at least one ultrasonic transducer; and at least one diffuser inlet for the inflow of fluid mixture into the acoustic chamber.

[0008a] In one aspect, there is provided an acoustophoresis device, comprising: a housing having a sidewall that defines an acoustic chamber; at least one upper outlet in the acoustic chamber; a shallow wall leading to at least one lower outlet in the acoustic chamber; at least one ultrasonic transducer located on the sidewall of the housing; at least one reflector located on the sidewall of the housing opposite the at least one ultrasonic transducer; and at least one acoustic chamber inlet above the shallow wall for the inflow of fluid mixture.

[0009] The at least one diffuser inlet may be part of a dump diffuser. The at least one diffuser inlet may be located at a height between 0% and 100% of the height of the acoustic chamber, as measured from the bottom. The at least one diffuser inlet can be in the shape of holes or slots that provide a flow direction normal to the axial direction of an acoustic standing wave generated by the at least one ultrasonic transducer. The shallow wall concentrate outlet can serve to collect particle clusters, and may have an angle of 60° or less relative to a horizontal plane. The device may have a circular or rectangular cross-section in a flow direction.

[0010] In some particular embodiments, the at least one diffuser inlet is a plurality of diffuser inlets located about the housing so that the device has a vertical plane or line of symmetry and the inflow of fluid is symmetrical. The plurality of diffuser inlets can be fed by a plurality of dump diffusers.

[0011] In other particular embodiments, the at least one diffuser inlet is located at an upper end of the acoustic chamber along with the at least one upper outlet. A wall separates the at least one diffuser inlet from the at least one upper outlet such that fluid flows vertically downwards from the at least one diffuser inlet, then horizontally, then vertically upwards to the at least one upper outlet.

[0012] Also disclosed are methods of separating a host fluid from a second fluid or particulate carried in suspension. The methods comprise flowing a mixture of the host fluid and the second fluid or particulate in suspension through an acoustophoresis device in a uniform fashion. The device comprises: a housing having a sidewall that defines an acoustic chamber; at least one upper outlet in the acoustic chamber; a shallow wall leading to at least one lower concentrate outlet below the acoustic chamber; at least one ultrasonic transducer located on the sidewall of the housing, the transducer including a piezoelectric material driven by a voltage signal to create a multi-dimensional acoustic standing wave in the acoustic chamber; at least one reflector located on the sidewall of the housing opposite the at least one ultrasonic transducer; and at least one diffuser inlet in the sidewall of the acoustic chamber above the shallow wall concentrate outlet. The methods further comprise capturing smaller particles of the

second fluid or particulate in the multi-dimensional acoustic standing wave to cluster and continuously gravity separate the second fluid or particulate from the host fluid; wherein the gravity separated second fluid or particulate subsequently falls into the at least one lower concentrate outlet. The mixture of the host fluid and the second fluid or particulate can be a slurry.

[0012a] In another aspect, there is provided a method of separating a host fluid from a second fluid or particulate, the method comprising flowing a mixture of the host fluid and the second fluid or particulate through an acoustophoresis device in a uniform fashion, the device comprising: a housing having a sidewall that defines an acoustic chamber; at least one upper outlet in the acoustic chamber; a shallow wall leading to at least one lower outlet in the acoustic chamber; at least one ultrasonic transducer located on the sidewall of the housing, the transducer including a piezoelectric material driven by a voltage signal to create a multi-dimensional acoustic standing wave in the acoustic chamber; at least one reflector located on the sidewall of the housing opposite the at least one ultrasonic transducer; and at least one acoustic chamber inlet in the sidewall above the shallow wall for the inflow of fluid; capturing smaller particles of the second fluid or particulate in the multi-dimensional acoustic standing wave to cluster and continuously gravity separate the second fluid or particulate from the host fluid; wherein the gravity separated second fluid or particulate subsequently falls into the at least one lower outlet.

[0013] Disclosed in other embodiments herein are acoustophoresis devices, comprising: a housing defining a primary flow channel between an inlet end and an outlet end of the housing; at least one ultrasonic transducer located on a side of the housing; at least one reflector located on the side of the housing opposite the at least one ultrasonic transducer; and at least one baffle extending into the primary flow channel.

[0013a] In another aspect, there is provided an acoustophoresis device, comprising: a housing defining a primary flow channel between an inlet end and an outlet end of the housing; at least one ultrasonic transducer located on a side of the housing; at least one reflector located on the side of the housing opposite the at least one ultrasonic transducer; and at least one baffle extending into the primary flow channel.

[0014] The acoustophoresis device can further include a port on a side of the housing between the at least one transducer and the at least one reflector connecting to a secondary flow channel, the at least one baffle extending into both the primary flow channel and the secondary flow channel. The secondary flow channel may be angled relative to the primary flow channel. In particular embodiments, the angle between the primary flow channel and the secondary flow channel is from about 15° to 90°. At least one baffle is generally angled relative to the primary flow channel, but is not angled relative to the secondary flow channel. A collection well may be located in the secondary flow channel downstream of the at least one baffle.

[0015] The acoustophoresis device may have a plurality of baffles, arranged in a variety of configurations. The plurality of baffles can be arranged in parallel to each other. The plurality of baffles can extend into the primary flow channel in at least two different distances. The baffles in the plurality of baffles can be arranged in at least two different angles relative to the primary flow channel. The baffles in the plurality of baffles may all have the same length, or may vary in length.

[0016] In some embodiments, the primary flow channel is substantially U-shaped. In others, the inlet end and the outlet end are located on opposite ends of the housing, i.e. the primary flow channel is straight.

[0017] Also disclosed are methods of separating a second fluid or a particulate from a host fluid, comprising flowing a mixture of the host fluid and the second fluid or

particulate through an acoustophoresis device. The device comprises: an acoustic chamber having at least one inlet and at least one outlet that define a primary flow channel; an ultrasonic transducer located on a wall of the acoustic chamber, the transducer including a piezoelectric material driven by a voltage signal to create a multi-dimensional acoustic standing wave in the acoustic chamber; and at least one reflector located on a wall of the acoustic chamber opposite the at least one ultrasonic transducer; and at least one baffle extending into the primary flow channel. The methods further comprise capturing smaller particles of the second fluid or particulate in the multi-dimensional acoustic standing wave to clump, aggregate, and coalesce and continuously gravity separate the second fluid or particulate from the host fluid; wherein the gravity separated second fluid or particulate subsequently contact the at least one baffle and are directed to a collection outlet.

[0017a] In another aspect, there is provided a method of separating a second fluid or a particulate from a host fluid, the method comprising continuously flowing a mixture of the host fluid and the second fluid or particulate through an acoustophoresis device, the device comprising: an acoustic chamber having at least one inlet and at least one outlet that define a primary flow channel; an ultrasonic transducer located on a wall of the acoustic chamber, the transducer including a piezoelectric material driven by a voltage signal to create a multi-dimensional acoustic standing wave in the acoustic chamber; and at least one reflector located on a wall of the acoustic chamber opposite the at least one ultrasonic transducer; and at least one baffle extending into the primary flow channel; capturing smaller particles of the second fluid or particulate in the multi-dimensional acoustic standing wave to clump, aggregate, and coalesce and continuously gravity separate the second fluid or particulate from the host fluid; wherein the gravity separated second fluid or particulate subsequently contact the at least one baffle and are directed to a collection well.

[0018] The particulate may be Chinese hamster ovary (CHO) cells, NS0 hybridoma cells, baby hamster kidney (BHK) cells, insect cells or human cells such as stem cells and T-cells. The mixture may be continuously flowed through the acoustic chamber.

The standing wave may have an axial force and a lateral force, the lateral force being at least the same order of magnitude as the axial force.

[0019] These and other non-limiting characteristics are more particularly described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The following is a brief description of the drawings, which are presented for the purposes of illustrating the exemplary embodiments disclosed herein and not for the purposes of limiting the same.

[0021] **Figure 1** is an exterior perspective view of a basic acoustophoresis device made from three different modules: an ultrasonic transducer module, a collection well module, and an inlet/outlet module.

[0022] **Figure 2** is a schematic showing the U-shaped flow path of the fluid passing through the device of **Figure 1**.

[0023] **Figure 3** is a perspective view of a flow chamber that incorporates a separation system formed from baffles.

[0024] **Figure 4** is a side view of the flow chamber of **Figure 3**.