CLAIMS

1. A catalytic distillation structure, comprising:

a rigid framework having at least two grids;

a plurality of horizontal fluid permeable tubes mounted to said grids to form a plurality of fluid pathways among the plurality of horizontal fluid permeable tubes, wherein each horizontal fluid permeable tubes have a profile of a six-sided polygon; and

a plurality of vertical plates or wires connecting vertically aligned tubes of the plurality of horizontal fluid permeable tubes, wherein the plurality of vertical plates or wires connects from a corner of one vertically aligned tube to a corner of an adjacent vertically aligned tube, wherein the catalytic distillation structure further comprises a first series of vertically aligned tubes and a second series of vertically aligned tubes, wherein the first series comprises the plurality of horizontal fluid permeable tubes arrayed in a parallel, adjacent and vertically aligned columns within the first series, and the second series comprises the plurality of horizontal fluid permeable tubes arrayed in a parallel, adjacent and vertically aligned columns within the second series, wherein the first series of vertically aligned tubes are offset from the second series of vertically aligned tubes thereby the horizontal fluid permeable tubes of the first series overlap the horizontal fluid permeable tubes of the second series without contacting the horizontal fluid permeable tubes of the second series to thereby form a tortuous fluid pathway, and wherein a height of the plurality of vertical plates or wires evenly space apart the horizontal fluid permeable tubes in the first series and the second series, and wherein the first series and the second series are stacked side-by-side a distance apart.

2. The catalytic distillation structure of claim 1, further comprising:

a geometry of the six-sided polygon forming a first angle in four corners of the six-sided polygon, a second angle in two corners of the six-sided polygon, wherein the first angle is greater than the second angle,

wherein the second angle is in the corners of vertically aligned tubes that are connected by the plurality of vertically plates or wires,

wherein the six-sided polygon comprises two sides of a first length and four sides of a second length,

wherein the first angle is at a corner of a connection of a side of the first length and a side of the second length and the second angle is at a corner of a connection of two sides of the second length, and

wherein the second length is greater than or shorter than the first length.

3. The catalytic distillation structure of claim 1, wherein the plurality of horizontal fluid permeable tubes and plurality of vertical plates or wires are made of a same material, wire mesh.

4. The catalytic distillation structure of claim 1, further comprising at least one support rod to rigidly hold the at least two grids at distance apart from each grid.

5. The catalytic distillation structure of claim 1, wherein each of the plurality of horizontal fluid permeable tubes have an opening at a first end and second end of said tubes.

6. The catalytic distillation structure of claim 1, wherein the grids comprises a plurality of openings, wherein the plurality of openings of the grids have a profile equal to the profile of the plurality of horizontal fluid permeable, and wherein the plurality of horizontal fluid permeable tubes are positioned in the plurality of openings of the grids.

7. The catalytic distillation structure of claim 1, wherein the six-sided polygon is a hexagon, and the plurality of vertical plates or wires connect the vertically aligned tubes from a top corner of the hexagon of one vertically aligned tube to a bottom corner of the hexagon of the adjacent vertically aligned tube.

8. A distillation column reactor for concurrently carrying out reactions and separating the products from the reactants, comprising:

a vertically disposed vessel;

one or more catalytic distillation structures as defined in Claim 1 and disposed in the vertically disposed vessel.

9. The distillation column reactor of claim 8, further comprising one or more re-boilers, condensers, feeding tanks, or separators connected to the vertically disposed vessel via flow

lines, and wherein the flow line from the feeding tanks connects to the vertically disposed vessel at, above, or below the one or more catalytic distillation structures.

10. The distillation column reactor of claim 8, wherein the rigid framework is removably attached to the vertically disposed vessel by welding, crimping, adhesives, or mechanical fasteners.