ratus can be imposed by external heating or cooling via a thermally conducting column housing heat exchange channels adjacent to some or all the microchannel distillation sections. This makes it possible to achieve a temperature profile that is very close to the equilibrium line **200** shown in **FIG. 3**.

[**0055**] The heat exchange channels 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.

[**0056**] The height to an equivalent theoretical plate (HETP) ratio is well known in the art 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 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 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 distillation column or apparatus 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 would require a distillation column that would be hundreds of feet high.

[**0057**] The microchannel distillation unit that may be used in the inventive distillation process, which includes processes employing the above-described distillation columns, including distillation columns **110** and **110**A, in one embodiment, may have the construction illustrated in **FIG. 4**. Referring to **FIG. 4**, microchannel distillation unit **300** comprises process microchannel **310**, liquid channel **330**, and heat exchange channels **350** and **360**. Liquid channel **330** is adjacent to process microchannel **310**. Heat exchange channel **350** is adjacent to process microchannel **310**, and heat exchange channel **360** is adjacent to liquid channel **330**. It will be understood that if the microchannel distillation unit **300** is repeated in a microchannel distillation column or apparauts, each repetition of the microchannel distillation unit **300** may share a heat exchange channel with the next adjacent microchannel distillation unit **300**, thus each repetition of the microchannel distillation unit **300** may have one heat exchange channel rather than two heat exchange channels. For example, the heat exchange channel **350** of one microchannel distillation unit **300** may also function as the heat exchange channel **360** of the next adjacent microchannel distillation unit **300**. Alternatively, a heat exchange channel may be placed adjacent to or near two or more microchannel distillation units **300**, for example two, three, four, five, six, etc., microchannel distillation units, and thereby provide the desired heat exchange requirements for such microchannel distillation units.

[**0058**] The illustrated embodiment depicted in **FIG. 4** contains three microchannel distillation sections, namely, microchannel distillation sections **370**, **370***a*, and **370***b*. It will be understood, however, that the microdistillation unit **300** may comprise 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 (**371**, **371***a*, **371***b*), a capture structure (**372**, **372***a*, **372***b*), a liquid outlet (**374**, **374***a*, **374***b*), and a liquid inlet (**376**, **376***a*, **376***b*). The interior wall (**371**, **371***a*, **371***b*) may function as a wetted wall. The capture structures (**372**, **372***a*, **372***b*) and the liquid exits (**374**, **374***a*, **374***b*) are adjacent to each other and are suitable for permitting the flow of liquid from the process microchannel **310** to the liquid channel **330**. The liquid inlets (**376**, **376***a*, **376***b*) are positioned upstream from the liquid outlets (**374**, **374***a*, **374***b*) and are suitable for permitting liquid to flow from the liquid channel **330** into the process microchannel **310**. The liquid channel **330** comprises a wicking region **332**. The wicking region **332** comprises a wick and/or a wicking surface. The wicking region **332** includes flow passages (e.g., grooves) which allow liquid to flow through the wicking region from the liquid exit (for example, liquid outlet **374***b*) of each microchannel distillation section to the liquid entrance (for example, liquid inlet **376***a*) of the next adjacent upstream microchannel distillation section.

[**0059**] In operation, a liquid phase containing components X and Y flows through flow passages in the wicking region **332** in the liquid channel **330**. 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 **332** through liquid inlet **376***b*, as indicated by arrow **333**. The liquid phase enters microchannel distillation section **370***b* and flows along interior wall **371***b* as a thin film, as indicated by arrow **373***b*, until it contacts capture structure **372***b*. A vapor phase containing components X and Y flows through capture structure **372***a* into microchannel distillation section **370***b*, as indicated by arrow **313**, and flows through microchannel distillation section **370***b* until it contacts capture structure **372***b*. The flow of the liquid phase along the interior wall **371***b* may be driven by gravity, capillary force and/or drag from the flow of the vapor phase through the microchannel distillation section **370***b*. In the microchannel distillation section **370***b* the liquid phase and the vapor phase contact each other. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The vapor phase flows through capture structure **372***b*, as indicated by arrow **314**. The liquid phase flows from capture structure **372***b* through liquid outlet **374***b*. The flow of the liquid phase through the liquid exit **374***b* may be as a result of capillary force. The liquid phase flows through flow passages in the wicking region **332**, as indicated by arrow **334**, and then through liquid inlet **376***a*. The flow of the liquid phase through the liquid inlet **376***a* may be driven by gravitational force, a pressure differential as a result of the flow of the vapor phase near the liquid inlet **376***a*, and/or a wetting effect resulting from the flow of the liquid phase along the interior wall (**371**, **371***a*, **371***b*). The liquid phase flowing through liquid inlet