processes are described in Becker et al., "The World's Largest Partitioned Column with Trays—Experiences from Conceptual Development to Successful Start-Up," Reports on Science and Technology 62/2000, pages 42-48. The microchannel distillation units used with the inventive process can be employed in these distillation processes. An advantage of using the inventive process is that microchannel distillation columns or apparatuses disclosed herein can be built on smaller scales that consume significantly less energy and still produce the same level of product output and purity as conventional distillation systems. Another advantage of using the microchannel distillation columns or apparatuses disclosed herein relates to the ability to closely space partitions within these microchannel distillation columns or apparatuses or to closely space thermally coupled streams by integration of such thermally coupled streams with adjacent columns or apparatuses or within adjacent or nearly adjacent layers in the same column or apparatus. The close spacing of the thermally coupled streams may reduce one or more of thermal response times, control feedback times, and start-up times needed for achieving steady-state operations for continuous distillation processes.

[0104] The number of theoretical sections or stages for effecting a desired separation for two components in a distillation process may be calculated using the McCabe-Thiele graphical method which is illustrated in **FIG. 13**. Referring to **FIG. 13**, an equilibrium line **360** for the vapor phase and the liquid phase of component X is plotted. The operating lines **362** and **364** for a conventional distillation process are depicted in **FIG. 13** for purposes of comparison. Line **362** would be the rectifying operating line while line **364** would be the stripping operating line. The number of theoretical sections or stages required for the distillation can be calculated using the horizontal and vertical lines extending from the rectifying line **362** and stripping line **364** to the equilibrium line **360**. Operating line **366** which is also shown in **FIG. 13** would correspond to an operating line which closely approaches a reversible distillation process. A process following operating line **366** would not be economical using conventional technology due to the prohibitive cost of adding separation sections or stages and heat exchangers. While no chemical process is reversible in a thermodynamic sense, and entropy always increases, an advantage of the inventive process is that reversible distillation can be closely approached. With the inventive process, the difference in temperature between the vapor and liquid phases in each microchannel distillation section can be minimized. A longitudinal temperature profile in the microchannel distillation unit can be imposed by external heating or cooling via a thermally conducting column housing heat exchange channels adjacent to some or all of the microchannel distillation sections. This makes it possible to achieve a temperature profile that is very close to the equilibrium line **360** shown in **FIG. 13**. The heat exchange channels used in the microchannel distillation columns or apparatuses may impose tailored temperature profiles for individual microchannel distillation sections or groups of microchannel distillation sections. Computational design methods for multi-component fractionations are known in the art and may be applied to this invention where heat exchange channels are used to create a close approach to equilibrium.

[0105] The height of an equivalent theoretical plate (HETP) ratio may be used for calculating the mass transfer efficiency of hardware for effecting vapor-liquid contacting processes. In conventional distillation processes, the HETP is typically on the order of about 2 feet (about 61 cm) for trays and packing. On the other hand, with the inventive process the HETP may be less than about 1 foot (about 30.5 cm), and in one embodiment less than about 6 inches (15.24 cm), and in one embodiment less than about 2 inches (5.08 cm), and in one embodiment less than about 1 inch (about 2.54 cm), and in one embodiment in the range from about 0.01 to about 1 cm. This provides the inventive process with the advantage of employing more theoretical distillation sections or stages in a more compact system than conventional processes and yet achieve similar separation and product throughput results. For example, for the separation of ethane from ethylene in the production of >99% by volume pure ethylene, the microchannel distillation unit used with the inventive process may be less than about 20 meters (about 65 feet), and in one embodiment less than about 3 meters (about 9.8 feet), while with conventional processes the same separation may require a distillation column that may be hundreds of feet high.

[0106] In one embodiment, the microchannel column or apparatus (e.g., microchannel distillation column or apparatus **110** or **210**) may contain one or more microchannel distillation units having the construction of microchannel distillation unit **400** illustrated in **FIG. 14**. Referring to **FIG. 14**, microchannel distillation unit **400** comprises process microchannel **410** and liquid channel **430**. Liquid channel **430** is adjacent to process microchannel **410**. Microchannel distillation unit **400** contains three microchannel distillation sections or stages, namely, microchannel distillation sections **450**, **450***a* and **450***b*. It will be understood, however, that microchannel distillation unit **410** may contain any desired number of microchannel distillation sections, for example, four, five, six, eight, ten, tens, hundreds, thousands, etc. Each of the microchannel distillation sections comprises an interior wall (**451**, **451***a*, **451***b*), a capture structure (**452**, **452***a*, **452***b*), a liquid outlet (**454**, **454***a*, **454***b*), and a liquid inlet (**456**, **456***a*, **456***b*). The interior wall may function as a wetted wall. The capture structures and the liquid exits are adjacent to each other and are suitable for permitting the flow of liquid from the microchannel **410** to the liquid channel **430**. The liquid inlets are positioned upstream from the liquid outlets and are suitable for permitting liquid to flow from the liquid channel **430** into the microchannel **410**. The liquid channel **430** comprises a wicking region **432**. The wicking region **432** comprises a wick and/or a wicking surface. The wicking region **432** includes flow passages (e.g., grooves) which allow liquid to flow through the wicking region from the liquid outlet (for example, liquid outlet **454***b*) of each microchannel distillation section to the liquid inlet (for example, liquid inlet **456***a*) of the next adjacent upstream microchannel distillation section.

[0107] In operation, a liquid phase containing components X and Y flows through flow passages in the wicking region **432** in the liquid channel **430**. The flow of the liquid phase may be driven by gravitational force and/or a pressure differential. The pressure differential may be effected by a pump, a suction device, or other apparatus or techniques known in the art. In one embodiment, a combination of gravitational force and pumping may be used. The liquid phase flows from the wicking region **432** through liquid inlet **456***b*, as indicated by arrow **433**. The liquid phase enters microchannel distillation section **450***b* and flows along inte-