than the boiling point of the coolant, with the highest readings seen for the inlet, or top, of the reactor bed. The skin temperatures drop in the direction of flow, but they all lie above the Therminol boiling point for an extended time. These elevated temperatures are indicative of dry out in a large number of channels. The high temperatures seen the top of the bed thermowell were indicative of dryout as they were substantially higher than the saturation temperature of the coolant at the design pressure. It shows that there may have been a large maldistribution of flow from the top to the bottom of the channel, as the bottom has a lower temperature (close to the boiling operation temperature) and the positions closer to the top substantially higher in temperature. This profile indicates that we may have had biased coolant flow: More flow in the channels near the reactor outlet and less at the top of the reactor channel. When the heat exchanger channel dries out the gas phase pressure drop can be much larger than in the partial boiling channels, making the problem one of flow distribution design in addition to convective boiling. During this time it is believed that the Fischer-Tropsch catalyst deactivated at the elevated temperatures.

EXAMPLE 6

[0253] A series of experiments was run to evaluate partial boiling and assess the fouling effects in microchannels when partial water boiling occurs. Accelerated tests with either 0.5-1 ppm or 10-20 ppm total dissolved solids (TDS) were operated to quantify the impact of fouling on the boiling side of the partial vaporizer.

Device Description:

[0254] Two low pressure and one high pressure partial vaporizers were operated, and the device descriptions follow. For the low pressure vaporizers, the water side consists of 12 channels, each 1" wide×1" long×0.020' gap. The air side consists of 11 channels, each 1"×0.020"×1". The overall design is a cross-flow pattern. The air and water channels alternate, with a water channel being the outermost channel on both sides. The device was oriented such that the water would flow vertically upward (opposite gravity), and the air flowed parallel to horizontal.

[0255] The internal design of the header is shown in **FIG. 25**. The circular channel indicated with '1' is 0.180" ID, channel '2' is 0.031" ID, channel '3' is 0.063", and channel '4' is 0.100". The water flowed vertically upward into 'tube 1' (the drawing is upside down from the orientation the device was operated).

Low Pressure Vaporizer Water Footer

[0256] The internal design of the footer is simply a pyramid shaped cavity measuring 1"×1" at the start of the footer (by the microchannels), tapering down to a 0.180circular exit opening. Prior to the actual long term operation, acrylic devices were constructed to evaluate water flow distribution through the headers, microchannels and footers in the low and high pressure vaporizers. Using deionized water and food coloring as dye, the colored water flowed through the devices at flowrates equal to that of the actual long term operations, and the results were videotaped. The videos were reviewed to determine if flow was evenly dispersed, and changes to the design were made if needed. For the low pressure vaporizer header, a four way splitting method was chosen which delivered water feed to the four corners of the microchannel region. For the high pressure vaporizer header, the choice of distribution plates was critical to achieving even distribution. The final designs that were chosen are presented previously.

Experimental Setup and Operation:

[0257] Two low pressure and one high pressure partial vaporizers were operated and full details follow. A flow diagram for the low and high pressure partial vaporizer test stands follows.

[0258] The partial vaporizers were operated by controlling the air inlet flowrate on the hot side of the vaporizer and the water flowrate on the cold side of the vaporizer. The air was heated via a conventional heater to the desired temperature prior to entrance into the vaporizer. The air flowed out of the partial vaporizer into a microchannel heat exchanger which preheated the feed water. Water was pumped out of the bulk supply through the microchannel heat exchanger into the partial vaporizer. The high pressure vaporizer had an additional task of maintaining a constant backpressure. The water and steam mixture upon exiting the partial vaporizer was cooled and condensed.

[0259] Type K thermocouples (TC) from Omega Engineering were installed on the outer surface of the partial boiling vaporizer, and at all inlet and outlet locations. The air feed Brooks 5851 e series mass flow controller, the NoShok pressure transducers model 1001501127 and 1003001127, Omega latching relay controllers model CNI 1653-C24, LabAlliance HPLC Series 3 water pump, and Swagelok variable pressure relief valves, etc were calibrated and verified for proper operation. Air flowrate was calibrated against a primary standard calibrator, the Dry-Cal DC-2M Primary Flow Calibrator, which was calibrated and certified by BIOS International. Pressure transducers were calibrated using a Fluke pressure calibrator model 718 1006 with a Fluke 700P07 or 700P06 pressure module which were calibrated and certified by Fluke. The water pump was a Lab Alliance Model IV HPLC pump. The Omega CDCE-90-X conductivity sensor was calibrated using conductivity standards purchased from Cole Parmer. The entire system was constructed with Swagelok 316 stainless steel tubing and fittings.

[0260] Each vaporizer system was pressure tested by applying a static pressure to the water inlet line while plugging the outlet line. The applied pressure was 80-90 psig for the low pressure vaporizers and ~360 psig for the high pressure vaporizer, and was generated using a nitrogen fluid. The pressure was left on this side of the device. Concurrently, the air side was pressurized to ~40 psig. If there the leak rate does not exceed 0.5 psig in 15 minutes, then the vaporizer system was ready for operation.

[0261] Each vaporizer system was started up by turning on the preheaters and the air flow to the values indicated in the run plan. When the system was within ~35-45° C. of the desired temperature as indicated in the run plan, then water was introduced to the system. The water was started at full-flow to avoid low flowrates that would have very high percent boiling and risk dryout in the channels. In the case of the high pressure vaporizer, the back pressure control valve was then adjusted until the desired operating pressure was achieved. The microchannel heat exchanger immedi-