Application Note – Manual Method for Accelerated Cooling of Scribner Fuel Cell Test System Humidifiers

Introduction

Sometimes there is a need to rapidly cool the humidifier in a fuel cell test system. Scribner's fuel cell test systems are designed for rapid and stable heating of the insulated humidifiers but are not designed for rapid cooling; natural cooling of the humidifiers from typical elevated temperature testing (*e.g.*, ~ 80 ^{o}C) can take hours.

Rapid cooling of the humidifier water can be achieved by sequential draining and filling of the humidifiers with cold water. The key is to not cause a "Low Water Alarm" which will occur if at the end of an auto water fill cycle the low water level sensor is not satisfied. In that case, the test system will need to power cycled to re-set the low water level alarm.

The following describes a set of operating conditions and procedure for cooling the humidifiers from 80 ^{o}C to ~ 30 ^{o}C in 20~30 min. A source of pressurized water is required.

Tools

- Manual ¼ inch Swagelok® 3-way valve
- ¼ inch Swagelok® T-fitting
- ¼ inch tubing
- 9/16 inch or adjustable wrench

Test Conditions

- 80 ^{o}C initial humidifier temperature
- 30 ^{o}C target final humidifier temperature
- 100 kPa (~ 15 PSI) back pressure (BP) on anode and cathode to assist the drain process
- 1 SLM flow rate (to maintain BP)
- 310 kPa (45 PSI) water pressure
- Humidifier temperatures were set to 15 ^{o}C prior to initiating the cool-down process.

A manual 3-way valve is connected to the drain as shown in Figure 1. One of the valve ports is connected to drain water to a catch vessel. The other valve port is connected to the pressurized water source using a T-fitting on the main pressurized water supply. In this way, you can either drain or manually fill the humidifier through the drain valve, permitting much more water to be drained than relying on the auto-fill cycle alone.

The auto water fill cycle is 13 pulses, each pulse is ~ 1 sec with 20 sec between pulses. A complete fill cycle takes ~ 4 min and 10 sec (250 sec). With the water source pressure and back pressure listed above, one can drain the humidifier for ~ 2 min (120 sec) and then switch to manually filling until the water is ~ 1 cm from the top of the sight glass

before the 4 min auto fill cycle terminates. In this way the Low Water Alarm is not triggered because the low water level sensor is satisfied at the end of the auto water fill cycle.

Two drain/auto water fill cycles can be performed in ~ 10 min per humidifier with the effect of decreasing the humidifier to ~ 35 ^{o}C (Figure 2). A third cycle might be needed to reduce the humidifier to 30 ^{o}C or less, depending on the temperature of the feed water.

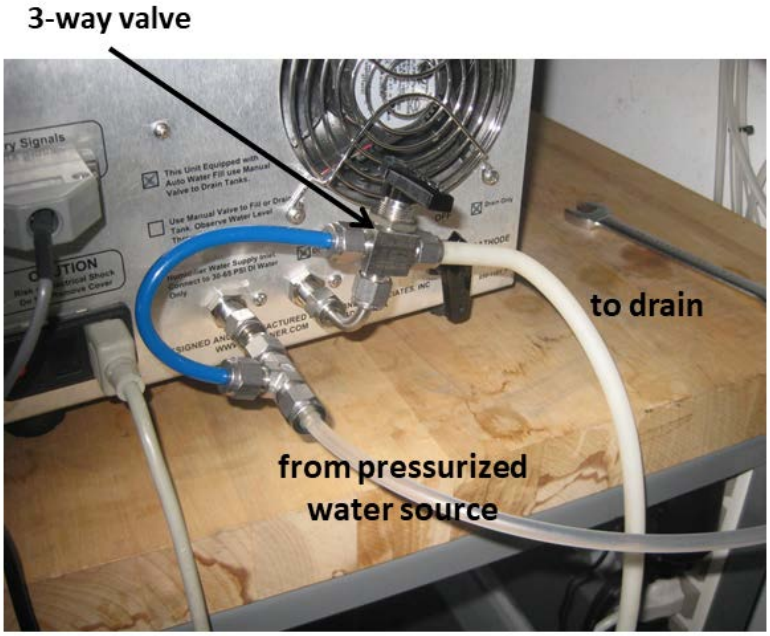

Figure 1. Setup for rapid humidifier draining using a T-fitting and 3-way manual valve.

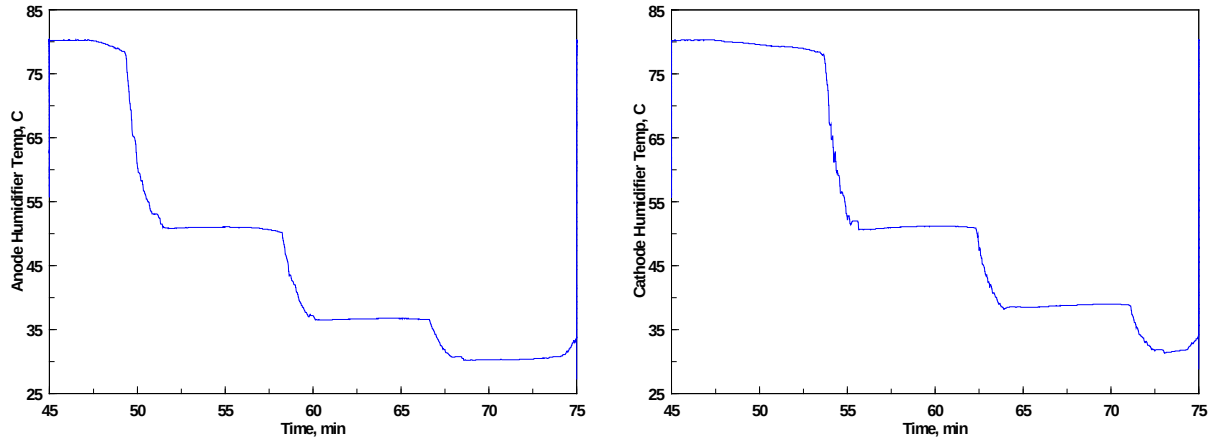

Figure 2. Example of accelerated humidifier cooling using the drain/manual fill procedure. The 1st anode drain began at 45 min and the 1st cathode drain at 50 min. The 2nd and 3rd drain and fill cycles followed at ~ 5 min intervals alternating between the two humidifiers. The total process took just under 30 min.