Performance of Automatic Electrolysis Pressure Regulator for Water Management
08/2025

Introduction

The Automatic Electrolysis Pressure Regulator (AEPR) is used to operate electrolysis cells at a differential pressure of up to 30 Bar on the hydrogen-producing side. The interest in operating cells under pressure comes from the need to pressurize hydrogen after its production. By producing hydrogen under pressurized conditions, the process becomes more efficient. The AEPR regulates the pressure within the cell by using a pilot gas line to regulate the outlet of the tank, which generates pressure within the tank to match the pressure of the pilot line.

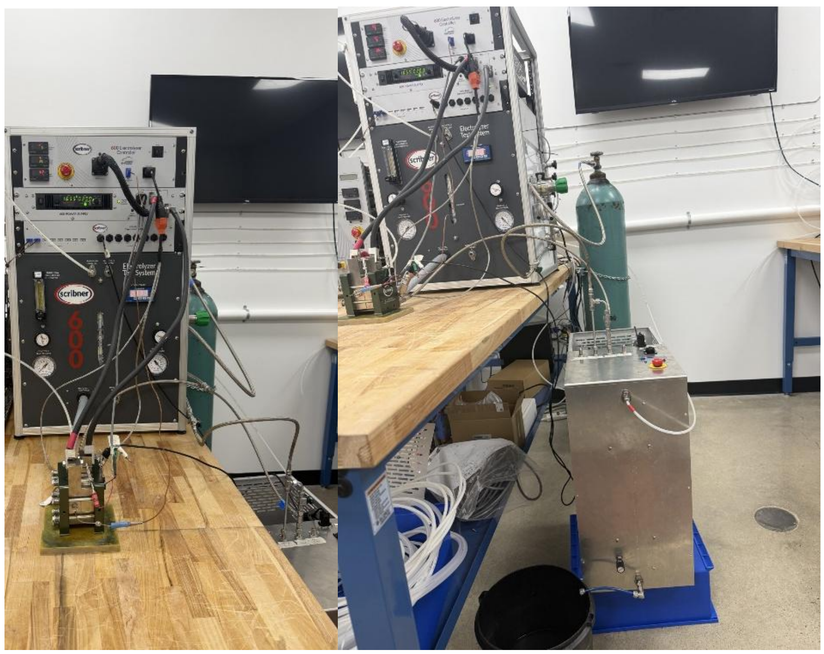

Figure 1: Images of Electrolysis experiment with the back pressure regulator. AEPR shown is Scribner's prototype unit. Actual production units will vary in appearance

Method

The AEPR was set up, and the drain valve was opened according to the manual by turning the dial 1 and a half turns. A Scribner high-pressure cell built with an Ionpower 25 cm^2 water electrolysis MEA and platinized titanium flow fields was connected to a Scribner 600 electrolysis test station. The cell was heated to 80 °C, and water was provided to the anode at a rate of 50 mL/min. The cell was pressurized to 30 bar using the AEPR setup shown in Figure 1. The current was varied to 10, 20, 30, 40, and 50 Amps while the pressure was monitored.

Results

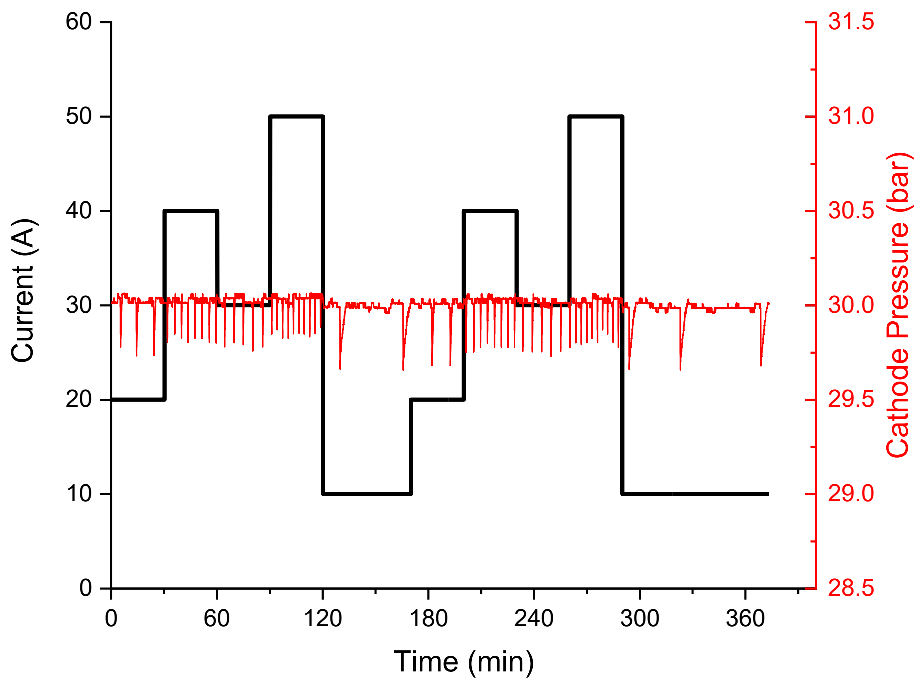

Figure 2: Current in Amps (black) and pressure in bar (red) vs time during electrolysis

The pressure remained steady near 30 bar with fluctuations caused by water drain events to maintain a constant water level in the pressurized tank. At high current values, these events are frequent due to the higher water drag and water vapor brought with the produced hydrogen to the tank. At 50 amps (A), the water drain events occur every 3 min with a recovery time of less than 20 seconds. At lower current values, the recovery time is much slower due to the lower amount of hydrogen produced, but the drain events occur at a much lower frequency. At 10 A, the drain events occur every 35 min with a recovery time of about 4 min. Table 1 summarizes the times of drain events for each of the currents applied to the cell.

Table 1: Average time of drain events and time between drain events for all currents applied

Current (A)	Duration of Drain Event (s)	Time Between Drain Events (s)
10	240	2160
20	70	600
30	36	318
40	32	240
50	21	185

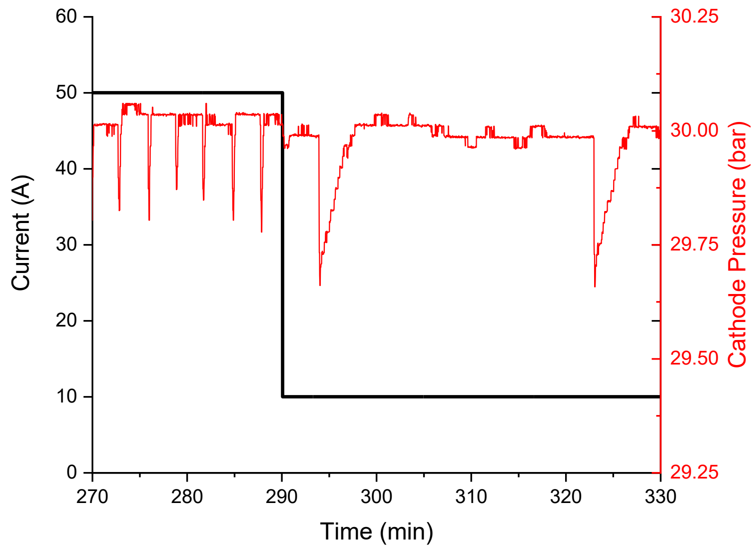

Figure 3: Inset of Figure 2 depicting current (black) and pressure (red) vs. time

Figure 3 shows a zoomed-in portion of Figure 2 depicting the drain events at 50 A and 10 A. The drain events at 50 A are shorter but more frequent, while the drain events at 10 A are less frequent but last longer.

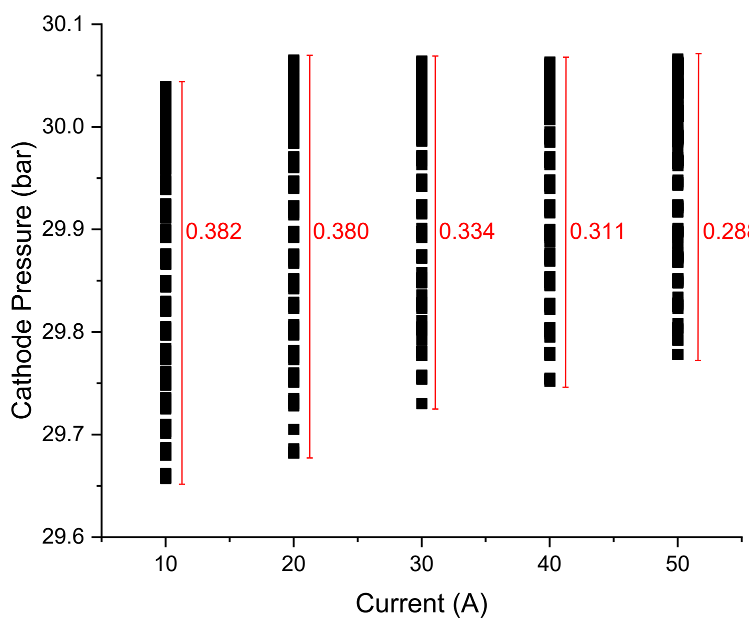

Figure 4: All pressure readings that were collected at various currents during electrolysis with the labelled min and max for each current

Figure 4 shows a scatter plot of every point collected at each current applied. As the current decreased, the dip in pressure increased, with the lowest point collected under

10 A being 29.657 bar. At 50 A, the lowest point collected was only 29.778 bar. The increased flow rate of gas recovers the lost pressure from the drain event more rapidly, keeping the pressure higher than at the low flow rates.

The results above highlight the pressure losses under regular operation at various currents when the drain valve is calibrated using the manual. The AEPR is capable of maintaining 30 bar within a 0.5 bar threshold with continuous water management. The drain can be adjusted depending on expected currents and flow rates to get a desired drain rate frequency and impact on pressure. Closing the drain too tightly may lead to a buildup of water in the tank, which will eventually cause a high-pressure alarm and depressurize the system.