Introduction

High-performance low-temperature polymer electrolyte membrane fuel cells (PEMFCs) are susceptible to self-heating and undesirable cell temperature rise at high current. Cell self-heating is driven by ohmic (IR) heating, the heat generated when a large current I (A) passes through a resistor R_{ohmic} (Ω):

$$Thermal\ Power\ (W) = I^2 \times R_{ohmic}$$

Passive convective heat loss maybe insufficient to prevent a rise in the cell temperature at high current. Active cooling with small fans located on either side of the fuel cell end-plates (Figure 1) is a cost-effective approach to eliminating or significantly decreasing IR-heating during polarization (V-I) testing (Figure 2 and Figure 3) and voltage or current cycling (Figure 4).

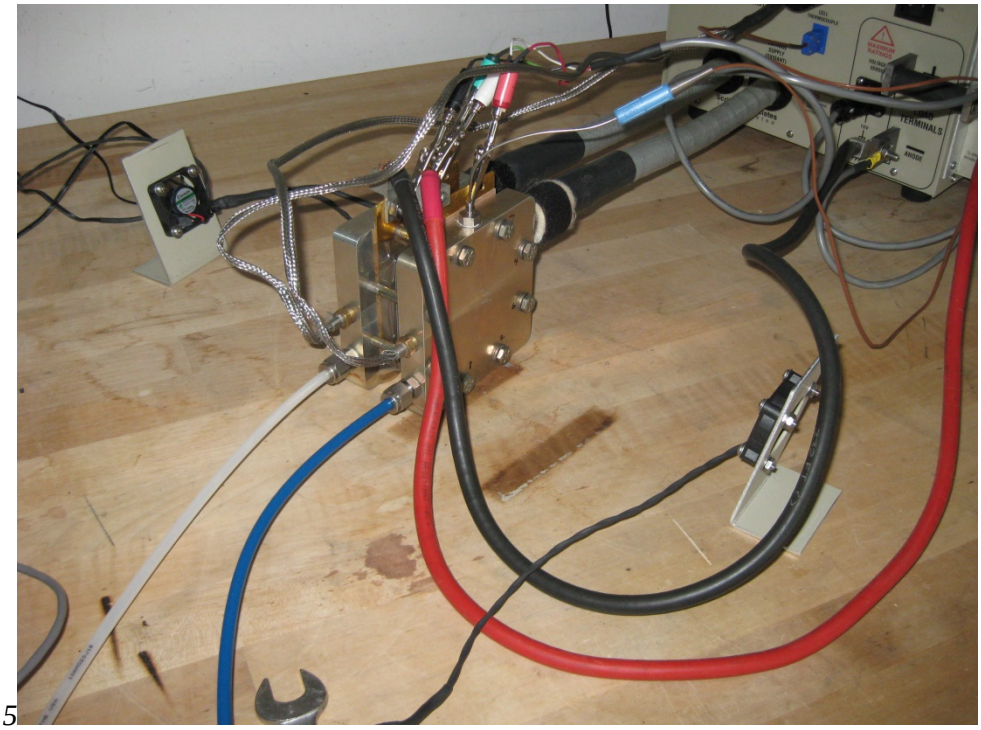

Figure 1. Active cell cooling with a pair of small fans positioned ~ 20 cm (8 in.) from either side of the cell. The cell heaters are forced to work against the increased convective cooling provided by the fans.

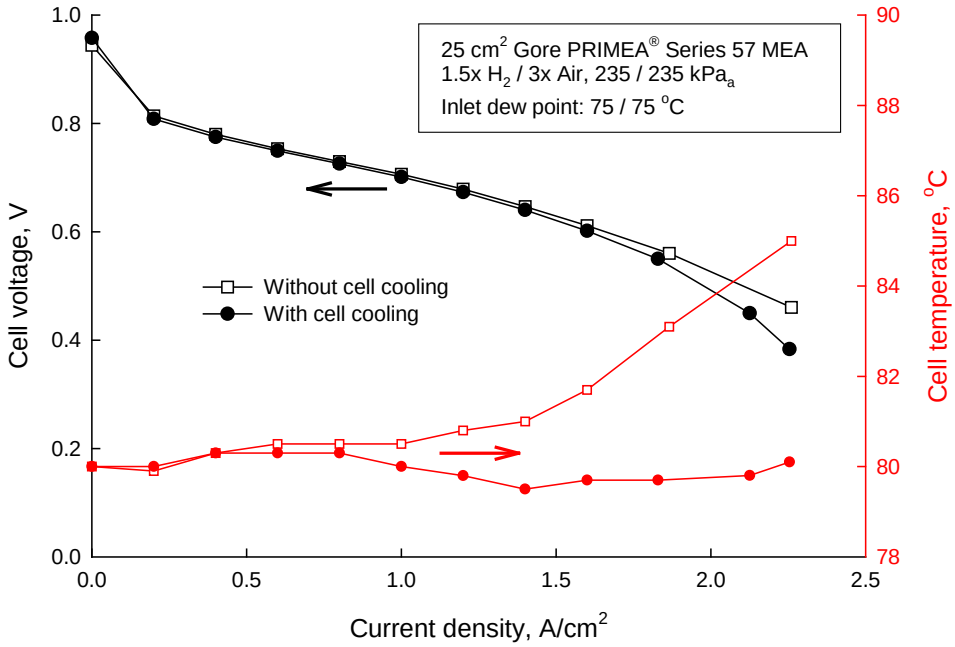

Figure 2. Without active cooling, the cell temperature can increase, particularly at high current, during a simple polarization scan. Without cell cooling (open symbols), with cell cooling (filled symbols).

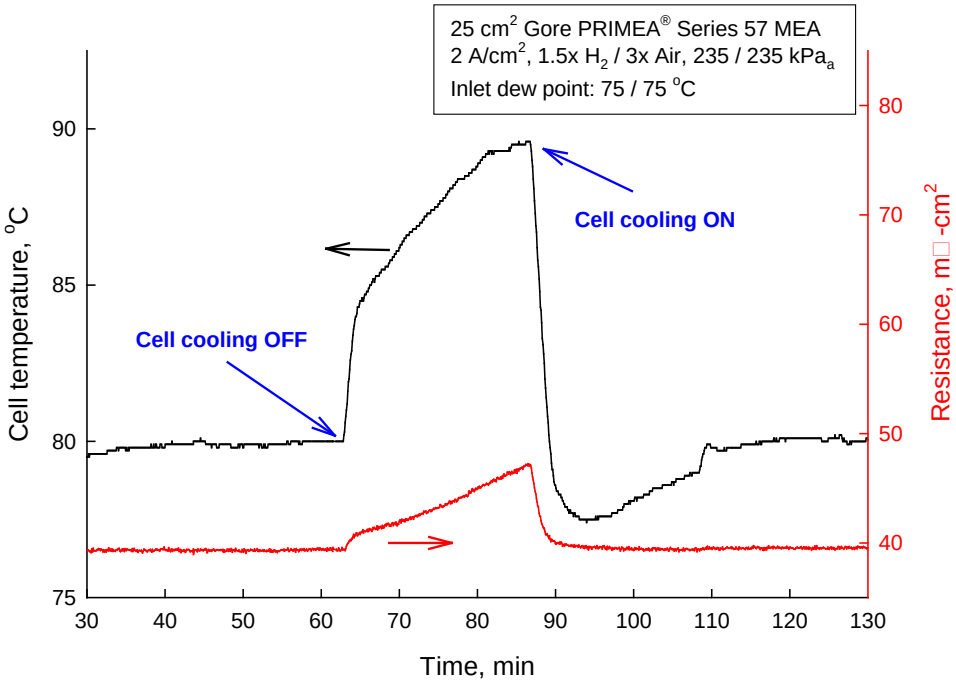

Figure 3. Active cell cooling maintains the cell temperature at the desired operating condition. Without active cooling, the cell temperature rapidly rose 10 °C.

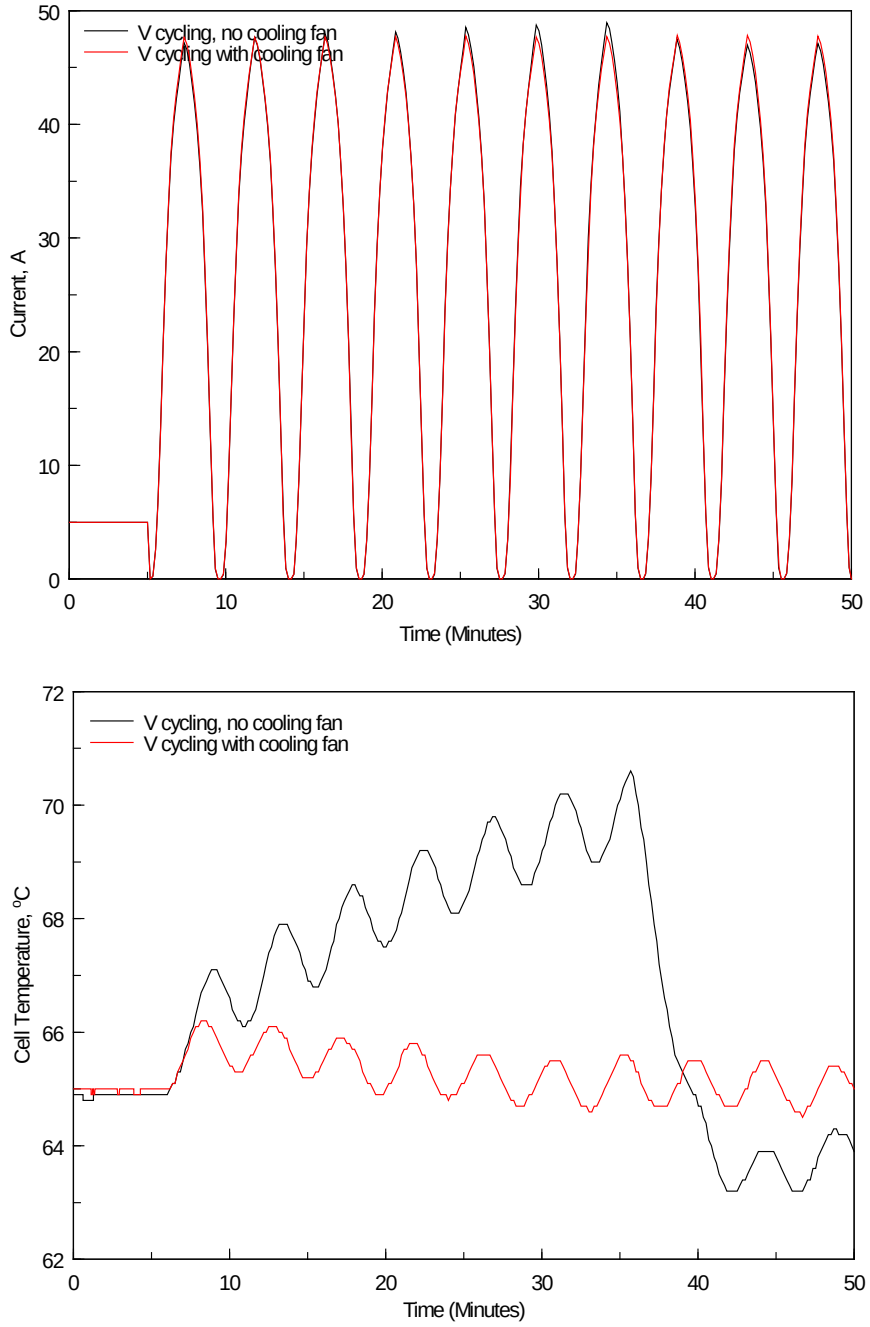

Figure 4. Active cooling with fans during voltage cycling significantly decreased the ohmic-heating driven temperature fluctuations and limits overall cell heating to ~ 1 °C above target cell temperature. Conditions: 25 cm² Gore PRIMEA® 57 Series MEA, 1.5x H_2 / 2.5x O_2 (as Air), T_{cell} = 65 °C, 65 °C anode and cathode inlet dew point (100% RH), 250 kPa_a / 250 kPa_a, V-cycling between OCV and 0.3 V, 0.05 V/step, 10 sec/step.