W/cm^3. The flow paths are countercurrent within the device, with water flowing up from the bottom and air down from the top. Measured heat losses were around 5% for this device.

[0128] No fouling was detected within the microchannel device after over 5000 hours. Fouling is measured via the outlet gas temperature. As scale builds up, the resistance to heat transfer in the channel increases and the outlet gas temperature is expected to increase, thus showing less heat that is transferred from the gas to the partially boiling water. The higher superficial velocity within the microchannels is anticipated to contribute to the reduce rate of fouling as compared to conventional boilers.

Example 3

[0129] An alternate microchannel design and construction orientation, sandwich style, can also be used to create an offsetting rib structure, shown in **FIG. 13**. This structure is similar to **FIG. 10*b*** that was made with the ortho style except that the ortho style can easily round the edges of the microchannels. The sandwich style microchannel described in **FIG. 13** includes the use of 4 distinct shims stacked in repeating units of at least 6 shims.

[0130] The first shim **1302** represents a wall shim that either seprates the microchannel from the environment, from another microchannel, or from a speed bump shim used to connect channel flows to headers and footers.

[0131] The second shim **1304** in the stack is the speed bump shim that creates a flow passage way by joining the microchannels **1306** of fluid A in shim **1308** with the header or footer of shim **1302**.

[0132] The third shim **1308** is the array of parallel microchannels through which fluid flows and a unit operation is performed. There may be alternately only one microchannel on this sheet.

[0133] The fourth shim **1310** in the stack is identical to shim **1302** and separates the fluid streams.

[0134] The fifth shim **1312** in the stack is identical to shim **1304**. This shim creates a flow passage by joining the microchannels in the sixth shim with the inlet and outlet header/footer that would be next in the stack (and identical to shim **1302**).

[0135] The sixth shim **1314** is the array of parallel microchannels **1316** through which fluid flows and a unit operation is performed. There may alternately only be one microchannel on the sheet **1314**.

[0136] This shim design shown in **FIG. 13** creates a pressure-resistant structure in which microchannels have staggered (rather than aligned) supports. This design option is less desirable in that rounded edges for each flow channel may not be achieved and thus thicker wall shims (shim **1302**) may be required. It does however offer advantages of reducing the requirement to create small microfeatures in the shims as well as making the alignment of shims easier. Different applications may be optimized with different designs styles.

[0137] The invention includes devices having the one or more of the features illustrated in **FIG. 13**, as well as methods of making devices using shims with such features and methods of conducting unit operations using devices that include one or more of the illustrated design features.

[0138] Pressure Test Measurement for Characterizing some Preferred Devices of the Present Invention.

[0139] Microchannel devices for unit operations, such as reaction, separation, heat exchange, vaporization, condensation and the like have been designed to operate with high interstream pressure differentials. The high pressure vaporizer of example 2 was operated with a differential pressure of 272 psig at over 210° C. for over 5000 hours.

[0140] Pressure Test

[0141] For a microchannel unit operation with at least one critical channel dimension less than about 2 mm, operate with at least two inlet fluid streams. The first fluid stream must be at 279° C. and 8 psig. The second fluid stream must be at 210° C. and 280 psig. Any flow rate may be used. Operate the device for 1000 hours during which there are 10 thermal cycles to ambient temperature of entire device. After 1000 hours operation, pressurize each fluid flow line to 50 psig and hold for 2 hours. The pressure must remain constant indicating minimal leak paths to the environment. Then, pressurize the second fluid flow line to 50 psig, leaving the first fluid flow line open to atmosphere, and hold for 2 hours. The pressure must remain constant indicating minimal internal leak paths. A minimal leak path is defined as a leak rate of less than 10^{-6} standard cubic centimeters per second of helium when helium is used as the fluid for the final leak test.

[0142] The invention also includes methods of conducting unit operations in the device having the pressure resistance characteristic described above.

We claim:

1. A process of making a device for conducting unit operations on a fluid comprising:

stacking a plurality of shims such that a continuous flow path is formed through the shims;

wherein the flow path extends in a direction substantially parallel to shim thickness;

wherein the plurality of shims comprises at least three adjacent shims through which a flow path is formed and wherein a straight, unobstructed line is present through the flow path in said at least three shims;

wherein the three shims are configured such that a unit operation can be performed on a fluid in the flow path; and

bonding the shims to form a device capable of performing a unit operation on a fluid.

2. The process of claim 1 wherein the each of the at least three adjacent shims comprise at least one aperture selected from the group consisting of: circles, triangles, waves, ovals, irregular shapes and rectangles or squares or triangles with rounded corners.

3. The process of claim 2 wherein the each of the at least three adjacent shims comprise at least one aperture selected from the group consisting of: circles and triangles; and

wherein the at least three shims are bonded to form a device comprising a channel having a cylindrical or prismatic shape.