sample sizes in order to be processed according to conventional purification techniques. The step of dividing the original sample into smaller volume samples increases processing time and/or labor. Furthermore, distributing the original sample across multiple containers or wells may enlarge the footprint or workstation space needed for the purification system. Also, conventional purification processes can be labor-intensive if, for example, they require a laboratory technician to manually pipette the sample between various containers.

[0005] The present disclosure sets forth purification systems and methods embodying advantageous alternatives to existing purification system and methods, and that may address one or more of the challenges or needs mentioned herein, as well as provide other benefits and advantages.

SUMMARY

[0006] One aspect of the present disclosure provides a purification system which may include a container receiving portion, a first pump, and a plurality of magnetic field generating elements. The container receiving portion may be configured to receive and support a first container containing a mixture. The first pump may be configured to remove the mixture from the first container after a target substance has been separated from a remainder of the mixture. The plurality of magnetic field generating elements may be movable relative to the container receiving portion between a respective position remote from the container receiving portion and a respective position adjacent an outer periphery of the container receiving portion. The magnetic field generating elements are arranged around the container receiving portion and movable concurrently toward or away from a center of the container receiving portion.

[0007] Another aspect of the present disclosure provides a purification method which may include: (a) adding a mixture including a target substance to a container; (b) adding

magnetic beads to the container; (c) separating the target substance from a remainder of the mixture with the magnetic beads, wherein the target substance temporarily binds to the magnetic beads; (d) moving the magnetic field generating elements concurrently toward the container receiving portion to apply a magnetic field to hold the magnetic beads against an interior surface of the container; and (e) removing the mixture from the container while the magnetic field holds the magnetic beads against the interior surface of the container.

[0008] An additional aspect of the present disclosure provides a purification system which may include a first container, a second container having a smaller volume than the first container, a first magnetic field generating element, and a second pump. The first container may be configured to initially contain a mixture and the magnetic beads for separating a target substance from a remainder of the mixture. The first magnetic field generating element may be positioned adjacent an exterior surface of the second container. The first pump may be configured to transfer the mixture and magnetic beads from the first container to the second container. The second pump may be configured to remove the mixture from the second container while the first pump transfers the mixture and the magnetic beads from the first container to the second container. Additionally, the first magnetic field generating element may magnetically attract the magnetic beads to hold the magnetic beads against an interior surface of the second container while the second pump removes the mixture from the second container.

[0009] Yet another aspect of the present disclosure provides a purification method which may include: (a) adding a mixture including a target substance to a first container; (b) adding magnetic beads to the first container; (c) separating the target substance from a remainder of the mixture in the first container with the magnetic beads, wherein the target substance temporarily binds to the magnetic beads; (d) transferring a first

volume of the mixture and a first quantity of the magnetic beads from the first container to a second container, wherein a volume of the second container is less than a volume of the first container; (e) applying a magnetic field to hold the first quantity of the magnetic beads against an interior surface of the second container; (f) removing the first volume of the mixture from the second container while the magnetic field holds the first quantity of the magnetic beads against the interior surface of the second container; (g) transferring a second volume of the mixture and a second quantity of the magnetic beads from the first container to the second container; and (h) removing the second volume of the mixture from the second container while the magnetic fields holds the first and second quantities of the magnetic beads against the interior surface of the second container while transferring the second volume of the mixture and the second quantity of the magnetic beads from the first container to the second container.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] It is believed that the disclosure will be more fully understood from the following description taken in conjunction with the accompanying drawings. Some of the drawings may have been simplified by the omission of selected elements for the purpose of more clearly showing other elements. Such omissions of elements in some drawings are not necessarily indicative of the presence or absence of particular elements in any of the embodiments, except as may be explicitly delineated in the corresponding written description. Also, none of the drawings is necessarily drawn to scale.

[0011] Fig. 1 is a top view of a schematic representation of one embodiment of a purification system constructed in accordance with principles of the present disclosure.

What is claimed is:

1. A purification system comprising:

a container receiving portion configured to receive and support a first container containing a mixture;

a first pump configured to remove the mixture from the first container after a target substance has been separated from a remainder of the mixture; and

a plurality of magnetic field generating elements, wherein each magnetic field generating element is movable relative to the container receiving portion between a respective position remote from the container receiving portion and a respective position adjacent an outer periphery of the container receiving portion;

wherein the magnetic field generating elements are arranged around the container receiving portion and movable concurrently toward or away from a center of the container receiving portion.

2. The purification system of claim 1, the first magnetic field generating element being configured to move toward and away from the container receiving portion along a first fixed path, and the second magnetic field generating element being configured to move toward and away from the container receiving portion along a second fixed path.

3. The purification system of claim 2, the first fixed path being linear and aligned with a first imaginary radial line emanating from a center of the container receiving

portion, and the second fixed path being linear and aligned with a second imaginary radial line emanating from the center of the container receiving portion.

4. The purification system of any one of claims 1 to 3, comprising an actuator configured to move the first magnetic field generating element from the first position to the second position.

5. The purification system of claim 4, the actuator including a hydraulic or pneumatic cylinder.

6. The purification system of any one of claims 1 to 5, the first magnetic field generating element including a first permanent magnet.

7. The purification system of claim 6, the first permanent magnet having a maximum magnetic pull force equal to or greater than 100 N.

8. The purification system of any one of claims 1 to 7, comprising a fluid conduit having a first end in fluid communication with the first pump and a second end configured to be inserted through an open top of the first container.

9. The purification system of any one of claims 1 to 8, comprising magnetic beads to be submerged in the mixture in the first container and each having an exterior

surface configured to temporarily bind to the target substance to separate the target substance from the remainder of the mixture.

10. The purification system of claim 9, wherein the first magnetic field generating element is configured to hold the magnetic beads against an interior surface of the first container when the first magnetic field generating element is arranged in the second position.

11. The purification system of any one of claims 1 to 10, the container receiving portion being configured to receive and support a container having a volume greater than or equal to 0.5 L.

12. The purification system of any one of claims 1 to 11, comprising a second pump configured to transfer the mixture from a second container to the first container.

13. The purification system of claim 12, the first pump being configured to remove the mixture from the first container simultaneously while the second pump transfers the mixture from the second container to the first container such that a continuous flow of the mixture through the first container is achieved.

14. The purification system of claim 13, wherein the first magnetic field generating element, when arranged in the second position, is configured to magnetically attract and hold magnetic beads submerged in the mixture against an interior surface of

the first container such that the first pump does not remove the magnetic beads from the first container when removing the mixture from the first container.

15. A purification method comprising:

adding a mixture including a target substance to a container;

adding magnetic beads to the container;

separating the target substance from a remainder of the mixture with the magnetic beads, wherein the target substance temporarily binds to the magnetic beads;

moving the magnetic field generating elements concurrently toward the container receiving portion to apply a magnetic field to hold the magnetic beads against an interior surface of the container; and

removing the mixture from the container while the magnetic field holds the magnetic beads against the interior surface of the container.

16. The purification method of claim 15, comprising adding a washing fluid to the container after removing the mixture from the container, and subsequently removing the washing fluid from the container while the magnetic field holds the magnetic beads against the interior surface of the container.

17. The purification method of claim 16, comprising removing the magnetic field after adding the washing fluid to the container so that the magnetic beads are free to disperse in the washing fluid, and subsequently re-applying the magnetic field to hold the magnetic beads against the interior surface of the container during removal of the washing fluid from the container.

18. The purification method of any one of claims 15 to 17, comprising adding an eluent to the container after removing the mixture from the container to elute the target substance bound to the magnetic beads, and subsequently removing the eluent and the target substance from the container while the magnetic field holds the magnetic beads against the interior surface of the container.

19. The purification method of claim 18, comprising removing the magnetic field after adding the eluent to the container so that the magnetic beads are free to disperse in the eluent, and subsequently re-applying the magnetic field to hold the magnetic beads against the interior surface of the container during removal of the eluent from the container.

20. The purification method of any one of claims 15 to 19, wherein removing the mixture from the container comprises aspirating the mixture from the container via an automated pump.

21. The purification method of any one of claims 15 to 20, wherein applying the magnetic field to hold the magnetic beads against an interior surface of the container comprises activating an actuator to move at least one magnetic field generating element from a first position remote from the container to a second position adjacent an exterior surface of the container.

22. The purification method of claim 21, wherein the actuator includes a pneumatic or hydraulic cylinder configured to move the at least one magnetic field generating element between the first position and the second position.

23. The purification method of any one of claims 21 to 22, wherein the container has an open end and a closed end and a longitudinal axis extending between the open end and the closed end, and wherein the actuator is configured to move the at least one magnetic field generating element in a direction non-parallel to the longitudinal axis when moving the at least one magnetic field generating element from the first position to the second position.

24. The purification method of any one of claims 15 to 20, wherein applying the magnetic field to hold the magnetic beads against the interior surface of the container comprises arranging a first permanent magnet and a second permanent magnet on opposite sides of the container.

25. The purification method of any one of claims 15 to 20, wherein applying the magnetic field to hold the magnetic beads against the interior surface of the container comprises arranging a plurality of permanent magnets around a perimeter of the container at equally spaced intervals.

26. The purification method of claim 15, wherein each permanent magnet of the plurality of permanent magnets has a maximum magnetic pull force equal to or greater than 100 N.

27. The purification method of any one of claims 15 to 26, wherein the target substance is a biomolecule.

28. The purification method of any one of claims 15 to 27, wherein the container has a volume equal to or greater than 0.5 L.

29. A purification system comprising:

a first container configured to initially contain a mixture and magnetic beads for separating a target substance from a remainder of the mixture;

a second container having a smaller volume than the first container;

a first magnetic field generating element positioned adjacent an exterior surface of the second container;

a first pump configured to transfer the mixture and magnetic beads from the first container to the second container;

a second pump configured to remove the mixture from the second container while the first pump transfers the mixture and the magnetic beads from the first container to the second container; and

wherein the first magnetic field generating element magnetically attracts the magnetic beads to hold the magnetic beads against an interior surface of the second container while the second pump removes the mixture from the second container.

30. The purification system of claim 29, the second pump being configured to remove the mixture from the second container simultaneously while the first pump transfers the mixture and the magnetic beads from the first container to the second container, such that a continuous flow of the mixture through the second container is achieved.

31. The purification system of any one of claims 29 to 30, the first magnetic field generating element being movable relative to the second container between a first position remote from the second container and a second position adjacent the exterior surface of the second container.

32. The purification system of claim 31, the second magnetic field generating element being movable relative to the second container between a third position remote from the second container and a fourth position adjacent the exterior surface of the second container.

33. The purification system of claim 32, the first magnetic field generating element being configured to move toward and away from the second container along a first fixed path, and the second magnetic field generating element being configured to move toward and away from the second container along a second fixed path.

34. The purification system of claim 33, the first fixed path being linear and aligned with a first imaginary radial line emanating from a longitudinal axis of the second

container, and the second fixed path being linear and aligned with a second imaginary radial line emanating from the longitudinal axis of the second container.

35. The purification system of any one of claims 29 to 34, comprising an actuator configured to move the first magnetic field generating element from the first position to the second position.

36. The purification system of claim 35, the actuator including a pneumatic or hydraulic cylinder.

37. A purification method comprising:

adding a mixture including a target substance to a first container;

adding magnetic beads to the first container;

separating the target substance from a remainder of the mixture in the first container with the magnetic beads, wherein the target substance temporarily binds to the magnetic beads;

transferring a first volume of the mixture and a first quantity of the magnetic beads from the first container to a second container, wherein a volume of the second container is less than a volume of the first container;

applying a magnetic field to hold the first quantity of the magnetic beads against an interior surface of the second container;

removing the first volume of the mixture from the second container while the magnetic field holds the first quantity of the magnetic beads against the interior surface of the second container;

transferring a second volume of the mixture and a second quantity of the magnetic beads from the first container to the second container; and

removing the second volume of the mixture from the second container while the magnetic field holds the first and second quantities of the magnetic beads against the interior surface of the second container while transferring the second volume of the mixture and the second quantity of the magnetic beads from the first container to the second container.

38. The purification method of claim 37, wherein removing the first volume of the mixture from the second container comprises removing the first volume of the mixture from the second container while simultaneously transferring the second volume of the mixture and the second quantity of the magnetic beads from the first container to the second container.

39. The purification method of claim 38, comprising adding a washing fluid to the second container after removing the second volume of the mixture from the second container, and subsequently removing the washing fluid from the second container while the magnetic field holds the first and second quantities of the magnetic beads against the interior surface of the second container.

40. The purification method of claim 39, comprising removing the magnetic field after adding the washing fluid to the second container so that the first and second

quantities of magnetic beads are free to disperse in the washing fluid, and subsequently re-applying the magnetic field to hold the first and second quantities of magnetic beads against the interior surface of the second container during removal of the washing fluid from the second container.

41. The purification method of any one of claims 37 to 40, comprising adding an eluent to the second container after removing the second volume of the mixture from the second container to elute the target substance bound to the first and second quantities of magnetic beads, and subsequently removing the eluent and the target substance from the second container while the magnetic field holds the first and second quantities of magnetic beads against the interior surface of the second container.

42. The purification method of claim 41, comprising removing the magnetic field after adding the eluent to the second container so that the first and second quantities of the magnetic beads are free to disperse in the eluent, and subsequently re-applying the magnetic field to hold the first and second quantities of the magnetic beads against the interior surface of the second container during removal of the eluent and the target substance from the second container.

43. The purification method of any one of claims 37 to 42, wherein transferring the first volume of the mixture and the first quantity of the magnetic beads from the first container to the second container comprises pumping the first volume of the mixture and the first quantity of the magnetic beads via an automated pump.

44. The purification method of claim 43, wherein removing the combined first and second volumes of the mixture from the second container comprises pumping the combined first and second volumes of the mixture from the second container via the automated pump.

45. The purification method of any one of claims 37 to 44, wherein applying the magnetic field to hold the first quantity of the magnetic beads against the interior surface of the second container comprises activating an actuator to move at least one magnetic field generating element from a first position remote from the second container to a second position adjacent an exterior surface of the second container.

46. The purification method of claim 45, wherein the actuator includes a pneumatic or hydraulic cylinder configured to move the at least one magnetic field generating element between the first position and the second position.

47. The purification method of any one claims 45 to 46, wherein the second container has an open end and a closed end and a longitudinal axis extending between the open end and the closed end, and wherein the actuator is configured to move the at least one magnetic field generating element in a direction non-parallel to the longitudinal axis when moving the at least one magnetic field generating element from the first position to the second position.

48. The purification method of any one of claims 37 to 47, wherein applying the magnetic field to hold the first and second quantities of magnetic beads against the interior surface of the second container comprises positioning a first permanent magnet and a second permanent magnet on opposite sides of the container.

49. The purification method of any one of claims 37 to 47, wherein applying the magnetic field to hold the first and second quantities of magnetic beads against the interior surface of the second container comprises arranging a plurality of permanent magnets around a perimeter of the second container at equally spaced intervals.

50. The purification method of claim 49, wherein each permanent magnet of the plurality of permanent magnets has a maximum magnetic pull force equal to or greater than 100 N.

51. The purification method of any one of claims 37 to 50, wherein the target substance is a biomolecule.