[0005] Several companies have built point-of-care instruments to bridge this divide. However, these instruments are limited to single types of tests and fail to completely meet the workflow needs of primary care providers for a single system that produces simple, comprehensive, and fast test results. A product to meet these needs is currently under development. It achieves this through a highly automated workflow enabled through the use of centrifugal microfluidics discs.

[0006] Centrifugal microfluidics are used in clinical chemistry, immunoassays, hematology, medicine, biomedical research and other fields. Many of these applications use an unvented chamber connected to a siphon channel to work as an air pressure-dependent valve. The pressure change in such a valve, however, depends on the radial position of the siphon inlet at the chamber. In addition, many of these applications require stopping the cartridge during certain workflows to accommodate multiple washing requirements. However, existing valve designs, such as conventional pneumatic siphons, simple siphon metering valves and capillary siphon valves, are unsatisfactory for these applications.

[0007] Accordingly, there remains a need for improved devices and methods in centrifugal microfluidics.

SUMMARY

[0008] The present disclosure addresses these and other needs in the art by providing (i) a siphon valve structure that decouples the pressure change inside the chamber from the radial position of the siphon inlet at the chamber and/or takes less space on a cartridge, (ii) a reusable siphon valve structure independent of the leftover fluid, and (iii) a centrifugal device and method that can not only hold magnetic particles while washing a reaction chamber from all the unwanted components but also allows these particles to move back into the main reaction chamber and homogenize the mixture.

[0009] In an aspect, the present disclosure provides a device. The device includes a rotatable axis, a vent port, a siphon, a ballast chamber, and/or other components disclosed herein (e.g., the U-channel described below) to put a liquid inside the ballast chamber without allowing for the air to escape the ballast chamber. The siphon has a crest positioned radially outwards of the vent port or any portion of a channel connected to the vent port with respect to the rotational axis. The ballast chamber has a first outlet connected to the vent port and a second outlet connected to an inlet of the siphon. The first outlet of the ballast chamber is positioned radially inwards of the second outlet of the ballast

chamber and radially outwards of the crest of the siphon with respect to the rotational axis, thereby dividing the ballast chamber into an unvented ballast portion radially inwards of the first outlet and a vented portion radially outwards of the first outlet. The second outlet of the ballast chamber is formed at or adjacent to a radially outermost location of the ballast chamber.

[0010] In some embodiments, the device further includes a first channel connecting the first outlet of the ballast chamber to the vent port, an upstream chamber connected to the ballast chamber, a U-channel connecting the ballast chamber to the upstream chamber, a downstream chamber connected to an outlet of the siphon, or any combination thereof.

[0011] In some embodiments, the ballast chamber includes an inlet at the unvented ballast portion, and the upstream chamber is connected to the inlet at the unvented ballast portion of the ballast chamber. In some embodiments, the upstream chamber includes an outlet connected to the ballast chamber, and the crest of the siphon and the vent port are radially inwards of the outlet of the upstream chamber. In some such embodiments, the outlet of the upstream chamber is formed at a radially outermost location of the upstream chamber.

[0012] In some embodiments, a volume inside the ballast chamber between a radial position of the first outlet and a radial position of the second outlet is larger than a volume needed for overcoming the crest of the siphon. In some embodiments, the downstream chamber is positioned radially outwards of the ballast chamber.

[0013] In some embodiments, the vent port, siphon, ballast chamber, first channel, upstream chamber, U-channel, or any combination thereof are configured to allow initial loading of a fluid by rotating the device at a speed that causes the fluid to fill the ballast chamber and the siphon, forming a first meniscus inside of the ballast chamber that is radially inwards of the first outlet and a second meniscus inside of the siphon that is radially outwards of the crest of the siphon.

[0014] In some embodiments, the vent port, siphon, ballast chamber, first channel, upstream chamber, U-channel, or any combination thereof are configured to allow emptying of the upstream chamber by decreasing the speed. Alternatively, in some embodiments, the vent port, siphon, ballast chamber, first channel, upstream chamber, U-channel, or any combination thereof are configured to allow emptying of the upstream chamber by increasing the speed.