SINGLE-USE GENDERLESS ASEPTIC FLUID COUPLINGS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Serial No. 62/892,491, filed August 27, 2019, and U.S. Provisional Application Serial No. 62/948,607, filed December 16, 2019. The disclosures of the prior applications are considered part of (and are incorporated by reference in) the disclosure of this application.

BACKGROUND

1. Technical Field

This document relates to fluid coupling devices for fluid systems and methods. For example, some embodiments described in this document relate to single-use, aseptic fluid coupling devices.

2. Background Information

Some fluid systems, such as some bioprocessing fluid systems or blood handling systems, may require fluid couplings that can aseptically connect a fluid flow path. In one example implementation, it is desirable to connect one or more sample bags to be able to receive a sample of fluid from a bioreactor system in a manner that prevents contamination of the fluid sample. In that scenario, an aseptic coupling can be used to connect the sample bag(s) to receive the fluid(s) from the bioreactor system while substantially preventing biological contamination of the fluid(s) from the coupling and the environment.

SUMMARY

According to a first aspect of the present invention, there is provided an aseptic fluid coupling comprising:

a main body defining a longitudinal axis and a bore, the main body comprising:

a front face;

a termination that is at an opposite end of the main body in comparison to the front face;

an alignment post; and

an alignment guide defining internal space configured to slidably receive an alignment post of another aseptic fluid coupling when two of the aseptic fluid couplings are mated together;

a seal member having a width along the longitudinal axis between a first end and a second end of the seal member, the seal member including a portion disposed within the bore and a portion extending from the front face around the longitudinal axis; and

a flexible membrane including a portion attached to the front face around the seal member to block contaminants from entering a fluid flow path, the membrane also including a tail end portion that is at an opposite end of the membrane in comparison to the portion attached to the front face;

wherein the fluid flow path is defined through the aseptic fluid coupling,

wherein a portion of the fluid flow path is defined by the seal member along an entirety of the width of the seal member,

wherein the alignment post and the alignment guide each include attachment features whereby the alignment post latches with an engaged alignment guide and the alignment guide latches with an engaged alignment post, and

wherein the attachment features of the alignment guide includes at least one flexible latch member.

According to a second aspect of the present invention, there is provided an aseptic fluid coupling comprising:

a main body defining a longitudinal axis, a bore, and a fluid flow path through the main body along the longitudinal axis, the main body comprising:

a front face;

an alignment post; and

an alignment guide;

a seal member including a portion extending from the front face, the seal member having a width along the longitudinal axis between a first end and a second end of the seal member, the seal member defining a central longitudinal bore that includes two cylindrical end portions and a central portion that is a segment of an ovoid;

a flexible membrane including a portion attached to the front face around the seal member;

wherein the alignment post and the alignment guide each include attachment features whereby the alignment post latches with an engaged alignment guide and the alignment guide latches with an engaged alignment post; and

wherein the attachment features of the alignment guide includes at least one flexible latch member.

This document describes a number of fluid coupling devices for fluid systems and methods. In some embodiments, the fluid coupling devices can be implemented as single-use, aseptic fluid coupling connection devices. In the context of this disclosure, the term "fluid" includes both gases and liquids.

In particular embodiments, the fluid coupling devices described herein are single-use devices because, after the two portions of the coupling (also referred to herein as "coupling halves" and/or "connectors") are connected to each other, the coupled portions are designed to resist uncoupling. For example, such single-use coupling devices are equipped with one or more mechanical components that operate

like locks to maintain the two portions of the coupling in the coupled state. Hence, in these particular embodiments, the fluid coupling devices provided herein are structurally configured to be single-use connection devices so that, after the single-use coupling halves have been connected to each other, they cannot be operably disconnected from each other (as such, preserving the sterility or biological integrity of the system/flow path/etc.).

Additionally, in such single-use embodiments or in other embodiments, the fluid coupling devices can be configured as "aseptic" coupling devices in that can be connected to each other while inhibiting biological contamination from migrating into the flow paths. Such an "aseptic" coupling will also serve to limit the exposure of the fluid to the surrounding environment.

Further, in such single-use embodiments, or other embodiments, the fluid coupling devices can be configured as genderless couplings. That is, the two coupling portions can be designed exactly alike so that there is no male or female coupling halves as in many conventional fluid coupling designs.

In one example, this disclosure is directed to an aseptic fluid coupling and methods for use. In some embodiments, such an aseptic fluid coupling can include: (i) a main body defining a longitudinal axis, a bore, and a fluid flow path through the main body along the longitudinal axis; (ii) a seal member including a portion disposed within the bore and a portion extending from the front face around the longitudinal axis; and (iii) a flexible membrane including a portion attached to the front face around the seal member to block contaminants from entering the fluid flow path, the membrane also including a tail end portion that is at an opposite end of the membrane in comparison to the portion attached to the front face. The main body can include a front face; a termination that is at an opposite end of the main body in comparison to the front face; an alignment post; and an alignment guide defining internal space configured to slidably receive an alignment post of another aseptic fluid coupling when two of the aseptic fluid couplings are mated together.

Such an aseptic fluid coupling may optionally include one or more of the following features. The alignment post may extend parallel to the longitudinal axis. The membrane may be porous such that air can pass through the membrane. The alignment post and the alignment guide may each include attachment features whereby the alignment post latches with an engaged alignment guide and the alignment guide latches with an engaged alignment post. The attachment features of

the alignment post may include at least one groove. The attachment features of the alignment guide may include at least one flexible latch member. The main body may include a termination member that includes the termination. The termination member may extend into the bore. The termination member may snap into engagement with other portions of the main body. The termination member may be rotatable about the longitudinal axis in relation to the other portions of the main body. The aseptic fluid coupling may also include a seal disposed between the termination member and the other portions of the main body. The termination member may define a portion of the fluid flow path. The termination member may abut against the seal member within the bore. The aseptic fluid coupling may also include a protective cover that is releasably engageable with the main body. The protective cover may press two layers of the membrane against the seal member while the protective cover is engaged with the main body. The protective cover may define an opening aligned with the longitudinal axis while the protective cover is engaged with the main body.

In another example, this disclosure is directed to an aseptic fluid coupling that includes a main body defining a longitudinal axis, a bore, and a fluid flow path through the main body along the longitudinal axis; a seal member including a portion extending from the front face; and a flexible membrane including a portion attached to the front face around the seal member. The main body includes a front face, an alignment post, and an alignment guide.

Such an aseptic fluid coupling may optionally include one or more of the following features. The alignment guide may define an internal space configured to slidably receive an alignment post of another aseptic fluid coupling when two of the aseptic fluid couplings are mated together. A centerline of the alignment post, a centerline of the alignment guide, and the longitudinal axis may all be in a same plane. The bore may be between the alignment post and the alignment guide. In some embodiments, a distance between the longitudinal axis and the centerline of the alignment post is equal to a distance between the longitudinal axis and the centerline of the alignment guide.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a main body; a cover slidably attached to the main body; a first seal between the cover and the main body; a second seal within the main body; a seal pusher slidably coupled to the main body and positioned to abut against the second

seal; and a lock ring threadedly coupled to the main body and rotatably coupled to the seal pusher.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a main body defining a longitudinal axis; a seal within the main body; a seal pusher movably coupled to the main body and positioned to abut against the seal, the seal pusher comprising a seal pusher lever slidably coupled in a slot defined by the main body; and a membrane removably coupled to a front face of the main body. The slot defined by the main body extends at an acute angle relative to the longitudinal axis such that rotating the seal pusher relative to the main body pushes the seal along the longitudinal axis relative to the main body.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a main body; and a seal disposed within the main body and having a pull tab unitarily formed therewith. The main body includes a piercing element positioned to pierce a portion of the seal or pull tab.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a main body at least a portion of which has an ovular cross-sectional shape; a seal disposed within the main body; and an insert slidably coupled to the main body and slidable along a longitudinal axis of the main body between a first position and a second position. Moving the insert from the first position to the second position causes the insert to pierce the seal.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a seal body; a first seal within the seal body; a twist collar threadedly coupled to the seal body; and a plunger slidably coupled to the seal body and positioned to pierce the first seal in response to rotation of the twist collar in relation to the seal body. The plunger includes a second seal attached to a tip thereof.

In another example, this disclosure is directed to an aseptic fluid coupling device that includes: a main body defining a longitudinal axis; a seal within the main body; a seal pusher movably coupled to the main body and positioned to abut against the seal, the seal pusher comprising a seal pusher lever with two radially-extending portions slidably, the seal pusher lever slidably coupled in a slot defined by the main body; and a membrane removably coupled to a front face of the main body and covering the seal. The slot defined by the main body extends at an acute angle relative to the longitudinal axis such that rotating the seal pusher relative to the main body pushes the seal along the longitudinal axis relative to the main body.

Particular embodiments of the subject matter described in this document can be implemented to realize one or more of the following advantages. First, in some embodiments, the fluid coupling devices may advantageously provide a user with audible, visual, and/or tactile feedback in reference to the motions performed for physically connecting the two portions of the fluid coupling devices to each other. Such audible and/or tactile feedback can provide the user with an efficient and conclusive indication or confirmation of the proper function and desired configuration of the fluid coupling device.

Second, some embodiments of the fluid coupling devices provided herein are a metallic-free construction (also referred to as a nonmetallic fluid coupling device). As such, such embodiments of the nonmetallic fluid coupling devices can be advantageously sterilized using a gamma sterilization technique. Also, in some circumstances, the nonmetallic fluid coupling devices exhibit enhanced fatigue-resistance characteristics, minimal installed stress, and enhanced corrosion resistance in comparison to some fluid couplings that include traditional metallic parts such as metal springs.

Third, some embodiments of the fluid coupling devices provide an improved aseptic connection capability that may optionally reduce or eliminate the need for sterile rooms or sterile benchtop environments in some cases. As such, these embodiments of the aseptic fluid coupling devices described herein may facilitate efficient and cost-effective operations or uses that would otherwise be high-cost or even cost prohibitive in some traditional settings that required the connection of particular fluid couplings in a sterile room or within a sterile flow-hood to prevent biological contamination.

Fourth, some embodiments of the fluid coupling devices provided herein are advantageously designed to be genderless. Accordingly, usage of the fluid coupling devices are simplified and a user may be able to carry less inventory of fluid coupling components. Also, the genderless example of the fluid couplings offers additional system flexibility because anything with one of these couplings can connect to anything else with another one of these couplings.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure pertains. In addition, the materials, methods, and examples of the embodiments described herein are illustrative only and not intended to be limiting.

The details of one or more embodiments of the claimed invention are set forth in the accompanying drawings and the description herein. Other features, and advantages of the claimed invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of an example fluid system including an example fluid coupling arranged in a pre-connected configuration, in accordance with some embodiments provided herein.

FIG. 2 is a perspective view of an example aseptic coupling in accordance with some embodiments.

FIG. 3 is a top view of the aseptic coupling of FIG. 2.

FIG. 4 is a longitudinal cross-sectional view of the aseptic coupling of FIG. 2 taken along break line 4—4 of FIG. 3.

FIG. 5 is a perspective view of two of the aseptic couplings of FIG. 2 in an uncoupled configuration.

FIG. 6 shows a longitudinal cross-sectional view of two of the aseptic couplings of FIG. 2 in an uncoupled configuration.

FIG. 7 is a side view of two of the aseptic couplings of FIG. 2 in a pre-coupled configuration.

FIG. 8 is a perspective view of another example aseptic coupling in accordance with some embodiments.

FIG. 9 is a side view of the aseptic coupling of FIG. 8.

FIG. 10 is a longitudinal cross-sectional view of the aseptic coupling of FIG. 8 taken along break line 10—10 of FIG. 9.

FIG. 11 is a perspective view of two of the aseptic couplings of FIG. 8 in a pre-coupled configuration.

FIG. 12 is a side view of two of the aseptic couplings of FIG. 8 in a pre-coupled configuration.

FIG. 13 is a longitudinal cross-sectional view of two of the aseptic couplings of FIG. 8 in the pre-coupled configuration taken along break line 13—13 of FIG. 12.

FIG. 14 is a perspective view of another example aseptic coupling in accordance with some embodiments.

FIG. 15 is a side view of the aseptic coupling of FIG. 14.

WHAT IS CLAIMED IS:

1. An aseptic fluid coupling comprising:

a main body defining a longitudinal axis and a bore, the main body comprising:

a front face;

a termination that is at an opposite end of the main body in comparison to the front face;

an alignment post; and

an alignment guide defining internal space configured to slidably receive an alignment post of another aseptic fluid coupling when two of the aseptic fluid couplings are mated together;

a seal member having a width along the longitudinal axis between a first end and a second end of the seal member, the seal member including a portion disposed within the bore and a portion extending from the front face around the longitudinal axis; and

a flexible membrane including a portion attached to the front face around the seal member to block contaminants from entering a fluid flow path, the membrane also including a tail end portion that is at an opposite end of the membrane in comparison to the portion attached to the front face;

wherein the fluid flow path is defined through the aseptic fluid coupling,

wherein a portion of the fluid flow path is defined by the seal member along an entirety of the width of the seal member,

wherein the alignment post and the alignment guide each include attachment features whereby the alignment post latches with an engaged alignment guide and the alignment guide latches with an engaged alignment post, and

wherein the attachment features of the alignment guide includes at least one flexible latch member.

2. The aseptic fluid coupling of claim 1, wherein the alignment post extends parallel to the longitudinal axis.

3. The aseptic fluid coupling of claim 1 or 2, wherein the membrane is porous such that air can pass through the membrane.

4. The aseptic fluid coupling of claim 1, wherein the attachment features of the alignment post includes at least one groove.

5. The aseptic fluid coupling of any one of claims 1 through 4, wherein the main body comprises a termination member that includes the termination, and wherein the termination member extends into the bore.

6. The aseptic fluid coupling of claim 5, wherein the termination member snaps into engagement with other portions of the main body.

7. The aseptic fluid coupling of claim 6, wherein the termination member is rotatable about the longitudinal axis in relation to the other portions of the main body.

8. The aseptic fluid coupling of claim 6 or 7, further comprising a seal disposed between the termination member and the other portions of the main body.

9. The aseptic fluid coupling of any one of claims 5 through 8, wherein the termination member defines a portion of the fluid flow path.

10. The aseptic fluid coupling of any one of claims 5 through 9, wherein the termination member abuts against the seal member within the bore.

11. The aseptic fluid coupling of any one of claims 1 through 10, further comprising a protective cover that is releasably engageable with the main body.

12. The aseptic fluid coupling of claim 11, wherein the protective cover presses two layers of the membrane against the seal member while the protective cover is engaged with the main body.

13. The aseptic fluid coupling of claim 11 or 12, wherein the protective cover defines an opening aligned with the longitudinal axis while the protective cover is engaged with the main body.

14. An aseptic fluid coupling comprising:

a main body defining a longitudinal axis, a bore, and a fluid flow path through the main body along the longitudinal axis, the main body comprising:

a front face;

an alignment post; and

an alignment guide;

a seal member including a portion extending from the front face, the seal member having a width along the longitudinal axis between a first end and a second end of the seal member, the seal member defining a central longitudinal bore that includes two cylindrical end portions and a central portion that is a segment of an ovoid;

a flexible membrane including a portion attached to the front face around the seal member;

wherein the alignment post and the alignment guide each include attachment features whereby the alignment post latches with an engaged alignment guide and the alignment guide latches with an engaged alignment post; and

wherein the attachment features of the alignment guide includes at least one flexible latch member.

15. The aseptic fluid coupling of claim 14, wherein the alignment guide defines an internal space configured to slidably receive an alignment post of another aseptic fluid coupling when two of the aseptic fluid couplings are mated together.

16. The aseptic fluid coupling of claim 14 or 15, wherein a centerline of the alignment post, a centerline of the alignment guide, and the longitudinal axis are all in a same plane.

17. The aseptic fluid coupling of claim 16, wherein the bore is between the alignment post and the alignment guide.

18. The aseptic fluid coupling of claim 16 or 17, wherein a distance between the longitudinal axis and the centerline of the alignment post is equal to a distance between the longitudinal axis and the centerline of the alignment guide.