fill volume is intermediate a full pump chamber volume and an empty pump chamber volume of the corresponding pump chambers in the disposable pumping cassette.

26. The cassette analog of claim 19, wherein the opposing face of the volumetric standard cassette is flat.

27. The cassette analog of claim 19, wherein the first face of the volumetric standard cassette includes a number of projections which are surrounded by the sealing ribs, the number of projections being disposed at locations corresponding to a number valve seats in the disposable pumping cassette.

28. The cassette analog of claim 19, wherein the cassette analog is devoid of ports, spikes, and attached fluid lines.

29. A method for calibrating a cassette based pumping system, the method comprising:

serially installing a number of volumetric calibration cassettes in the cassette based pumping system, each of the number of volumetric calibration cassettes including a pump chamber region having a known volume;

measuring, with the cassette based pumping system, the known volume of the pump chamber region in each of the volumetric calibration cassettes;

generating a calibration curve for volume measurements conducted with the cassette based pumping system based at least in part on the known volumes for each of the number of volumetric calibration cassettes and a corresponding measured volume of the pump chamber region for each volumetric calibration cassette.

30. The method of claim 29, wherein measuring the known volume of the pump chamber region in each of the volumetric calibration cassettes comprises taking a plurality of measurements of the known volume of the pump chamber region of each of the volumetric calibration cassettes and analyzing the plurality of measurements to determine a single value for the volume of the pump chamber region which serves as the corresponding measured volume.

31. The method of claim 30, wherein analyzing the plurality of measurements comprises averaging the plurality of measurements.

32. The method of claim 29, wherein generating the calibration curve comprises generating a best fit equation.

33. The method of claim 29, wherein generating the calibration curve comprises generating a best fit polynomial.

34. The method of claim 33, wherein the best fit polynomial is a third order polynomial.

35. The method of claim 29, wherein generating the calibration curve comprises conducting a least squares regression.

36. The method of claim 29, wherein generating the calibration curve comprises constraining at least one region of the curve to at least one limit.

37. The method of claim 36, wherein the limit is an allowable range of derivative values for points along the at least one region.

38. The method of claim 29, wherein generating the calibration curve comprises enforcing a constraint on the allowable derivative values at the zero crossing of the calibration curve.

39. The method of claim 29, wherein measuring the known volume of the pump chamber region in each of the volumetric calibration cassettes comprises taking a plurality of measurements of the known volume of the pump chamber region of each of the volumetric calibration cassettes, determining their conformance to a predefined criteria, and analyzing the plurality of measurements to determine a single value for the volume of the pump chamber region which serves as the corresponding measured volume.

40. The method of claim 39, wherein the predefined criteria is a predefined allowed variability.

41. The method of claim 39, wherein the predefined criteria is an allowed standard deviation.

42. The method of claim 29, wherein the method further comprises refining the calibration curve to a second calibration curve which accounts for volume measurement error attributable to a disposable pumping cassette.

43. The method of claim 29, wherein the method further comprises refining the calibration curve to another calibration curve which accounts for volume measurement error attributable to the head height of a fluid source or destination.

44. A cassette based pumping system comprising:

a fluid handling set including a pumping cassette having a flexible membrane overlaying at least one pumping chamber;

a cycler comprising:

a mounting location sized to receive the pumping cassette and position the cassette against a control surface;

a plurality of pressure reservoirs;

a pressure delivery assembly for applying pressure from the pressure reservoirs to the pumping cassette to pump fluid through the cassette, the pressure delivery assembly having the control surface, pneumatic channels, and control chambers for actuating the flexible membrane and pressure sensors as well as at least one reference chamber of known volume for measuring pump chamber volume, the pneumatic channels in selective communication with the pressure reservoirs via a number of valves; and

a controller configured receive data from the pressure sensors, determine a raw measured volume of fluid pumped via the data, and adjust the raw measured volume of fluid pumped based at least in part upon a cycler specific calibration equation.

45. The system of claim 44, wherein the controller is configured to adjust the raw measured volume of fluid pumped based at least in part upon a cycler specific calibration equation and a pumping cassette volumetric error calibration equation.

46. The system of claim 44, wherein the controller is configured to adjust the raw measured volume of fluid pumped based at least in part upon a cycler specific calibration equation, a pumping cassette volumetric error calibration equation, and a head height error calibration equation.

47. The system of claim 44, wherein the cycler specific calibration equation is a best fit polynomial through a data set of test measurements of a series of volumetric standard cassettes.

48. The system of claim 44, wherein the controller is configured to adjust the raw measured volume of fluid pumped based a second calibration equation which is a function of the cycler specific calibration equation.

49. The system of claim 48, wherein the second equation is a pumping cassette volumetric error calibration equation.

50. The system of claim 48, wherein the controller is configured to adjust the raw measured volume of fluid pumped based a third calibration equation which is a function of the second calibration equation.

51. The system of claim 50, wherein the second equation is a pumping cassette volumetric error calibration equation and the third equation is a head height error calibration equation.

52. The system of claim 50, wherein the second equation is a head height error calibration equation and the third equation is a pumping cassette volumetric error calibration equation.

53. The system of claim 44, wherein the controller is configured to adjust the raw measured volume of fluid pumped based at least in part upon a cycler specific calibration equation and a second calibration equation.

54. The system of claim 53, wherein the system further comprises a database of pumping cassette volumetric error calibration equations associated with cassette related unique identifiers.

55. The system of claim 54, wherein the cycler further comprises a user interface and the controller is configured to receive a cassette related unique identifier input through the user interface, and communicate with the database to acquire the pumping cassette volumetric error calibration equation associated with the cassette related unique identifier input, the pumping cassette volumetric error calibration equation associated with the cassette related unique identifier input being used as the second calibration equation.

56. The system of claim 54, wherein the cycler further comprises an imager and controller is configured to determine cassette related unique identifier data via imager data, and communicate with the database to acquire the pumping cassette volumetric error calibration equation associated with the cassette related unique identifier data, the pumping cassette volumetric error calibration equation associated with the cassette related unique identifier data being used as the second calibration equation.

57. The system of claim 44, wherein the fluid handling set comprises a coded cassette related unique identifier.