Reynolds number is (1030)×(Suratmann number)$^{-0.67}$ and the liquid phase recovered is 85%. The ratio of gas Reynolds number to liquid Reynolds number is 0.27.

[0228] Another experiment is run with the same arrangement of the device. The air-water mixture is made by mixing water flowing at 80 ml/min and air flowing at 5.0 SLPM. The suction heat for the liquid is 10 cm. The ratio of gas phase Reynolds number to liquid phase Reynolds number is (14740)×(Suratmann number)$^{-0.67}$. The liquid phase recovered is 0.3%. The ratio of gas Reynolds number to liquid Reynolds number is 3.9. Unlike conventional distillation columns where the heating and cooling are provided by condenser and reboiler located at the top and the bottom of the column respectively, in the microchannel distillation units provided for herein the wall temperature may be precisely controlled by heat exchange fluids flowing in the heat exchange channels. An advantage offered by this technology is to heat up and cool down the microchannel distillation unit quickly during start up and shut down. To reach the desired steady state process conditions, the process microchannels and wall between the process microchannels may be heated or cooled using a flowing heat exchange fluid. Due to high heat transfer coefficient and small single channel process capacity associated with the microchannels, the start-up time and shut down time may be reduced drastically as compared to conventional systems.

[0229] An advantage of microchannel technology is that it is modular in nature. This permits the use of performance calculations for a repeating unit to be used as the basis for estimating the performance for an entire structure employing a plurality of the repeating units. For example, it is estimated that in a system employing the inventive microchannel distillation units with same total capacity as a conventional ethylene fractionator, if one heat exchange channel serves five process microchannels in the microchannel distillation units, the start-up time may be less than about 24 hours, and in one embodiment less than about 12 hours, and in one embodiment less than about 6 hours, and in one embodiment less than about 4 hours, for reducing the temperature of the overall system from room temperature to −33° C. In one embodiment, it is estimated that a system employing a plurality of repeating units using one heat exchange channel and five microchannel distillation units wherein the material of construction is stainless steel **304** and the repeating unit is cooled from ambient temperature to a steady state temperature of −33° C. by flowing a heat exchange fluid at a temperature of 40° C. in the heat exchange channel, the time for start up may be about 2 hours.

[0230] While the invention has been explained in relation to specific embodiments, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims.

1. A process for distilling a fluid mixture in a microchannel distillation unit, the microchannel distillation unit comprising a plurality of microchannel distillation sections, the microchannel distillation unit having at least one feed inlet, the fluid mixture comprising a more volatile component and a less volatile component, the process comprising:

flowing a vapor phase through the microchannel distillation unit in a first direction;

flowing a liquid phase through the microchannel distillation unit in a second direction that is counter-current to the first direction; and

flowing the fluid mixture through the feed inlet into at least one microchannel distillation section, part of the more volatile component transferring from the fluid mixture to the vapor phase to form a more volatile component rich vapor phase, part of the less volatile component transferring from the fluid mixture to the liquid phase to form a less volatile component rich liquid phase.

2. The process of claim 1 wherein the microchannel distillation unit has a distillate end and a bottoms end, the process further comprises:

flowing the more volatile component rich vapor phase through a plurality of the microchannel distillation sections towards the distillate end, the more volatile component rich vapor phase contacting the liquid phase in each microchannel distillation section and becoming enriched with the more volatile component; and

flowing the less volatile component rich liquid phase through a plurality of the microchannel distillation sections towards the bottoms end, the less volatile component rich liquid phase contacting the vapor phase in each microchannel distillation section and becoming enriched with the less volatile component.

3. The process of claim 1 wherein the microchannel distillation unit comprises at least one heat exchanger.

4. The process of claim 1 wherein the microchannel distillation unit comprises at least one process microchannel, the process microchannel comprising an area to permit flow of the vapor phase and an area to permit flow of the liquid phase.

5. The process of claim 1 wherein the microchannel distillation unit has a distillate end and a microchannel condenser at the distillate end.

6. The process of claim 5 wherein the microchannel condenser is in the form of a microchannel distillation section.

7. The process of claim 1 wherein the microchannel distillation unit has a bottoms end and a microchannel reboiler at the bottoms end.

8. The process of claim 7 wherein the microchannel reboiler is in the form of a microchannel distillation section.

9. The process of claim 1 wherein the microchannel distillation unit has a distillate end and or bottoms end and further comprises a microchannel condenser at the distillate end and a microchannel reboiler at the bottoms end.

10. The process of claim 9 wherein the microchannel condenser and the microchannel reboiler are in the form of microchannel distillation sections.

11. The process of claim 4 wherein a wicking layer separates the area for vapor phase flow and the area for liquid phase flow.

12. The process of claim 4 wherein the process microchannel has an interior wall in the area for vapor phase flow and an interior wall in the area for liquid phase flow, each of the walls being opposite each other and having surface features to enhance the mixing of the vapor phase with the liquid phase.