FuelCell Addendum – Configuring Water Pump and CH4 Gas for Internal Reforming

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Introduction

This addendum describes the use of a water pump linked to a natural gas / methane (CH_4) flow to provide the liquid water (H_2O) necessary to internally reform CH4 into usable fuel.

Before using this document, configure the CH_4 gas mass flow controller as described in the FuelCell Software Manual. In this addendum, it is assumed that the CH_4 gas is controlled the Reformate Simulator Signal #1.

Software Support

Requires FuelCell version 3.8d1 or later. The software version is displayed in the FuelCell program Help | About FuelCell… screen.

Hardware Support

Requires the 890C/CL/e/ZV Load Unit with Firmware version 3.17 or later. The firmware is displayed on the 890 LCD display screen during power up.

The water pump flow control uses signals normally reserved for Reformate Simulation. Contact your Gas Control Unit supplier or Scribner Associates for information on accessing the Reformate Mass Flow Controller signals.

Test the Liquid Pump

The liquid pump must be controllable with a 0-5 V signal. Consult your pump documentation to determine the following characteristics. Note that it is strongly suggested that the pump flow is tested using an independent 0-5 V signal (such as a high accuracy voltage supply) to confirm its scaling characteristics.

Maximum Flow: This is the flow rate in liters/minute achieved with a 5.000 volt control signal applied to the pump.

Offset Voltage: Assuming that the Flow vs. Voltage relationship is linear, this is the voltage where the flow is zero. For example, a pump may use a 0.25V to 5V signal to control flow rates between 0 and 0.1 liter/minute. The Offset Voltage is 0.25 V.

Minimum Voltage: Some pumps will stall with small control signals and cannot be used below a certain control voltage. For example, a pump may be scaled based on a 0.25 V to 5 V, but is not usable below 0.3 V. When a very small flow rate is requested, the Minimum Voltage will be applied to assure that the pump does not stall. The flow rate will not be accurate under these conditions.

Pump Channel: The pump control signal comes from the Internal Reformate control signals from the 890C/CL or 850C FuelCell Load instrument. Consult your FuelCell Hardware manual for information about these signal connectors. They are typically located on the *Fuel System Interface* connector. The pump may use any of the Reform Channels (1-5) that are not being used for other gas controls. Note that the Internal Reformate signals must be used. Signals from an external 891 Reformate Simulator cannot be used to control a pump.

Gas Follower: The pump can be configured to automatically follow a gas signal so that as a gas flow increases, the pump flow increases proportionally. Typically the pump will be configured to follow the Reformate channel containing CH4. If CH4 is configured as Reformate gas #1 as described in the document *FuelCell 3 Addendum – Multi Range Reformate Flow Controllers*, this value will be "1".

-1=follow the total flow of all anode gases
0=follow the Main gas (typically H2)
1=follow the gas configured as Reformate gas #1.
2=follow the gas configured as Reformate gas #2.
…

Gas Follower Stoich: This value is the theoretical amount of water necessary to completely reform CH4. This value is the cc of H2O necessary to reform 1 cc of CH4 (at STP). A value of 0.0008 is typical.

Configure the FuelCell Software

Using the Windows file explorer, go to *C:\FuelCell* and double-click on the file "fuelcell.ini" to open it in Notepad.

1) Add the EnableAnodePump=1 line to the [System] section as shown below. The other parameters in this section may be different than those shown.

```
[System]
EnableAnodeGas=3
EnableAnodePurge=1
EnableAnodeTemp=1
EnableCathodeGas=3
EnableCathodePurge=1
EnableCathodeTemp=1
EnableCathodeBurp=0
EnableCellTemp=1
EnableAnodePump=1
```

2) Add the ScalePumpAnode, ScalePumpAnodeOffsetV, ScalePumpAnodeMinV, and ScalePumpAnodeChannel values to the [ScaleInfo] section as shown below.

ScalePumpAnode= **Maximum Flow** value determined in the *Testing the Liquid Pump* section above.
ScalePumpOffsetV= **Offset Voltage** determined in the *Testing the Liquid Pump* section above.
ScalePumpMinimumV= **Minimum Voltage** determined in the *Testing the Liquid Pump* section above.
ScalePumpAnodeChannel= **Pump Channel** Internal Reformate signal channel determined in the *Testing the Liquid Pump* section above.

```
[ScaleInfo]
ScalePumpAnode=1
ScalePumpAnodeOffsetV=0.25
ScalePumpAnodeMinV=0.3
ScalePumpAnodeChannel=5
```

3) Add all of the lines shown below to the [PumpInfo] section.

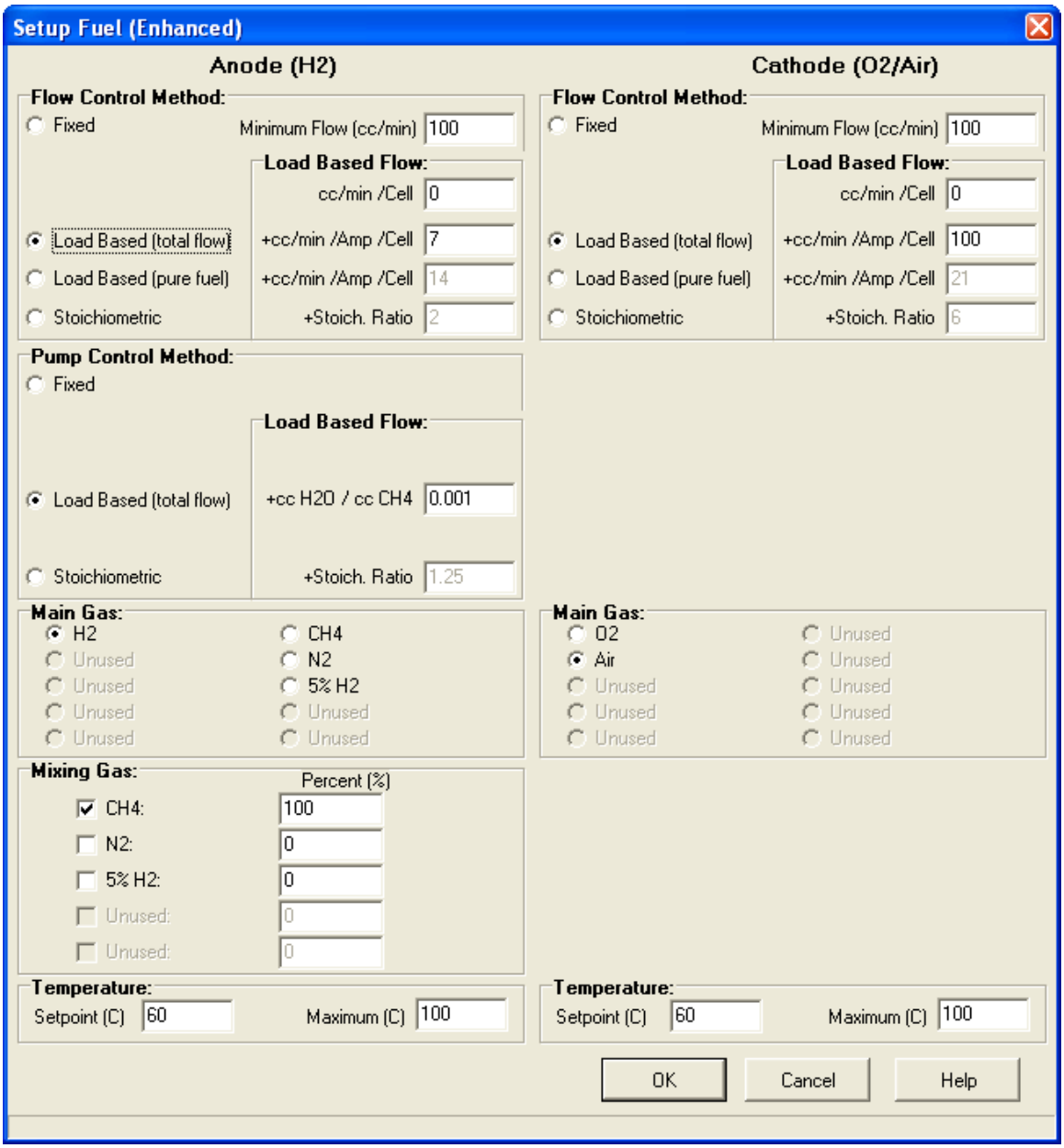
AnodeStoichType=2 configures the pump to follow a gas flow.
AnodeStoichGas= **Gas Follower** determined in the *Testing the Liquid Pump* section above.
AnodeStoich= **Gas Follower Stoich** determined in the *Testing the Liquid Pump* section above.
AnodePureFraction= always use a value of 1.
AnodeUnits=1 to display flow in liters/minute, 1000 to display flow in cc/minute
AnodeDisplay=1 will display the measured pump flow. This only applies if a "MFC" type pump is used, where the device provides a readback signal. Most traditional pumps do not provide a readback signal and would provide random values.

```
[PumpInfo]
AnodeStoichType=2
AnodeStoichGas=1
AnodeStoich=0.0008
AnodePureFraction=1
AnodeUnits=1000
AnodeDisplay=1
```

Save and close the modified fuelcell.ini file.

Operation of Water Pump

Start the FuelCell program. The Setup Fuel screen will appear similar to that shown below.



1) Under the Mixing Gas section, the gas is set to 100% CH4. The Load Based (total flow) is set to 7 cc/min/Amp/Cell. This means that for every Amp of current, 7 cc/minute of CH4 will be provided.

The Load Based (pure fuel) is the H2 equivalent of the CH4. Since CH4 donates twice the number of electrons as H2, 7 cc of CH4 is equivalent to 14 cc of H2.
Theoretically 3.5 cc/min of CH4 (or 7 cc/min of H2) are necessary to produce 1 Amp, so the Fuel Stoichiometric Ratio is 2 (twice as much fuel is provides as is necessary).

2) In the Pump Control section, the Load Based (total flow) is set to 0.001 cc H20 per cc CH4.

Theoretically, 0.0008 cc of H_20 is necessary to fully reform CH_4, so we have 0.001/0.0008 = 1.25 times as much water as necessary and the displayed Water Stoichiometric Ration is 1.25.