Fuel Cell Assembly Process Flow for High Productivity

Ram Ramanan and Chock Karuppaiah

Bloom Energy

Bloom Energy's (BE) power modules achieve their highest efficiencies due to many factors that include system architecture, mechanical, fuel cell and electrical systems. The building blocks for BE's fuel cell modules are called stacks which are composed of alternating groups of interconnects and fuel-cell elements which contain the anode and cathode. The stacks have many characteristic parameters related to their electrical performance. Some of these parameters are continuous functions and the others are discrete variables. The continuous variables are broken into "discrete" bins for practical considerations of physical storage and usage in to the fuel cell system. Some of these parameters are inherent physical attributes (of the sub-components), manufacturer chronological data and performance characteristics. There is more than one manufacturer for many of the sub-components.

As shown in the figure below, a fixed repeatable number of sub components (in a particular order) are assembled into a "stack" and then groups of stacks are made into a "column" and a group of columns are put into an individual power module (PWM). In each step of the assembly process, there is a "yield loss" i.e. only a percentage of parts pass to move to the next assembly.

For performance and process considerations, there are specific rules (or constraints) that have been developed for how the stacks are built, how the columns of stacks are assembled and how the columns are put together for a PWM. These constraints or rules are based on the value of the characteristic parameters of the sub-components and also characteristics of the stacks. Multiple columns of stacks are created by arranging the blocks one on top of the other.

For maximum productivity and best performance, the following questions need to be answered.

- What is the optimum number of discretized sub-bins for the "continuous" parameters?
- Which rules cause the biggest impact to improving productivity and what is their sensitivity?

- How can we predict the output (number of systems) based on input (number of incoming parts)?
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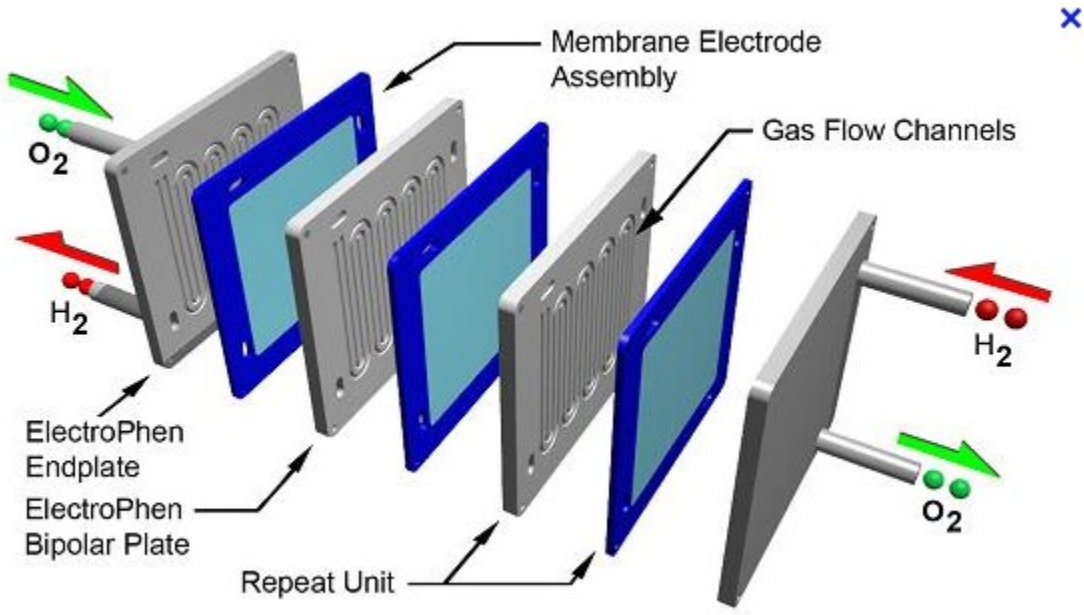
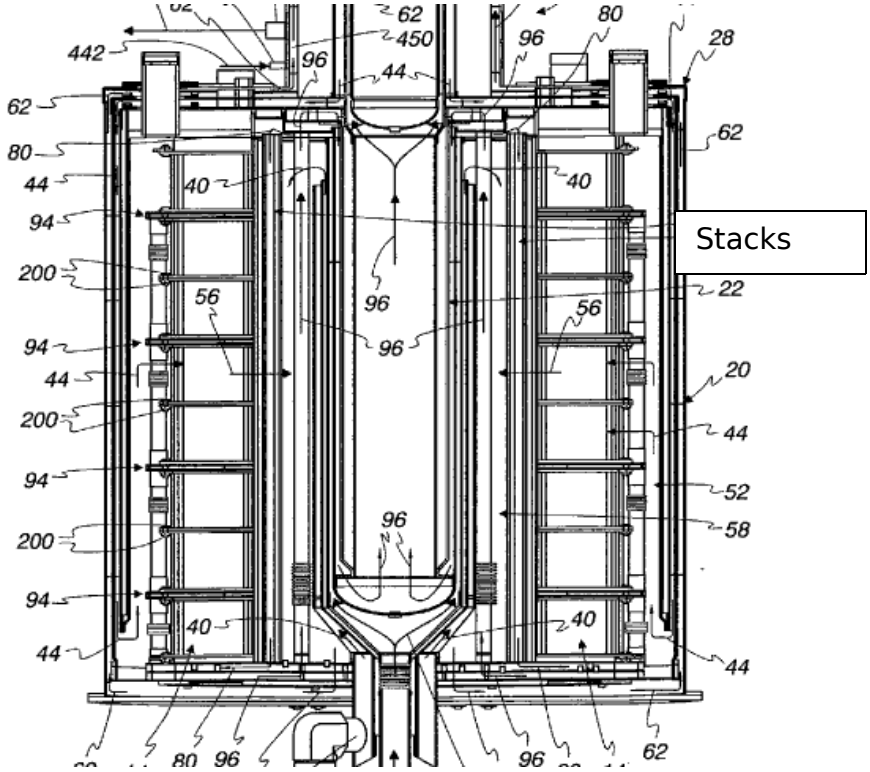


- Figure 1: Stack = A set of repeat units with interconnects and cells

- 

- Figure 2: A set of stacks make a column (shown here with 8 stacks in a column)