

boiling in the heat exchange channel zones, the temperature in each microchannel distillation section being different.

**165.** The process of claim 123 wherein the vapor phase flows through the process microchannel in a first direction, and a heat exchange fluid flows through the heat exchange channel in a second direction, the second direction being co-current, cross-current or counter-current relative to the first direction.

**166.** The process of claim 123 wherein a heat exchange fluid flows through the heat exchange channel, the heat exchange fluid comprising one or more of air, steam, liquid water, carbon dioxide, gaseous nitrogen, liquid nitrogen, a gaseous hydrocarbon or a liquid hydrocarbon.

**167.** The process of claim 123 wherein the pressure within the process microchannel is in the range from about 30 to about 100 atmospheres, and a heat exchange fluid flows in the heat exchange channel, the temperature of the heat exchange fluid being in the range from about -30 to about 200° C.

**168.** The process of claim 121 wherein at least part of the more volatile component rich vapor phase is condensed and withdrawn from each microchannel distillation unit.

**169.** The process of claim 168 wherein the more volatile component rich vapor phase is condensed in a microchannel condenser.

**170.** The process of claim 121 wherein at least part of the more volatile component rich vapor phase is condensed and flows into each microchannel distillation unit.

**171.** The process of claim 121 wherein at least part of the less volatile component rich liquid phase is withdrawn from the microchannel distillation unit.

**172.** The process of claim 121 wherein at least part of the less volatile component rich liquid phase is vaporized and flows into each microchannel distillation unit.

**173.** The process of claim 172 wherein the less volatile component rich liquid phase is vaporized in a microchannel reboiler.

**174.** The process of claim 121 wherein each microchannel distillation unit has a height of up to about 3 meters.

**175.** The process of claim 121 wherein the height of the equivalent theoretical plate ratio for each microchannel distillation unit is less than about one foot.

**176.** The process of claim 121 wherein the height of the equivalent theoretical plate ratio for each microchannel distillation unit is less than about one inch.

**177.** The process of claim 121 wherein the time for cooling the microchannel distillation unit from room temperature to about -33° C. is less than about 24 hours.

**178.** The process of claim 121 wherein a distillate product is formed, the distillate product being treated in another microchannel distillation unit.

**179.** The process of claim 178 wherein another distillate product is formed in the another microchannel distillation unit, the another distillate product being treated in a third microchannel distillation unit.

**180.** The process of claim 121 wherein a bottoms product is formed, the bottoms product being treated in another microchannel distillation unit.

**181.** The process of claim 180 wherein another bottoms product is formed in the another microchannel distillation unit, the another bottoms product being treated in a third microchannel distillation unit.

**182.** The process of claim 121 wherein the microchannel distillation unit has a distillate end and a distillate product is removed from the microchannel distillation unit at the distillate end.

**183.** The process of claim 121 wherein the microchannel distillation unit has a distillate end and at least one product is removed from the microchannel distillation unit downstream from the distillate end.

**184.** The process of claim 121 wherein the microchannel distillation unit has a bottoms end and a bottoms product is removed from the microchannel distillation unit at the bottoms end.

**185.** The process of claim 121 wherein the microchannel distillation unit has a bottoms end and at least one product is removed from the microchannel distillation unit upstream from the bottoms end.

**186.** The process of claim 121 wherein the microchannel distillation unit has a distillate end and a bottoms end and at least one feed stream is introduced into the microchannel distillation unit into at least one microchannel distillation section positioned between the distillate end and the bottoms end.

**187.** The process of claim 121 wherein the microchannel distillation sections have heat exchange channel zones thermally communicating with the microchannel distillation sections, each of the heat exchange channel zones comprising at least one heat exchange fluid loop.

**188.** The process of claim 187 wherein heat exchange fluid flows from one heat exchange fluid loop to another heat exchange fluid loop.

**189.** The process of claim 187 wherein at least two heat exchange fluid loops are nested.

**190.** The process of claim 121 wherein the gas to liquid Reynolds number is in the range from about  $500 \times (\text{Suratmann Number})^{-0.67}$  to about  $4500 \times (\text{Suratmann Number})^{0.67}$ .

**191.** A process for distilling a fluid mixture in a microchannel distillation unit, the microchannel distillation unit comprising a plurality of microchannel distillation sections, each microchannel distillation section comprising a vapor region and a capture structure, the process comprising: flowing a liquid stream in the capture structure, flowing a vapor stream in the vapor region, the capture structure comprising a first depth and a second depth, wherein the second depth is less than the first depth and the second depth comprises surface features that create a perpendicular velocity component in the liquid stream in at least a portion of the first depth that is greater than the second depth.

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