liquid phase to the vapor phase, and the transfer of the less volatile component X from the vapor phase to the liquid phase.

[0128] The feed stream F may be introduced into the microchannel distillation units using a number of different methods. These methods are dependent, in part, on whether the feed F is a gas or liquid, or whether it is a two-phase mixture comprising a gas and a liquid. Some of these methods are illustrated in **FIGS. 22-26**. **FIG. 22** shows a method for introducing a gaseous feed. **FIGS. 23 and 24** show methods for introducing a two-phase feed. **FIG. 25** shows a micromanifold for introducing a homogeneous feed (gas, liquid or mixture). **FIG. 26** shows a method for introducing a liquid feed.

[0129] The feed stream F may be distributed to the plurality of process microchannels (e.g., process microchannels **410**, **610**) within each microchannel distillation unit column or apparatus (e.g., **110**, **210**, **310**) through a process flow channel. The feed inlet may enter on one side of the microchannel distillation unit and the flow should traverse the width and/or depth of the microchannel distillation unit. As flow traverses the width of the microchannel distillation unit it may flow orthogonal to the direction of the process flow streams in the microchannels and liquid channels. This may create a challenge if the feed inlet port is in away from either end of the microchannel distillation unit. For the case where the feed inlet port is substantially away from the end, the flow distribution to each microchannel may be performed in an adjacent or nearby layer that is either above or below the process flow channel.

[0130] The feed F (either gaseous, liquid, or mixed phase) may traverse the microchannel distillation unit width in one or more separate flow passages that are either substantially open with flat walls or may alternatively contain microgrooves or wicks that assist with directing flow to the plurality of microchannels along the width of the microchannel distillation unit.

[0131] For the case of a liquid feed F, the liquid may be introduced adjacent to or nearby (for example, within about 5 microchannels) the process liquid flow path. The feed flow may move up or down a layer to the process liquid path through openings or apertures that connect the flow paths. The apertures may abut grooves or wick structures to facilitate liquid distribution into the process liquid removal structure. The abutting grooves or wick structures to the flow distribution apertures may be substantially similar or different in cross section, depth, height, or other physical characteristic to the process liquid removal structures. The abutting grooves may create passages that direct flow laterally (or along the width of the microchannel distillation unit) to the process liquid removal structures that substantially direct flow longitudinally (along the length of the microchannel distillation unit).

[0132] For the case of a gaseous feed F, the feed may be introduced adjacent or nearby to the process gaseous flow path. The feed flow may move up or down a layer, laminate, or shim to join the gaseous process flow stream. The gaseous feed when introduced into the process gaseous flow stream may be introduced in a way that does not directly impinge on the liquid flowing in the liquid removal structure. The gaseous feed may impinge upon a barrier wall that allows the feed flow stream to turn and substantially flow in the same direction as the gaseous process stream. (**FIG. 22**). Alternatively, the feed flow may be introduced into the process gaseous flow channel aligned with the direction of flow rather than orthogonal to the direction of flow.

[0133] The microchannel distillation unit may have one, two, three, or more feed inlet ports (e.g., inlet port **230**) for feed F to be added to the microchannel distillation unit. The feed may be at a different temperature at different feed ports. The feed ports may be located at different axial heights of the microchannel distillation unit that represent different microchannel distillation section numbers, where the first section is located at the bottoms end of the microchannel distillation unit (or near the highest temperature) and the final section is located at the distillate end of the microchannel distillation unit (or near the cold end). The number of outlet ports may match the number of inlet ports, or may be larger or smaller. The outlet ports may be attached to an external heating or cooling source and reintroduced into the microchannel distillation unit.

[0134] The number of inlet and outlet ports may be greater than two in embodiments where a multi-component distillation occurs and multiple product streams are drawn from the process. In one embodiment, a three component mixture may be fed to the microchannel distillation unit and three product streams may be removed. In this case, one component may be stripped from two others. A final section of the microchannel distillation unit may be used for the binary separation of the final constituents. In one embodiment, four or more components may be fed to the microchannel distillation unit. Each product stream may be removed at a different temperature than the others and as such may be represented by an outlet port corresponding to a different microchannel distillation section.

[0135] For some distillation applications, the feed stream F may be multi-phase and should be distributed sufficiently uniformly to the plurality of microchannels in the microchannel distillation unit. Multi-phase feed streams may be separated into single phase feed streams either external or internal of the microchannel distillation unit and subsequently each feed stream (gas or liquid) may be routed to the process gas or liquid flow path respectively. One method for separating the phases may include driving the two phase mixture into an annular flow regime, where the liquid flows along the walls and the gas flows along the center of the inlet, or internal flow chamber of the microchannel distillation unit. See, **FIG. 23**. The liquid stream may be retained along the walls of the inlet or internal flow chamber by the aid of a second set of capillary features that direct flow toward the process liquid flow stream. A first set of capillary features may be aligned with the process flow path where the distillation process occurs and are substantially orthogonal to the second set of capillary features used to aide the flow distribution of a two-phase feed.

[0136] The capillary features used for the inventive distillation process may be aligned with the direction of flow or aligned with an angle that is less than 90 degrees. The capillary features may be oriented vertically and run substantially parallel with the process liquid flow. The capillary features may align at an angle with the direction of flow. The angled capillary features may be connected in a manner that creates a continuous flow circuit in the vertical direction. The capillary features may be aligned laterally or orthogonal