SUMMARY

[0009a] According to a first aspect, there is provided a method of producing an analyte-free eluent, including: processing a fluid sample including an analyte in an analyte concentrator system, the analyte concentrator system retaining at least a portion of the analyte and discharging an effluent of the fluid sample that is free of the analyte; generating an eluent from the discharged effluent, the eluent being free of the analyte; and eluting at least a portion of the analyte retained by the analyte concentrator system with the eluent or storing the eluent for later use, wherein generating the eluent from the discharged effluent includes passing the discharged effluent into an eluent generation module, the eluent generation module producing the eluent from the discharged effluent; and wherein passing the discharged effluent into an eluent generation module includes passing the discharged effluent through a fluid coupling extending between the analyte concentrator system and the eluent generation module.

[0009b] According to a second aspect, there is provided an analyte concentrator system, including: an analyte concentrator assembly, including: a first fluid inlet for receiving a fluid sample including an analyte; an analyte retention mechanism coupled with the first fluid inlet, the analyte retention mechanism being configured to retain at least a portion of the analyte; a first fluid outlet for discharging an effluent of the fluid sample, the first fluid outlet being coupled with the analyte retention mechanism; and a second fluid inlet for receiving an eluent, the analyte retention mechanism being coupled with the second fluid inlet so as to receive the eluent; and an eluent generation module coupled with the first fluid outlet and with the second fluid inlet of the analyte concentrator assembly, the eluent generation module being configured to receive the discharged effluent and to generate the eluent from the discharged effluent, the eluent being free of the analyte.

[0009a] Disclosed herein is a method of concentrating an analyte, including: processing a first portion of a fluid sample including an analyte in a first analyte concentrator assembly, the first analyte concentrator assembly retaining a first portion of the analyte and discharging a first effluent that is free of the analyte, the discharged first effluent being fluid transferred from the first analyte concentrator assembly to an eluent generation module; processing a second portion of the fluid sample including the analyte in a second analyte concentrator

assembly, the second analyte concentrator assembly retaining a second portion of the analyte and discharging a second effluent that is free of the analyte, the discharged second effluent being fluid transferred from the second analyte concentrator assembly to the eluent generation module; processing the transferred first effluent within the eluent generation module so as to produce a first eluent that is free of the analyte from the transferred first effluent, the first eluent being fluid transferred from the eluent generation module to the second analyte concentrator assembly; processing the transferred second effluent within the eluent generation module so as to produce a second eluent that is free of the analyte from the transferred second effluent, the second eluent being fluid transferred from the eluent generation module to the first analyte concentrator assembly; eluting at least a portion of the analyte retained by the first analyte concentrator assembly with the second eluent so as to produce a first concentrated analyte sample, the first concentrated analyte sample being fluid transferred from the first analyte concentrator assembly to an analyte detection module; eluting at least a portion of the analyte retained by the second analyte concentrator assembly with the first eluent so as to produce a second concentrated analyte sample, the second concentrated analyte sample being fluid transferred from the second analyte concentrator assembly to the analyte detection module; analyzing the first concentrated analyte sample in the analyte detection module; and analyzing the second concentrated analyte sample in the analyte detection module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, or to further clarify the above and other advantages and features of the present disclosure, a more particular description of the disclosure briefly described above will be rendered by reference to specific implementations and/or embodiments thereof which are illustrated in the appended drawings. While the drawings are generally drawn to scale for some example embodiments, it should be understood that the scale may be varied and the illustrated embodiments are not necessarily drawn to scale for all embodiments encompassed herein.

[0011] Furthermore, it will be readily appreciated that the components of the illustrative embodiments, as generally described and illustrated in the figures herein, could be arranged and designed in a wide variety of different configurations, and that components within some figures are interchangeable with, or may supplement, features and components illustrated in other figures. Accordingly, understanding that the drawings depict only typical implementations and/or embodiments of the disclosure and are not, therefore, to be considered to be limiting of its scope, the embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0012] Figure 1 illustrates a schematic flow diagram of an exemplary prior art system;

[0013] Figure 2 illustrates a schematic flow diagram of an analyte concentrator system in accordance with an embodiment of the present disclosure;

[0014] Figure 3 illustrates a schematic diagram of an analyte concentrator assembly useful in the analyte concentrator system of Figure 2 in accordance with an embodiment of the present disclosure;

[0015] Figure 4A and 4B illustrate, respectively, schematic diagrams of an analyte concentrator assembly in a first (4A) and second (4B) configuration in accordance with an embodiment of the present disclosure;

[0016] Figure 5A and 5B illustrate, respectively, schematic diagrams of an analyte concentrator system in a first (5A) and second (5B) configuration in accordance with another embodiment of the present disclosure;

CLAIMS

1. A method of producing an analyte-free eluent, comprising:

processing a fluid sample comprising an analyte in an analyte concentrator system, the analyte concentrator system retaining at least a portion of the analyte and discharging an effluent of the fluid sample that is free of the analyte;

generating an eluent from the discharged effluent, the eluent being free of the analyte; and

eluting at least a portion of the analyte retained by the analyte concentrator system with the eluent ;

wherein generating the eluent from the discharged effluent comprises passing the discharged effluent into an eluent generation module, the eluent generation module producing the eluent from the discharged effluent; and

wherein passing the discharged effluent into an eluent generation module comprises passing the discharged effluent through a fluid coupling extending between the analyte concentrator system and the eluent generation module.

2. The method of claim 1, further comprising passing the eluent in the eluent generation module into the analyte concentrator system through a fluid coupling extending between the eluent generation module and the analyte concentrator system so as to elute at least a portion of the analyte retained by the analyte concentrator system with the eluent, wherein the analyte comprises at least one charged molecule or compound and the analyte concentrator system comprises an ion exchange element configured to retain the at least one charged molecule or compound under a first ionic strength and to release the at least one charged molecule or compound under a second ionic strength.

3. The method of claim 1, further comprising passing the eluent into the analyte concentrator system so as to elute at least a portion of the analyte retained by the analyte concentrator system with the eluent.

4. The method of claim 3, further comprising analyzing the eluted portion of the analyte in an analyte detection module, wherein the analyte detection module is fluid coupled with the analyte concentrator system, the method further comprising passing the eluted portion of the analyte through a fluid coupling extending between the analyte concentrator system and the

analyte detection module; and passing the eluted portion of the analyte through a chromatography member to separate the eluted portion of the analytes into individual components or fractions, the chromatography member being fluid coupled with the analyte concentrator system.

5. The method of claim 1, wherein:

the analyte concentrator system comprises a first analyte concentrator assembly and a second analyte concentrator assembly; and

the step of processing the fluid sample comprising the analyte in the analyte concentrator system comprises:

processing a first portion of the fluid sample comprising the analyte in the first analyte concentrator assembly, the first analyte concentrator assembly retaining a first portion of the analyte and discharging a first effluent that is free of the analyte; and

processing a second portion of the fluid sample comprising the analyte in the second analyte concentrator assembly, the second analyte concentrator assembly retaining a second portion of the analyte and discharging a second effluent that is free of the analyte; and

the step of generating the eluent from the discharged effluent comprises:

processing the first effluent so as to produce a first eluent that is free of the analyte; and

processing the second effluent so as to produce a second eluent that is free of the analyte;

transferring the first eluent to the second analyte concentrator assembly so as to elute at least a portion of the analyte retained by the second analyte concentrator assembly with the first eluent; and

transferring the second eluent to the first analyte concentrator assembly so as to elute at least a portion of the analyte retained by the first analyte concentrator assembly with the second eluent.

6. The method of claim 5, wherein the first effluent and the second effluent are both processed in a common eluent generation module that is fluid coupled to the first analyte concentrator assembly and the second analyte concentrator assembly.

7. An analyte concentrator system, comprising:

an analyte concentrator assembly, comprising:

a first fluid inlet for receiving a fluid sample comprising an analyte;

an analyte retention mechanism coupled with the first fluid inlet, the analyte retention mechanism being configured to retain at least a portion of the analyte;

a first fluid outlet for discharging an effluent of the fluid sample, the first fluid outlet being coupled with the analyte retention mechanism; and

a second fluid inlet for receiving an eluent, the analyte retention mechanism being coupled with the second fluid inlet so as to receive the eluent; and

an eluent generation module coupled with the first fluid outlet and with the second fluid inlet of the analyte concentrator assembly, the eluent generation module being configured to receive the discharged effluent and to generate the eluent from the discharged effluent, the eluent being free of the analyte.

8. The analyte concentrator system of claim 7, wherein the eluent generation module comprises an eluent generating component, the eluent generating component comprising an electrolytic chamber, the electrolytic chamber comprising:

a source ion chamber;

an eluent generation chamber; and

at least one ion exchange barrier, the source ion chamber separated from eluent generation chamber by the at least one ion exchange barrier, wherein the eluent generating component further comprises an anode and a cathode disposed opposite the anode, the electrolytic chamber disposed at least partially between the anode and the cathode.

9. The analyte concentrator system of claim 7, wherein the second fluid inlet is disposed between and fluid coupled with the eluent generation module and the analyte retention mechanism such that the eluent passes from the eluent generation module to the analyte retention mechanism via the second fluid inlet, wherein the analyte concentrator assembly further comprises a second fluid outlet for discharging a concentrated analyte sample, the second fluid outlet being coupled with the analyte retention mechanism.

10. The analyte concentrator system of claim 7, wherein:

the analyte retention mechanism comprises a first ion exchange element adapted for binding ionic molecules;

the analyte comprises at least one ionic molecule; and

the analyte concentrator assembly further comprises:

a second fluid inlet for receiving the eluent, the second fluid inlet being coupled with the eluent generation module and the analyte retention mechanism;

a second fluid outlet for discharging a concentrated analyte sample, the second fluid outlet being coupled with the analyte retention mechanism; and

a first analyte concentrator column comprising:

an encircling side wall extending from a first end of the first analyte concentrator column to an opposing second end of the first analyte concentrator column, the side wall of the first analyte concentrator column at least partially bounding a first internal cavity, the first ion exchange element being disposed within the first internal cavity;

a first opening disposed at the first end of the first analyte concentrator column and in fluid communication with the first internal cavity, the first opening being selectively fluid connectable with the first fluid inlet and with the second fluid outlet; and

a second opening disposed at the second end of the first analyte concentrator column and in fluid communication with the first internal cavity, the second opening being selectively fluid connectable with the first fluid outlet and with the second fluid inlet.

11. The analyte concentrator system of claim 10, wherein the analyte concentrator assembly further comprises a fluid valve having a plurality of selectively connectable ports, the fluid valve being selectively configurable between a plurality of configurations to selectively connect at least some of the plurality of ports, the first fluid inlet comprising a first of the plurality of ports, the first fluid outlet comprising a second of the plurality of ports, the second fluid inlet comprising a third of the plurality of ports, and the second fluid outlet comprising a fourth of the plurality of ports,

wherein in the first fluid valve configuration:

the first opening is in fluid communication with the first port;

fluid communication between the first opening and the fourth port is restricted;

the second opening is in fluid communication with the second port; and

fluid communication between the second opening and the third port is restricted, and

wherein in a second fluid valve configuration:

the first opening is in fluid communication with the fourth port;

fluid communication between the first opening and the first port is restricted;

the second opening is in fluid communication with the third port; and

fluid communication between the second opening and the second port is restricted.

12. The analyte concentrator system of claim 11, wherein the fluid valve further comprises:

a fifth port in fluid communication with the first opening, the fifth port being selectively fluid connectable with the first port and with the fourth port; and

a sixth port in fluid communication with the second opening, the fifth port being selectively fluid connectable with the second port and with the third port,

wherein in the first fluid valve configuration:

the fifth port is in fluid communication with the first port;

fluid communication between the fifth port and the fourth port is restricted;

the sixth port is in fluid communication with the second port; and

fluid communication between the sixth port and the third port is restricted, and

wherein in a second fluid valve configuration:

the fifth port is in fluid communication with the fourth port;

fluid communication between the fifth port and the first port is restricted;

the sixth port is in fluid communication with the third port; and

fluid communication between the sixth port and the second port is restricted.

13. The analyte concentrator system of claim 12, wherein the analyte concentrator assembly further comprises:

the second analyte concentrator column comprising:

an encircling side wall extending from a first end of the second analyte concentrator column to an opposing second end of the second analyte concentrator column, the side wall of the second analyte concentrator column at least partially bounding a second internal cavity, the second internal cavity having a portion of the ion exchange element disposed therein;

a third opening disposed at the first end of the second analyte concentrator column and in fluid communication with the second internal cavity; and

a fourth opening disposed at the second end of the second analyte concentrator column and in fluid communication with the second internal cavity,

the fluid valve further comprising:

a seventh port in fluid communication with the third opening;

an eighth port in fluid communication with the fourth opening;

a ninth port comprising a valve outlet; and

a tenth port comprising a valve inlet,

the seventh port being selectively fluid connectable with the first port and with the ninth port, and

the eighth port being selectively fluid connectable with the second port and with the third port,

the tenth port being in fluid communication with the ninth port,

wherein in the first fluid valve configuration:

the seventh port is in fluid communication with the ninth port;

fluid communication between the seventh port and the first port is restricted;

the eighth port is in fluid communication with the third port; and

fluid communication between the eighth port and the second port is restricted, and

wherein in the second fluid valve configuration:

the seventh port is in fluid communication with the first port;

fluid communication between the seventh port and the ninth port is restricted;

the eighth port is in fluid communication with the second port; and

fluid communication between the eighth port and the third port is restricted.

14. The analyte concentrator system of claim 7, further comprising an outlet valve disposed between and connected to the first fluid outlet and the eluent generation module, the outlet valve being selectively configurable between a plurality of configurations, wherein in a first outlet valve configuration the first fluid outlet is in fluid communication with the eluent generation module and in a second outlet valve configuration fluid communication between the first fluid outlet and the eluent generation module is restricted, a fluid pump connected to the eluent generating component and to the first fluid outlet of the analyte concentrator assembly, the fluid pump being configured to facilitate fluid transfer of the discharged effluent to the eluent generating component, wherein the fluid pump is connected to a fluid transfer line that fluidly couples the eluent generating component and the first fluid outlet of the analyte concentrator assembly, the fluid pump being connected to the fluid transfer line between the eluent generating component and the first fluid outlet so as to facilitate fluid transfer of the discharged effluent to the eluent generating component.