BekkTech worked in conjunction with UTC Fuel Cells in 2004 and 2005 to develop a protocol for in-plane conductivity testing of membrane samples developed under the U.S. Department of Energy's High Temperature Membrane Research Group. The protocol that follows originated from this work.

In-Plane Conductivity Test Protocol

- Sample size to be tested: 3mm x 20mm.
- Testing will be performed at the following conditions:
  100 kPa with a hydrogen flow rate of 500 sccm at 60C and at 80C
  230 kPa with a hydrogen flow rate of 500 sccm at 120C
- The sample will be tested as follows:
  1) Conditioned at 60C and 70% RH for 2 hours
  2) Stepped from 60% RH to 20% RH back up to 100% RH, at 10% RH intervals, allowing 15-30 minutes of stabilization at each RH.
  3) Adjusted to 80C and 70% RH for 2 hours.
  4) Stepped from 60% RH to 20% RH back up to 100% RH, at 10% RH intervals, allowing 15-30 minutes of stabilization at each RH.
  5) Adjusted to 120C and 70% RH for 2 hours
  6) Stepped from 60% RH to 20% RH back up to 100% RH, at 10% RH intervals, allowing 15-30 minutes of stabilization at each RH.
- Time on test: Approximately 23 hours per sample

See pages 2 through 5 of this document for examples of the resulting data.

BekkTech Test Results
Nafion 112 In-Plane Membrane Conductivity at 120 C

Test Date: 5-26-06

Equipment Used: BT-512 BekkTech Membrane Conductivity Test System

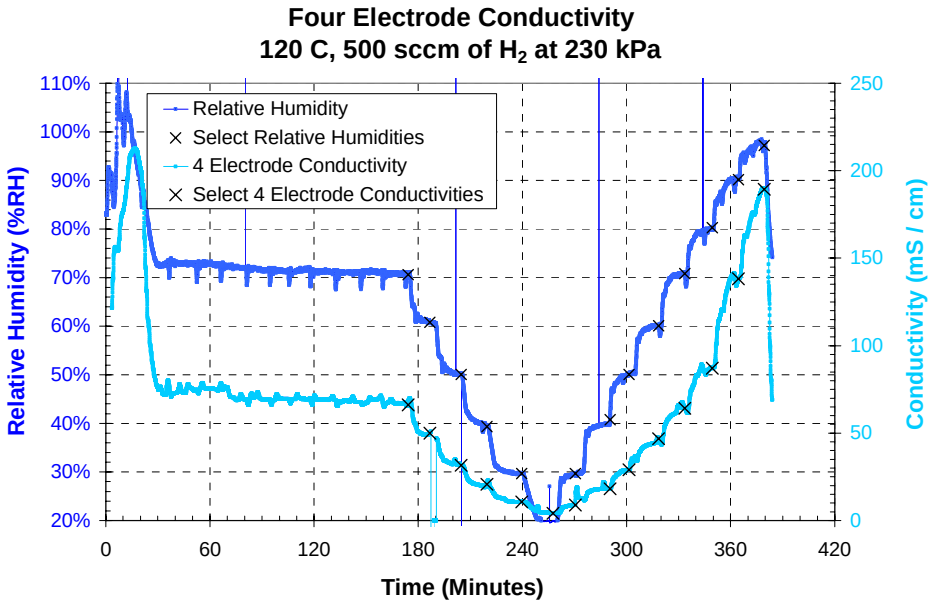

Figure 1: Membrane conductivity as a function of time

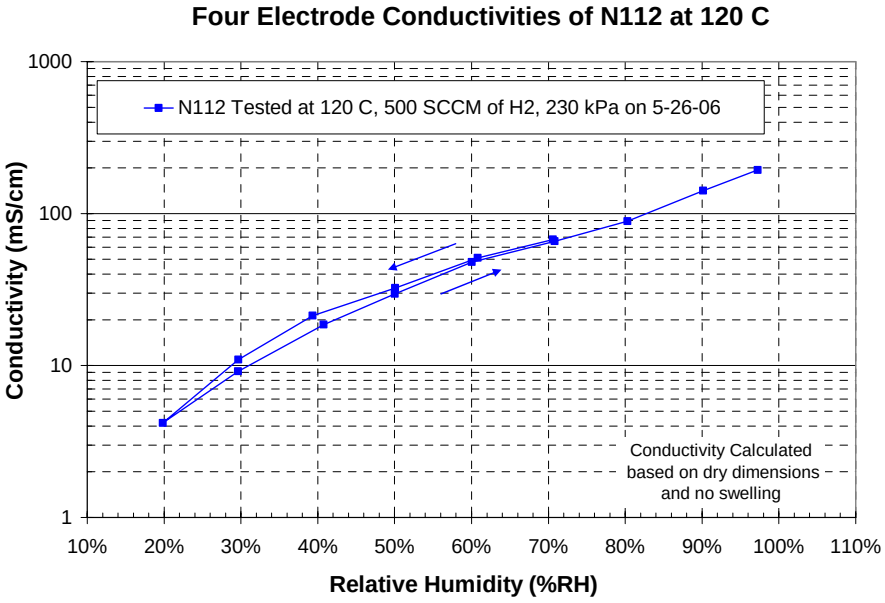

Figure 2: Conductivity as a function of Relative Humidity at 120 C

Figure 2 plots the X's from Figure 1

BekkTech Test Results
Nafion 112 In-Plane Membrane Conductivity at 80 C

Test Date: 5-26-06

Equipment Used: BT-512 BekkTech Membrane Conductivity Test System

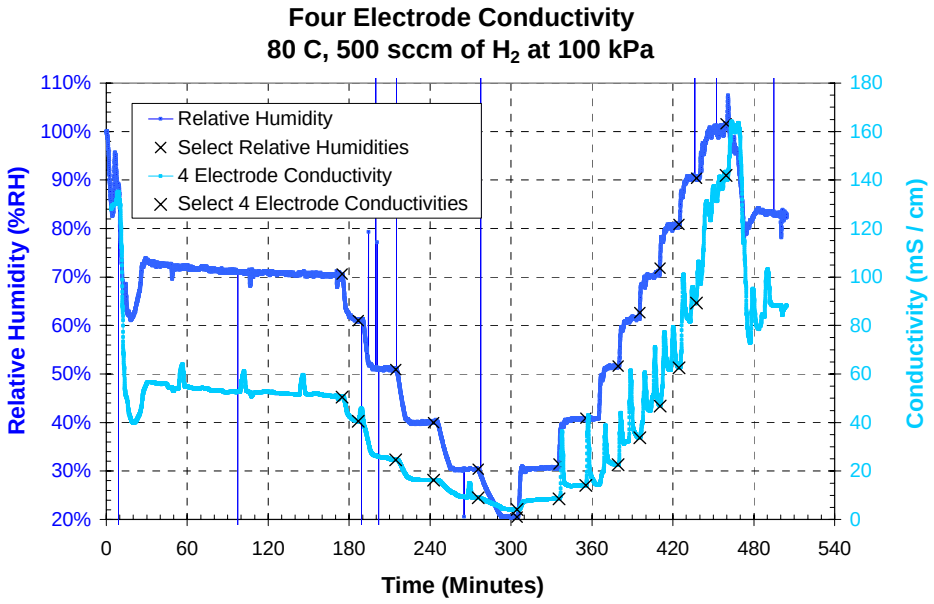

Figure 3: Membrane conductivity as a function of time

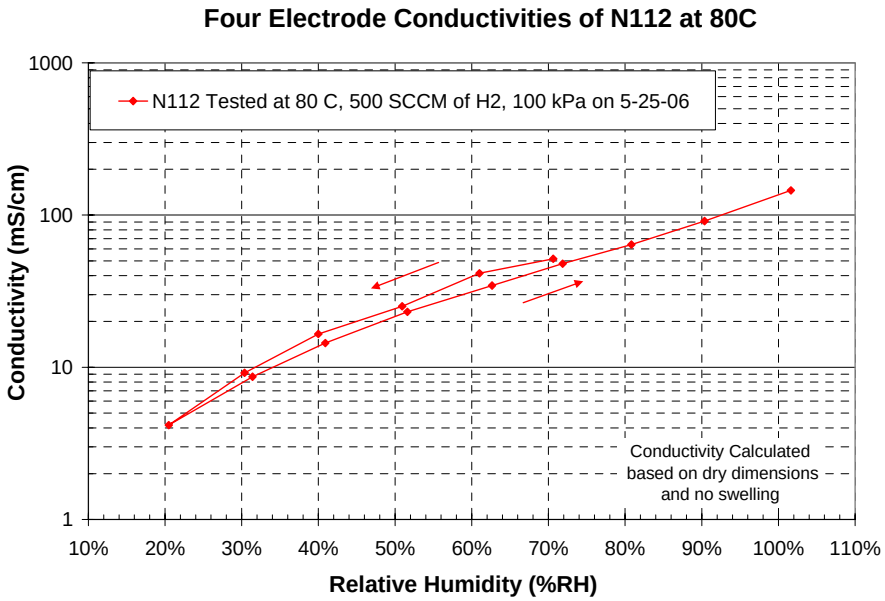

Figure 4: Conductivity as a function of Relative Humidity at 80 C

Figure 4 plots the X's from Figure 3

BekkTech Test Results
Nafion 112 In-Plane Membrane Conductivity at 60 C

Test Date: 5-26-06

Equipment Used: BT-512 BekkTech Membrane Conductivity Test System

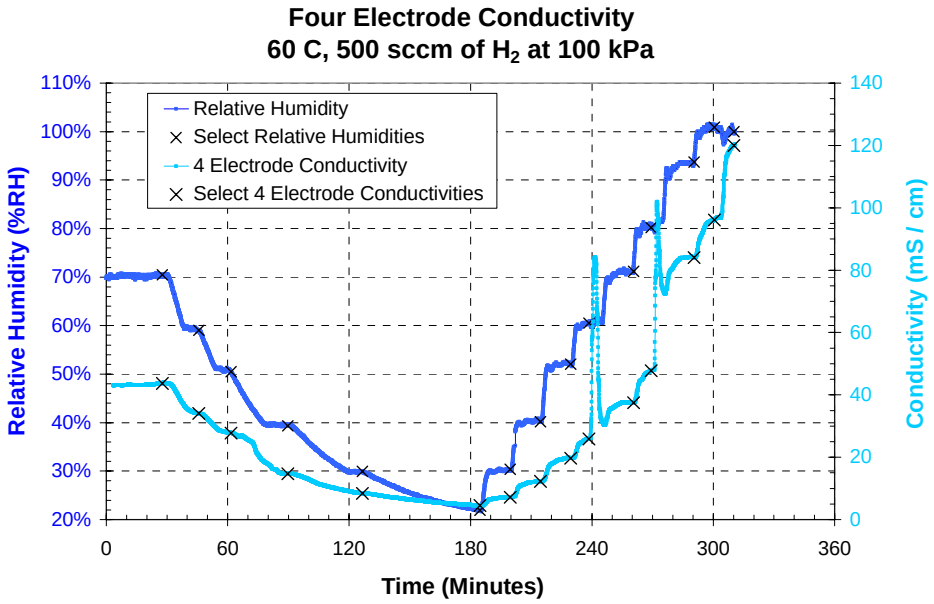

Figure 5: Membrane conductivity as a function of time

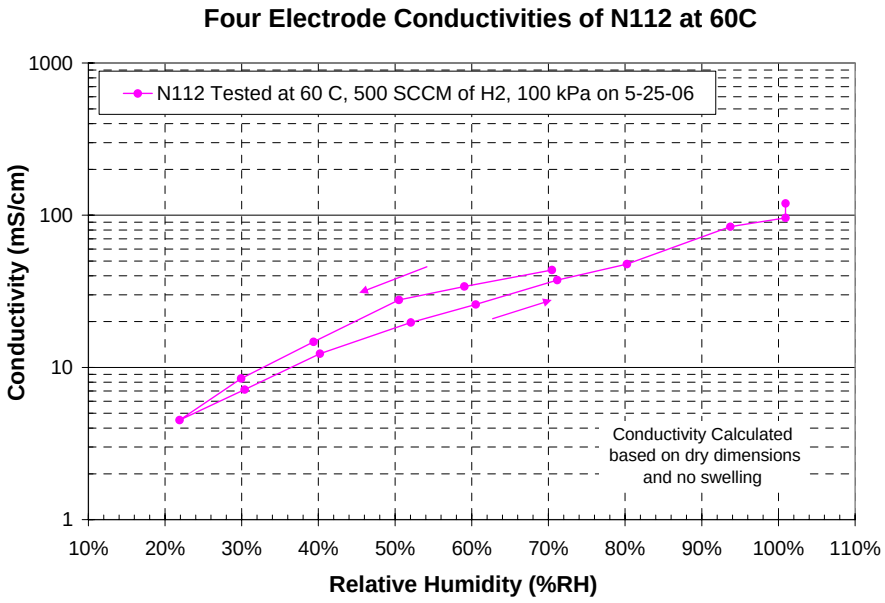

Figure 6: Conductivity as a function of Relative Humidity at 60 C

Figure 6 plots the X's from Figure 5

Review of BekkTech Test Results
Nafion 112 In-Plane Membrane Conductivity

Test Dates: 5-25-06 and 5-26-06

Equipment Used: BT-512 BekkTech Membrane Conductivity Test System

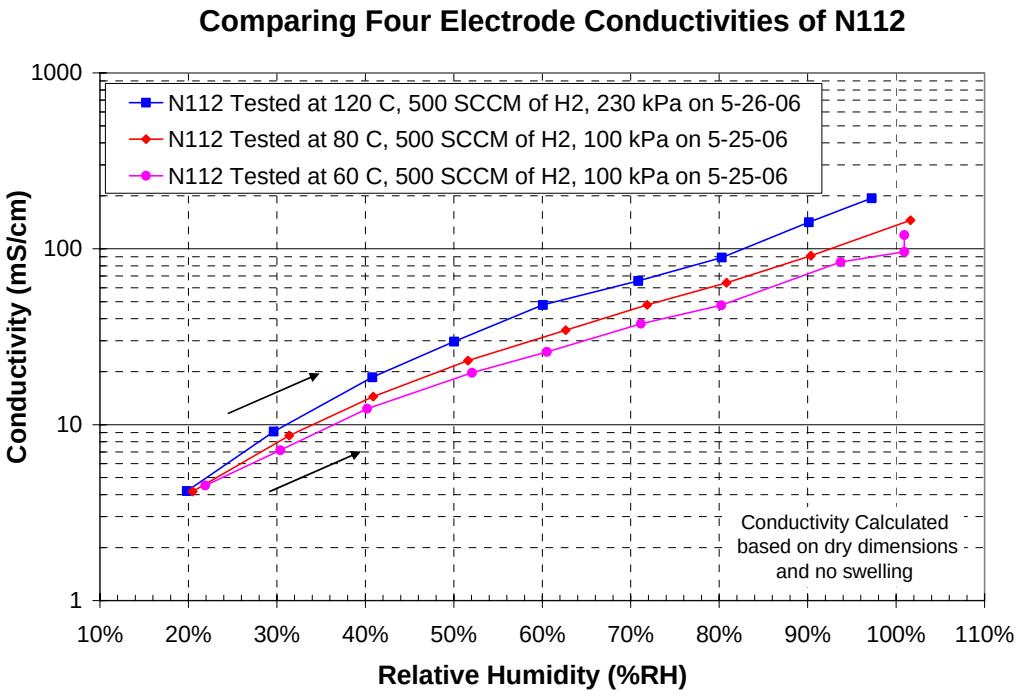

Figure 7: Nafion 112 at 60, 80 and 120 C. Relative Humidity Increasing.