

of the fluid mixture, 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;

separating the more volatile component rich vapor phase from the less volatile component rich liquid phase;

flowing the less volatile component rich liquid phase to another microchannel distillation section in the microchannel distillation unit upstream from the first microchannel distillation section; and

flowing the more volatile rich vapor phase to another microchannel distillation section in the microchannel distillation unit downstream from the first microchannel distillation section.

65. The process of claim 64 wherein the distillation process is conducted in all of the microchannel distillation units in the distillation apparatus.

66. The process of claim 64 wherein the distillation process is conducted in some but not all of the microchannel distillation units in the distillation apparatus.

67. A microchannel distillation unit, comprising: a process microchannel and a liquid channel; the liquid channel being adjacent to the process microchannel, the liquid channel comprising a wicking region; 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 for permitting liquid to flow as a thin film along the interior wall, a capture structure for capturing liquid and permitting vapor to flow through it, a liquid outlet for permitting liquid to flow from the capture structure into the liquid channel, and a liquid inlet for permitting liquid to flow from the liquid channel into the process microchannel.

68. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit further comprises a microchannel condenser for condensing vapor.

69. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit further comprises a microchannel reboiler for vaporizing liquid.

70. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit further comprises a heat exchange channel adjacent to the liquid channel, the process microchannel, or both the liquid channel and the process microchannel.

71. The microchannel distillation unit of claim 67 wherein the process microchannel has an internal dimension of width or height of up to about 10 mm.

72. The microchannel distillation unit of claim 67 wherein the process microchannel has an internal dimension of width or height of up to about 2 mm.

73. The microchannel distillation unit of claim 67 wherein the process microchannel is made of a material comprising: steel; monel; inconel; aluminum; titanium; nickel; copper; brass; an alloy of any of the foregoing metals; a polymer; ceramics; glass; a composite comprising a polymer and fiberglass; quartz; silicon; silicon carbide; boron carbide; metal carbide; silicon nitride; boron nitride; metal nitride; or a combination of two or more thereof.

74. The microchannel distillation unit of claim 67 wherein the liquid channel comprises a microchannel.

75. The microchannel distillation unit of claim 67 wherein the liquid channel has an internal dimension of width or height of up to about 10 mm.

76. The microchannel distillation unit of claim 67 wherein the liquid channel has an internal dimension of width or height of up to about 2 mm.

77. The microchannel distillation unit of claim 67 wherein the liquid channel is made of a material comprising: steel; monel; inconel; aluminum; titanium; nickel; copper; brass; an alloy of any of the foregoing metals; a polymer; ceramics; glass; a composite comprising polymer and fiberglass; quartz; silicon; silicon carbide; boron carbide; metal carbide; silicon nitride; boron nitride; metal nitride; or a combination of two or more thereof.

78. The microchannel distillation unit of claim 70 wherein the heat exchange channel has an internal dimension of width or height of up to about 10 mm.

79. The microchannel distillation unit of claim 70 wherein the heat exchange channel has an internal dimension of width or height of up to about 2 mm.

80. The microchannel distillation unit of claim 70 wherein the heat exchange channel is made of a material comprising: steel; monel; inconel; aluminum; titanium; nickel; copper; brass; an alloy of any of the foregoing metals; a polymer; ceramics; glass; a composite comprising polymer and fiberglass; quartz; silicon; silicon carbide; boron carbide; metal carbide; silicon nitride; boron nitride; metal nitride; or a combination of two or more thereof.

81. The microchannel distillation unit of claim 67 wherein the capture structure comprises wire mesh.

82. The microchannel distillation unit of claim 67 wherein the capture structure comprises one or more of inverted cones, liquid-nonwetting porous structure, liquid-wetting porous structure, perforated foil, and fibers.

83. The microchannel distillation unit of claim 67 wherein the capture structure comprises one or more of sintered metal, metal screen, metal foam, and polymer fibers.

84. The microchannel distillation unit of claim 67 wherein the wicking region comprises a wick.

85. The microchannel distillation unit of claim 67 wherein the wicking region comprises a wicking surface.

86. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit further comprises a first supplemental vapor channel and a second supplemental vapor channel, and each microchannel distillation section further comprises a supplemental vapor inlet and a supplemental vapor outlet, the first supplemental vapor channel and the supplemental vapor inlet being suitable for permitting vapor to flow from the first supplemental vapor channel into the microchannel distillation section, the second supplemental vapor channel and the supplemental vapor outlet being suitable for permitting vapor to flow from the microchannel distillation section to second supplemental vapor channel.

87. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit is formed using sheets of material with portions removed that allow flow passage.

88. The microchannel distillation unit of claim 67 wherein the microchannel distillation unit is formed using a stack of sheets to form an integrated microchannel distillation unit.