about 5 liters per minute (lpm), and in one embodiment about 0.01 to about 2 lpm, and in one embodiment about 0.01 to about 1 lpm. The velocity of the vapor phase flowing through these channels may be in the range from about 0.01 to about 500 meters per second (m/s), and in one embodiment about 0.01 to about 100 m/s, and in one embodiment about 0.1 to about 50 m/s. The Reynolds Number for the vapor phase flowing through these channels may be in the range from about 100 to about 50,000 and in one embodiment about 100 to about 5,000. The guage pressure within these channels may be in the range from about 0.01 to about 1,000 atmospheres, and in one embodiment about 0.01 to about 100 atmospheres, and in one embodiment from about 30 to about 100 atmospheres, and in one embodiment about 50 to about 100 atmospheres.

[**0096**] The flow rate of the liquid phase flowing as a thin film in each microchannel distillation section (**370**, **370***a*, **370***b*, **370***n*-**2**, **370***n*-**1**, **370***n*) may range from about 0.0001 to about 1 lpm, and in one embodiment about 0.001 to about 0.1 lpm. The velocity of the thin film flowing in the distillation sections may range from about 0.001 to about 5 m/s, and in one embodiment about 0.001 to about 2 m/s, and in one embodiment about 0.01 to about 1 m/s. The Reynolds Number for the thin film flowing in the distillation sections may range from about 0.01 to about 5000 and in one embodiment about 0.1 to about 1000, assuming the hydraulic diameter of the film is defined as the average film thickness.

[**0097**] The flow rate of the liquid phase flowing through the wicking region (**332**, **416**, **525**, **535**, **625**, **725**) in the liquid channels may be in the range from about 0.0001 to about 1 lpm, and in one embodiment about 0.001 to about 0.1 lpm. The velocity of the liquid phase flowing through the liquid channels may be in the range from about 0.0001 to about 5 m/s, and in one embodiment about 0.001 m/s to about 2 m/s. The Reynolds Number for the liquid phase flowing through the liquid channels may be in the range from about 0.01 to about 5,000 and in one embodiment about 1 to about 2,400. Superfacial velocity may be used to define liquid velocity. The guage pressure within the wicking region in the liquid channels may be in the range of about 0.01 to about 1,000 atmospheres, and in one embodiment about 0.01 to about 200 atmospheres. The pressure differential across the wicking region may range from about 0.0001 to about 0.01 atmospheres, and in one embodiment about 0.0001 to about 0.005 atomospheres.

[**0098**] The heat exchange fluid entering the heat exchange channels (**126**, **127**, **136**, **137**, **350**, **360**, **470**, **475**, **540**, **550**, **630**, **640**, **730**, **740**) may have a temperature of about −190° C. to about 400° C., and in one embodiment about −100° C. to about 200° C. The heat exchange fluid exiting the heat exchange channels may have a temperature in the range of about −100° C. to about 300° C., and in one embodiment about −50° C. to about 250° C. The pressure drop for the heat exchange fluid as it flows through the heat exchange channels may range from about 0.0001 to about 5 atmospheres per meter of length of the heat exchange channel (atm/m), and in one embodiment from about 0.001 to about 1 atm/m. The Reynolds Number for the flow of heat exchange fluid flowing through the heat exchange channels may be in the range from about 100 to about 100,000, and in one embodiment about 200 to about 10,000.

[**0099**] The heat exchange fluid may be any fluid. These include air, steam, liquid water, gaseous nitrogen, liquid nitrogen, other gases including inert gases, carbon monoxide, molten salt, oils such as mineral oil, and heat exchange fluids such as Dowtherm A and Therminol which are available from Dow-Union Carbide. The heat exchange fluid may comprise one or more of the liquids or liquid mixtures being separated.

[**0100**] In one embodiment, the heat exchange channels comprise process channels wherein an endothermic or exothermic process is conducted. These heat exchange process channels may be microchannels. Examples of endothermic processes that may be conducted in the heat exchange channels include steam reforming and dehydrogenation reactions. In one embodiment, the incorporation of a simultaneous endothermic reaction to provide an improved heat sink may enable a typical heat flux of roughly an order of magnitude or more above the convective cooling heat flux. Examples of exothermic processes that may be conducted in the heat exchange channels include water-gas shift reactions, methanol synthesis reactions and ammonia synthesis reactions.

[**0101**] In one embodiment, the heat exchange fluid undergoes a phase change as it flows through the heat exchange channels. This phase change provides additional heat addition or removal from the process microchannels or liquid channels beyond that provided by convective heating or cooling. For a liquid heat exchange fluid being vaporized, the additional heat being transferred would result from the latent heat of vaporization required by the heat exchange fluid. An example of such a phase change would be an oil or water that undergoes boiling. In one embodiment, the heat exchange fluid boils or undergoes partial boiling in the heat exchange channels. In one embodiment, the amount of heat exchange fluid boiling in the heat exchange channels may be in the range from about 1 to about 99% by volume of the total amount of heat exchange fluid in the heat exchange channel, and in one embodiment about 5 to about 50% by volume.

[**0102**] The heat flux for convective heat exchange or convective heating in the microchannel distillation unit may range from about 0.01 to about 125 watts per square centimeter of surface area of the process microchannels (W/cm^2) in the microchannel distillation unit, and in one embodiment from about 0.1 to about 50 W/cm^2, and in one embodiment from about 1 to about 25 W/cm^2, and in one embodiment from about 1 to about 10 W/cm^2. The heat flux for phase change heat exchange may range from about 1 to about 250 W/cm^2, and in one embodiment, from about 1 to about 100 W/cm^2, and in one embodiment from about 1 to about 50 W/cm^2, and in one embodiment from about 1 to about 25 W/cm^2, and in one embodiment from about 1 to about 10 W/cm^2.

[**0103**] In one embodiment, each microchannel distillation section (**370**, **370***a*, **370***b*, **370***n*-**2**, **370***n*-**1**, **370***n*, **410**, **410***a*) may be operated at or near isothermal conditions. That is, the temperature within each microchannel distillation section may be maintained at a level that varies by no more than about 5° C., and in one embodiment no more than about 2° C. In one embodiment, the temperature in each microchannel distillation section (**370**, **370***a*, **370***b*, **370***n*-**2**, **370***n*-**1**, **370***n*, **410**, **410***a*), microchannel condenser (**120**, **120**B,