

FuelCell Addendum - Back Pressure Controls

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Introduction

This addendum describes the back pressure control implementation if FuelCell Version 4.1a and later.

The FuelCell software should be installed and the system tested without pressure support prior to enabling pressure support.

The pressure PID controllers and backpressure regulators should be thoroughly tested separate from the software (directly from the PID controller) before attempting control through software.

Controller Configuration

Two LOVE CONTROLS Series 32A controllers must be used (one each for Anode and Cathode Pressure). The controllers must have output type 5 (0-20mA). A 250 ohm resistor may be used to convert this output to 0-5 V.

The controllers are operated in Manual Mode. The Manual Mode set-point is a 0 – 100% value which corresponds to a 0-20mA or 0-5V output of the control signal.

The following Secure Menu settings in the controller must be adjusted:

InP: VoLt
Unit: nonE
dPt: 0.0
SCAL: 0
SCAH: maximum pressure / 2
SCAH: 10 (for 5 PSI or 5 kPA maximum controller)
SCAH: 20 (for 10 PSI or 10 kPA maximum controller)
SCAH: 50 (for 25 PSI or 25 kPA maximum controller)
SCAH: 100 (for 50 PSI or 50 kPA maximum controller)
SPL: 0
SPH: 100
S#Ot: Curr
S#OL: 0
S#OH: 100

Enabling Pressure Support

Pressure support is enabled by manually editing the fuelcell.ini file on the computer. At this time, it cannot be configured through the Instrument Configuration screens in the FuelCell program.

- Open the “fuelcell.ini” located in the C:\FuelCell\ directory file using Notepad.

- Add the EnablePressure=3 line to the end of the [System] section of the ini file as shown below. Note that other settings in the [System] section may differ from those shown below.

```
[System]
EnableAnodeGas=1
EnableAnodePurge=1
EnableAnodeTemp=1
EnableCathodeGas=1
EnableCathodePurge=1
EnableCathodeTemp=1
EnableCellTemp=1
EnablePressure=3
```

Select RS485 Addresses

Add the RS485 addresses of the pressure PID controllers to the [RS485] section of the ini file as shown below.

The AnodePressureAddress and CathodePressureAddress values must match the RS485 addresses of the controllers, and the baud rate of the controllers must match any existing controllers on the external RS485 cable.

Note: For 890C units, all addresses on the external RS485 cable must have an address greater than 10.

```
[RS485]
AnodeAddress=32
CathodeAddress=31
CellAddress=30
AnodePressureAddress=35
CathodePressureAddress=36
```

Pressure Controller Scaling

Create the [PressureInfo] section if it does not exist and add the settings as shown below.

```
[PressureInfo]
Use PressureUnits=0 for PSI pressure units.
Use PressureUnits=1 for kPa pressure units.
```

The AnodePressureScale and CathodePressureScale values are the full scale of the controllers in PSI or kPa.

The pressure controllers may be designed to accept a 0-20mA / 0-5V signal or 4-20mA / 1-5V signal.

Use Anode420=0 for 0-20mA / 0-5V signals

Use Anode420=1 for 4-20mA / 1-5V signals

Use Cathode420=0 for 0-20mA / 0-5V signals

Use Cathode420=1 for 4-20mA / 1-5V signals

By default, the FuelCell program will not accept pressures larger than 75 PSI or 500 kPa. To change the pressure limit, add a PressureLimits value.

```
[PressureInfo]
PressureUnits=1
AnodeDecimal=0
AnodePressureScale=345
AnodePressureOffset=0
Anode420=1
CathodeDecimal=0
CathodePressureScale=345
CathodePressureOffset=0
Cathode420=1
PressureLimits=300
```

- Save the changes and close the fuelcell.ini file.

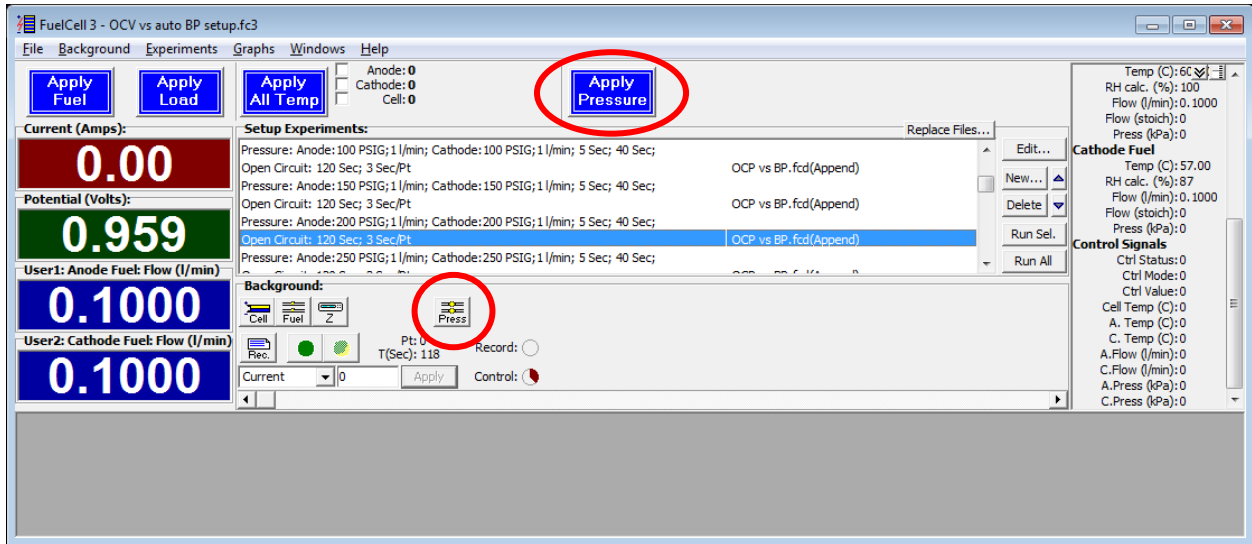
In the above example, pressure units are kPa, the full scale of the anode and cathode controllers is 345 kPa and the pressure limit is 300 kPa.

Pressure menus in FuelCell

The pressure settings in the FuelCell software are implemented in a similar fashion to the fuel flow settings. The user should familiarize themselves with the normal operation of the program before attempting pressurized control.

When starting the FuelCell program, the Setup Cell, Setup Fuel and Setup Pressure screens are displayed. The values entered in the Setup Pressure screen are **NOT** immediately applied. They are only applied when the Apply Pressure button is pressed from the main FuelCell screen. The Setup Pressure settings are described later in this addendum.

The following screen shot of the main FuelCell screen, showing the Setup Pressure and Apply Pressure buttons.



Background Settings

The Apply Pressure button is used to turn on the pressure. The system will always start in the Pressure Off condition. Note that changing the pressure set-point values will have no effect when the Pressure is Off. When pressure is On, a Stop Pressure button will replace the Apply Pressure button.



The Setup Pressure button is used to change the pressure set-points and alarm conditions. Changes will have an immediate effect if the pressure is On, but will have no effect if the pressure is Off.



Selecting the Setup Pressure button displays the following screen:

The **Anode** and **Cathode Pressure** set-points can be entered separately.

If the **Balance with Anode Pressure** box is checked, the Cathode pressure set-point cannot be independently set and will always match the Anode Pressure value.

The **Excess Flow** values allow the fuel flow to be boosted while the pressure is changing. Note that the flow values are not scaled by surface area or load based flows.

The **Excess Flows** are only applied when pressures are increased. If either pressure is increased, both excess flows are applied. The Excess Flows are not used when the pressure is decreased or switched Off by pressing the Stop Pressure button on the main FuelCell screen.

If **Apply Excess Flow during change** is selected, the flow will be increased by the specified amount. If **Apply Fixed Flow during change is selected** the specified total flow will be applied.

The Excess Flows may be applied for a specified time before the pressure change takes place. The **Pre-change Duration** controls this duration. Because the mass flow controllers may take some time to reflect the excess flow rate, a Pre-change duration of 2 or more seconds is recommended.

The **Post-change Excess Flow Duration** controls how long the excess flows are applied after the pressure set-point is changed. The post-change duration does not depend on the actual

pressure. User should experimentally determine for their test set-up – the combined fuel cell, gas handling system, condensate collection tanks, *etc.* – the time and excess flow rate required to pressurize their particular system.

Note: the pre-change and post-change duration are with respect to the when a new pressure set-point is sent to the controller and are independent of the actual system pressure.

Maximum Pressure controls the pressure alarm. If the measured pressure of the anode and cathode exceeds this value, the pressures will be removed and an alarm message will be displayed.

Maximum Differential Pressure controls the differential pressure alarm. If the measured pressure difference between anode and cathode exceeds this value, the pressures will be removed and an alarm message will be displayed.

Changing pressures from the Experiment List

A Setup Pressure experiment is available through the experiment list editor.

Select New... and choose the Change Pressure experiment type.

The same Setup Pressure window shown in the previous section is used to define the pressure state in an experiment list.

Note: The Change Pressure experiment can be used to change the pressure but cannot be used to turn on and off the pressure control. If the pressure is off on the main FuelCell screen, a pressure experiment will have no effect.

Changing Pressures with an Arbitrary Control Experiment

The pressures can be changed by an action line in an arbitrary control file. The pressure actions are described below, for more information on the operation of the Arbitrary Control experiment, consult the main FuelCell manual.

```
' Action = 27    set fuel pressure
' example      27    5 0.01  4      0.01  2      5      3      10    0      0
' set anode pressure to 5 psig
' set anode excess flow to 0.01 l/min during pressure change
' set cathode pressure to 4 psig
' set cathode excess flow to 0.01 l/min during pressure change
' apply excess flow for 2 seconds before changing the pressure values
' apply excess flow for 5 seconds after pressure change is completed
' alarm if the difference between anode and cathode pressures is over 3 psig
' alarm if either pressure exceeds 10 psig
```

```
' set anode excess flow method (0= add excess flow during change, 1= apply fixed flow during change)
' set cathode excess flow method (0= add excess flow during change, 1= apply fixed flow during change)
'
'
' Action = 33      turn off pressure
' example      33
' equivalent to clicking the Stop Pressure button on the main screen of FC3
```

Recording Pressure Data

The pressures are measured and updated approximately once per second and is displayed in the measured parameters list. In the Anode Fuel and Cathode Fuel sections, the Press (kPa) (or Press (PSI)) values reflect the measured pressures.

The A. Press and C. Press values in the Control Signals section reflect the Anode and Cathode pressure set-point values.

Items that are checked will be saved in the data file.

The Ctrl Status value reflects the combined state of the Apply Fuel, Apply Load and Apply Pressure buttons.

The status value is the sum of the values listed below:

```
Fuel On      = 1
Load On      = 2
Pressure On  = 4
```

