

boiling in the heat exchange channel zones, the pressure of the heat exchange fluid in each of the heat exchange channel zones being different.

47. The process of claim 1 wherein the microchannel distillation sections have adjacent heat exchange channel zones, a heat exchange fluid flows in the heat exchange channel zones, the heat exchange fluid undergoing partial boiling in the heat exchange channel zones, the temperature in each microchannel distillation section being different.

48. The process of claim 10 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.

49. The process of claim 10 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.

50. The process of claim 3 wherein the heat exchanger comprises an electric heating element, resistance heater and/or non-fluid cooling element.

51. The process of claim 10 wherein the gauge pressure within the microchannel distillation sections 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.

52. A process for distilling a fluid mixture in a microchannel distillation unit, the microchannel distillation unit comprising a process microchannel and an adjacent liquid channel, the fluid mixture comprising a more volatile component and a less volatile component, the process comprising:

flowing a vapor phase of the fluid mixture in one direction through the process microchannel, the process microchannel comprising a plurality of microchannel distillation sections, each microchannel distillation section comprising an internal space for permitting vapor flow, an interior wall, a capture structure, a liquid inlet and a liquid outlet, the capture structure and the liquid outlet being downstream from the liquid inlet, the interior wall extending from the liquid inlet to the liquid outlet, the capture structure being suitable for capturing liquid and permitting vapor to flow through it, the liquid outlet being suitable for permitting the flow of the liquid from the capture structure through the liquid outlet into the liquid channel, the liquid inlet being suitable for permitting liquid to flow from the liquid channel into the process microchannel;

flowing a liquid phase of the fluid mixture through the liquid channel in a direction opposite to the direction of flow of the vapor phase in the process microchannel, the liquid channel including a wicking region, the liquid phase flowing through the wicking region;

the liquid phase flowing from the liquid channel through the liquid inlet in a first microchannel distillation section of the process microchannel and flowing as a thin film along the interior wall to the capture structure within the first microchannel distillation section, the vapor phase flowing through the first microchannel distillation section in contact with the liquid phase flowing along the interior wall, part of the more volatile

component transferring from the liquid phase to the vapor phase to form a more volatile component rich vapor phase, part of the less volatile component transferring from the vapor phase to the liquid phase to form a less volatile component rich liquid phase, the less volatile component rich liquid phase contacting the capture structure and flowing from the capture structure through the liquid outlet of the first microchannel distillation section into the liquid channel, the more volatile component rich vapor phase flowing through the capture structure of the first microchannel distillation section.

53. The process of claim 52 wherein at least part of the more volatile component rich vapor phase is condensed and withdrawn from the microchannel distillation unit.

54. The process of claim 53 wherein the more volatile component rich vapor phase is condensed in a microchannel condenser.

55. The process of claim 52 wherein at least part of the more volatile component rich vapor phase is condensed and flows into the liquid channel.

56. The process of claim 55 wherein the more volatile component rich vapor phase is condensed in a microchannel condenser.

57. The process of claim 52 wherein at least part of the less volatile component rich liquid phase is withdrawn from the microchannel distillation unit.

58. The process of claim 52 wherein at least part of the less volatile component rich liquid phase is vaporized and flows into the process microchannel.

59. The process of claim 59 wherein the less volatile component rich liquid phase is vaporized in a microchannel reboiler.

60. The process of claim 1 wherein the fluid mixture comprises natural gas, the fluid mixture flows through a series of microchannel distillation units to remove water, butanes and/or butylenes, propanes and/or propylene, and ethane and/or ethylene, from the fluid mixture.

61. A process for separating ethylene from a fluid mixture comprising ethylene and ethane in a distillation unit comprising a plurality of microchannel distillation sections, the process comprising: contacting a vapor phase of the fluid mixture with a liquid phase of the fluid mixture in each of the microchannel distillation sections, progressively enriching the vapor phase with ethylene to form an ethylene enriched vapor phase, and separating the ethylene enriched vapor phase from the distillation unit, the distillation unit having a height of up to about 20 meters, the separated ethylene enriched vapor phase having an ethylene content of at least about 95% by volume.

62. The process of claim 61 wherein the distillation unit has a height of up to about 3 meters.

63. The process of claim 61 wherein the ethylene enriched vapor phase has an ethylene content of at least about 99% by volume.

64. A process for distilling a fluid mixture in a distillation apparatus comprising a plurality of microchannel distillation units, each microchannel distillation unit comprising a plurality of microchannel distillation sections, the fluid mixture comprising a more volatile component and a less volatile component, the process comprising:

flowing a vapor phase of the fluid mixture in a first microchannel distillation section of at least one microchannel distillation unit in contact with a liquid phase