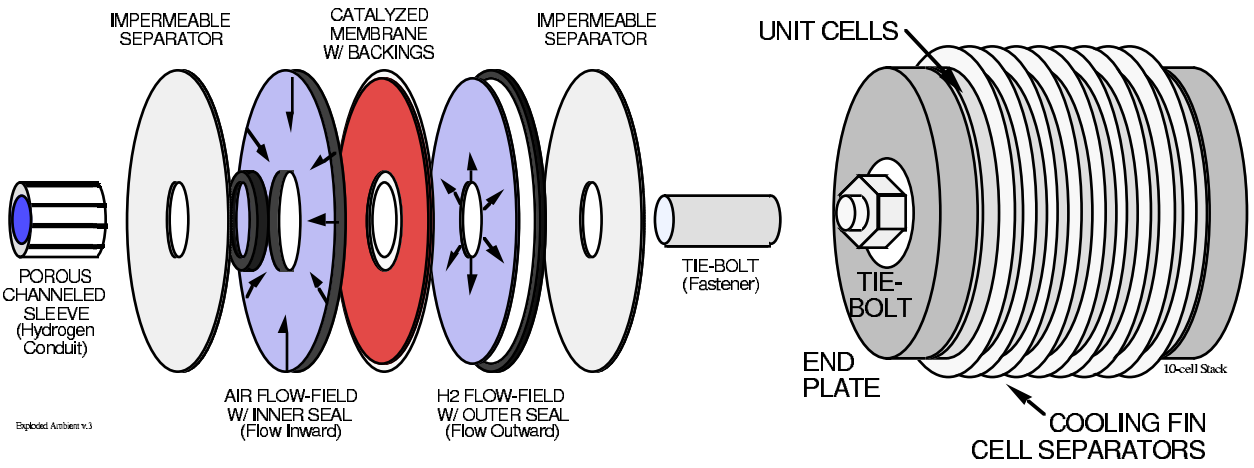

Figure 1 - Configuration and key components of a unit cell in an air-breather stack.

When the cells are stacked, not only do the structures heat up more but water accumulation in the annular region actually becomes a problem. Since the hydrogen supply is dead-ended, condensate can collect undisturbed and block the hydrogen from accessing the cells furthest from the hydrogen supply. The accumulation can be alleviated by introducing a wicking material in the annular region that draws the condensate away from the downstream cells (Wilson and Neutzler 1997).

Not surprisingly, cell performance is substantially affected by the thickness of the cathode flow-field because oxygen must diffuse in from the periphery through this structure. While the thicker flow-fields provide high powers at low temperatures, too much water is lost as the stack heats up to higher temperatures, especially at the relatively high altitude of LANL (2,250m or 7,300'). The optimum flow-field thickness for both power and stability at LANL is about 3 mm, but can be greater at low altitude. With the high altitude, the ambient pressure is only about 0.76 atm. Not only is the oxygen partial pressure lower (and hence kinetics poorer), but the stacks also tend to run much drier because the higher volume fraction of water vapor that can occur results in a greater driving force for removing water from the stack. Another aspect of high altitude operation is that cooling by free convection is much less effective than at sea level, which naturally exacerbates the drying effect. For these various reasons, a stack that stably produces 25 W at LANL can produce up to 35 W at sea level while actually operating cooler, and excess water may actually be accumulated. Thus, more leeway is afforded designs provided they are operated at lower altitudes. Conversely, products that are oriented towards camping or backpacking impose even more stringent design limitations.