# Novel SOFC Tubular Design Configurations

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A novel tubular solid oxide fuel cell configuration with high volumetric power packing density is discussed.

With good thermal shock resistance, high mechanical strength, easy sealing, and high volume manufacturing ability, tubular SOFC designs offer many advantages over planar designs. One shortcoming is the lower volumetric power packing density (VPPD). As a result, for a given stack power, planar SOFC stacks will be smaller than tubular SOFC stacks. For a tubular design, tube size is one of the critical parameters to be determined. Small tubes, less than 3 mm for example, will cause assembling problems due to the feasible nature of the tubes. The power of each cell is directly related to the cell active area. Obviously the bigger the tube, the larger the surface area results in more cell power. However, increasing the size in single tubular fuel cell will lead to lower power packing density and lower fuel utilization.

Multiple Tubular Fuel Cell (MTFC) design offers a potential solution. MTFC design arranges a group of different size tubular cells together as a basic module. One can assemble these basic modules to make a stack with high volumetric packing density. Comparing with a single tube design, the MTFC design increases VPPD by over 40% for a 2-tube assembly, over 80% for a 3-tube assembly, and 116% for a 5-tube assembly.

The VPPD of a tubular fuel cell stack (considering the diameter of the largest tube), $P_v$, is a function of fuel cell performance and cell design, and it can be expressed in the following equation:

$$P_v = \frac{4P_a n(d_1 + \frac{n-1}{2}\Delta d)}{\left[d_1 + (n-1)\Delta d\right]^2} \qquad [1]$$

Where $P_v$, VPPD, W/cm³; $P_a$, cell area power density, W/cm³; $d_1$, smallest tube ID, cm; $\Delta d$, ID difference between the two neighboring tubes, cm; $n$, number of tubes in a module.

MTFC design also increases the fuel utilization rate and the stack reliability. The module can be standardized and controlled individually. If one individual module fails, it can be switched off and replaced. This concept can be applied to any tubular design, for example electrolyte-, anode-, or cathode-supported designs. This concept of using MTFC design to increase volumetric power densities can also be extended to other type fuel cells.

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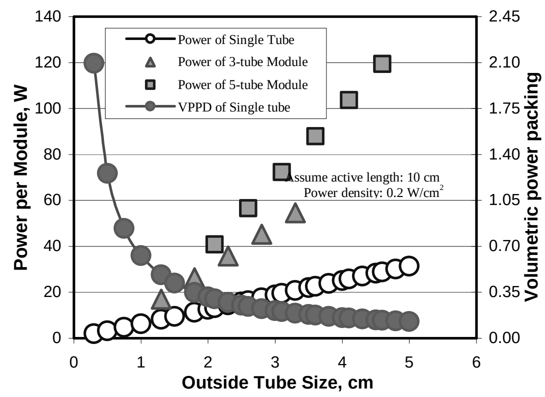


Fig.1 Power per tube and Power packing density (VPPD) as a function of tube size and design configurations.

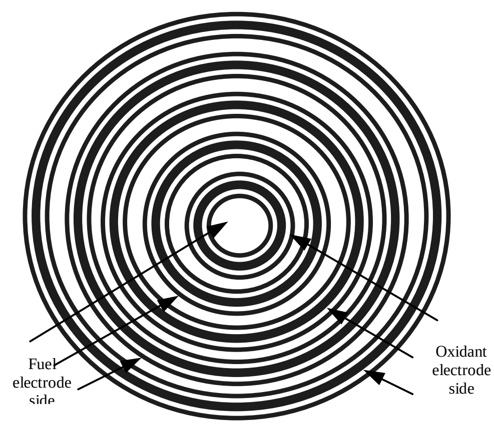


Fig.2 Schematic of Novel SOFC Tubular Design Configurations.

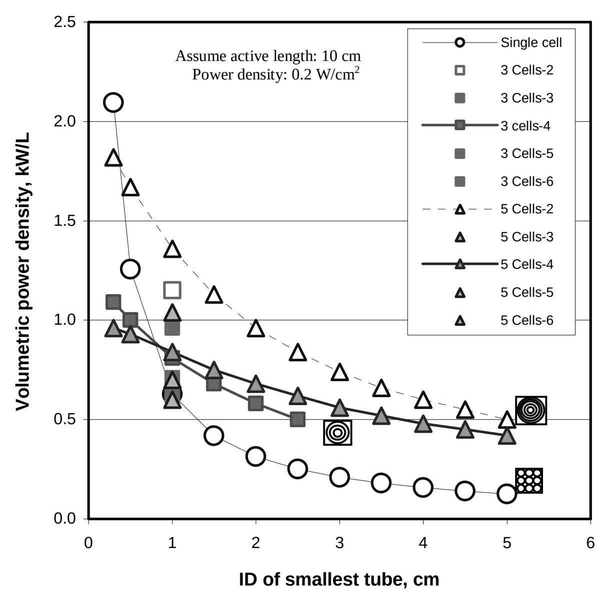


Fig.3 Volumetric power packing density (VPPD) as a function of tube size and design configurations.

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