

**STANDARD OPERATING PROCEDURE  
STAN MAYFIELD BIOREFINERY PILOT PLANT**

**TITLE:** Phosphoric Acid System

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**APPROVALS:** Process Change Committee

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**A. Scope**

This SOP describes the procedure to operate the Phosphoric Acid System in order to provide phosphoric acid for biomass pretreatment and pH adjustment during fermentation/propagation.

**B. Safety and Training Requirements**

Refer to UF lab safety policies regarding equipment listed in section D below before starting any process work.

Review the location of fire extinguishers, fire blankets, safety showers, spill cleanup equipment and protective gear before beginning any process work.

**CAUTION:** Appropriate personal protective equipment has to be worn at all times when dealing with concentrated acid.

During operations in the plant, the following safety gear will be utilized at all times:

- Chemical Resistant Apron (when handling concentrated acid)
- Safety Goggles or Face Shield
- Protective Gloves
- Hard Hat

**C. Related Documents and SOPs**

1. ~~Acid Weigh Scale manual XXXX~~
2. ~~Acidic Transfer Pump manual XXXX~~
3. ~~Phosphoric Acid Metering Pump manual XXXX~~
4. ~~Phosphoric Acid Metering Pump 1 manual XXXX~~
5. ~~Phosphoric Acid Metering Pump 2 manual XXXX~~
6. ~~Phosphoric Acid Mix Tank Agitator manual XXXX~~
7. ~~Phosphoric Acid Transfer Pump manual XXXX~~
8. ~~Phosphoric Acid Hold Tank Agitator manual XXXX~~
9. Air Supply System Operation SOP-9405
10. Process Water System Operation SOP-9505
11. ~~Biomass Pretreatment SOP 2110~~
12. ~~Fermentation Tank A SOP 3230~~
13. ~~Fermentation Tank B SOP 3235~~

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- ~~14. Fermentation Tank C SOP 3240~~
- ~~15. Primary Propagator 2A SOP 3210~~
- ~~16. Primary Propagator 2B SOP 3215~~
- ~~17. Secondary Propagator 3A SOP 3220~~
- ~~18. Secondary Propagator 3B SOP 3225~~
19. Sampling SOP-0511
20. Phosphoric Acid Measurement SOP-0501
21. 85% Phosphoric Acid MSDS
22. Experimental Plan

**D. Preparation/Materials/Equipment**

1. Concentrated Phosphoric Acid (85% w/w)
2. Acid Weigh Scale (WS-8301)
3. Acidic Transfer Pump (PA-8301)
4. Sample Containers

The other pumps like  
Conc. Phosphoric Acid  
Metering pump,  
Phosphoric acid  
metering pump 1 and  
2 should be added

**E. Detailed Procedure**

1. Initial valve positions settings are given in the table below.

Phosphoric Acid System				
Line	Line Number	Valve	Position	Check
<del>Air to Acidic Transfer Pump</del>	<del>AP-8301-07-CS95</del>	<del>8301-V-01</del>	<del>Close</del>	
		<del>8301-V-02</del>	<del>Close</del>	
<del>Refill Station to Phosphoric Acid Tote</del>	<del>PHOC-8301-01-SS97</del>	<del>8101-V-01</del>	<del>Close</del>	
		<del>8301-V-03</del>	<del>Close</del>	
<del>Drain</del>		<del>8301-V-05</del>	<del>Close</del>	
Phosphoric Acid Tote to Phosphoric Acid Metering Pump	PHOC-8101-01-SS97	8101-V-02	Close	
Phosphoric Acid Metering Pump to Phosphoric Acid Mix Tank	PHOC-8101-02-SS97	8101-V-05	Close	
	Pressure Indicator	8101-V-06	Open	
Process Water to Phosphoric Acid Mix Tank	RCW-9501-06-SS10	8101-V-07	Close	
H <sub>3</sub> PO <sub>4</sub> to Phosphoric Acid Transfer Pump	PHOD-8101-03-SS97	8101-V-10	Close	

2 extra back pressure  
valves before V-05  
should be closed

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Phosphoric Acid System				
Line	Line Number	Valve	Position	Check
Air to Phosphoric Acid Transfer Pump	AP-8101-08-CS95	8101-V-11	Close	
		8101-V-12	Close	
H <sub>3</sub> PO <sub>4</sub> to Phosphoric Acid Hold Tank	PHOD-8101-07-SS97	8101-V-14	Close	
		8102-V-01	Close	Open (very high)
		Pressure Indicator	8101-V-08	Open
Drain (phosphoric acid tote)		8101-V-03	Close	
Drain (phosphoric acid mix tank)		8101-V-09	Close	
H <sub>3</sub> PO <sub>4</sub> to Phosphoric Acid Metering Pump 1 and 2	PHOD-8102-03-SS97	8102-V-02	Close	
H <sub>3</sub> PO <sub>4</sub> to Downstream Process	PHOD-8102-04-SS97	8102-V-04	Close	
to Propagator 2A	PHOD-8102-06-SS97	8102-V-05	Close	
to Fermenter A	PHOD-8102-09-SS97	8102-V-06	Close	
to Propagator 3A	PHOD-8102-07-SS97	8102-V-07	Close	
to Propagator 2B	PHOD-8102-13-SS97	8102-V-08	Close	
to Fermenter B	PHOD-8102-10-SS97	8102-V-09	Close	
to Propagator 3B	PHOD-8102-08-SS97	8102-V-10	Close	
to Fermenter C	PHOD-8102-11-SS97	8102-V-11	Close	
<del>to Propagator 1A</del>	<del>PHOD-8102-05-SS97</del>	<del>8102-V-12</del>	Close	
<del>to Propagator 1B</del>	<del>PHOD-8102-12-SS97</del>	<del>8102-V-13</del>	Close	
to Hydrolyzer	PHOD-8102-15-SS97	8102-V-14	Close	
		8102-V-15	Close	

One extra drain valve must be closed before and after V-02

V-12 and V-13 should not say to propagator 1A and 1B if they don't exist

- Assure the Phosphoric Acid Tote contains sufficient phosphoric acid. How much??
- If needed, refill the Phosphoric Acid Tote.

Place the acid drum containing 85% phosphoric acid on the Acid Weigh Scale (WS-8301).

**CATION:** Make sure you are wearing the appropriate PPE according to the concentrated acid solution MSDS.

(HC-8301-09) to the hose FH 8301-01, then connect the...

- Connect the acid drum (hose FH-8301-01) to the Acidic Transfer Pump (PA-8301) and connect hose (FH-8301-02) from the Acidic Transfer Pump (PA-8301) to the phosphoric acid supply line (HC-8301-05).

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**TITLE:** Phosphoric Acid System, connect the hose FH-8101-01 to the lines HC-8101-07 and HC-8101-08 and open the

- b. Open valve 8301-V-03 and valve 8101-V-01 to open the line connecting from the acid drum to the Phosphoric Acid Tote.
  - c. Assure the air supply is ready according to the Air Supply System Operation SOP-9405.
  - d. Make sure that the pressure on PRV-8301-01 is set at (to be determined).
  - e. Open valves 8301-V-01, -02 to let the air flow into the Acidic Transfer Pump and start refilling the Phosphoric Acid Tote. (CHECK AFTER PLUMBING IS COMPLETE)
  - f. Monitor the level of the Phosphoric Acid Tote to make sure it does not overflow during refilling.
  - g. At HMI, monitor the weight change in WI-8301-01 during the refilling.
4. Make sure the Phosphoric Acid Tote is connected to the Phosphoric Acid Metering Pump (PM-8101).
5. Open valve 8101-V-02 to open the connecting line.
6. Assure process water is ready according to the Process Water System Operation SOP-9505.
7. Open valve 8101-V-7 to open the process water line to the Phosphoric Acid Mix Tank (TS-8101).
8. There are three methods that can be used in order to prepare the phosphoric acid solution to be used during pretreatment and for pH control during propagation and fermentation.
  - a. Flow control and / or
    - i. Set the ratio of 85% phosphoric acid to water in FY-8101-04 according to the experimental plan.
    - ii. Open valve 8101 V 05 to open the line to the Phosphoric Acid Mix Tank (TS-8101).
    - iii. Open valve 9501 V 25 to allow process water to start filling the Phosphoric Acid Mix Tank (TS 8101).
      1. The concentrated phosphoric acid will start to flow automatically to the set ratio as soon as the process water starts to flow.
    - iv. Monitor the flow of water and concentrated phosphoric acid using FIC-8101-01 and FIC-8101-04 respectively to make sure the phosphoric acid to water ratio is correct. on the HMI
    - v. After the level of the tank is higher than 15% in LI 8101-06, turn on the agitator (AG-8101) on the HMI. on the HMI
    - vi. Monitor the tank level using LI 8101-06 and once the tank is full close valve 8101-V-07 to stop the flow of process water and phosphoric acid into tank.
    - vii. Close valve 8101 V 05 to ensure that acid is not pumped into the tank accidentally.

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b. Conductivity control

- i. ~~Open valve 9501-V-25 to allow process water to start filling the Phosphoric Acid Mix Tank (TS-8101).~~
- ii. Monitor the water level using LI-8101-06, and once the tank is 75% full, close valve 8101-V-07 to stop the water flow.
- iii. Turn on the agitator (AG-8101) on the HMI.
- iv. ~~Open valve 8101-V-05 to open the line to the Phosphoric Acid Mix Tank (TS-8101).~~
- v. Turn on the Concentrated Phosphoric Acid Metering Pump (PM-8101) to start the addition of concentrated phosphoric acid into the tank.
- vi. On the HMI, monitor the acid concentration using the conductivity meter CI-8101-05.
- vii. Once the conductivity has reached the value stated in the experimental plan, turn off the Concentrated Phosphoric Acid Metering Pump (PM-8101) ~~and close valve 8101-V-05.~~

c. Weight Control

- i. 85% (w/w) phosphoric acid is diluted with water in the Phosphoric Acid Mix Tank (TS-8101) to produce the desired concentration of phosphoric acid according to the experimental plan. The table below specifies the amount of 85% (w/w)  $H_3PO_4$  and water needed to make different concentrations of phosphoric acid solution. **in a total of 6700 pounds**

Final Concentration (weight %)	85% $H_3PO_4$ (lb)	Water (lb)
2%	158	6542
3%	236	6464
4%	315	6385
5%	394	6306

- ii. ~~Open valve 9501-V-25 to allow process water to start filling the Phosphoric Acid Mix Tank (TS-8101).~~
- iii. Monitor the weight using WI-8101-08, and once the weight of water added has reached the desired value according to the table in step E.8.c.i, close valve 8101-V-07 to stop the water flow.
- iv. Turn on the agitator (AG-8101) on the HMI.

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- v. ~~Open valve 8101 V 05 to open the line to the Phosphoric Acid Mix Tank (TS-8101).~~
    - vi. Turn on the Concentrated Phosphoric Acid Metering Pump (PM-8101) to start the addition of concentrated phosphoric acid into the tank.
    - vii. Monitor the weight using WI-8101-08, and once the weight of acid added has reached the desired value according to the table in step E.8.c.i, turn off Acid Metering Pump PM-8101 to stop the acid flow.
  9. ~~Close valve 8101 V 05.~~ Open valves 8101 V 10, 14 once the Phosphoric Acid Mix Tank (TS-8101) contains the desired concentration of phosphoric acid according to the experimental plan. **Make sure the hoses FH-8101-02 and FH-8101-03 are connected**
  10. Assure the air supply is ready according to the Air Supply System Operation SOP-9405.
  11. ~~Open valve 8102 V 01 on the top of the Phosphoric Acid Hold Tank (TS-8102).~~
  12. ~~Open valves 8101 V 11, 12 to~~ turn on the Phosphoric Acid Transfer Pump (PA-8102) and start transferring the dilute phosphoric acid solution from the Phosphoric Acid Mix Tank (TS-8101) to the Dilute Phosphoric Acid Hold Tank (TS-8102).
  13. At HMI, monitor the Dilute Phosphoric Acid Hold Tank level in LI -8102-02.
  14. At HMI, turn on Dilute Phosphoric Acid Hold Tank Agitator (AG-8102) once the level of the tank is higher than 15%.
  15. To supply dilute phosphoric acid for pretreatment;
    - a. ~~Open valve 8102 V 02.~~
    - b. At the HMI, turn on the Dilute Phosphoric Acid Metering Pump 2 (PM-8104).
    - c. The phosphoric acid system is ready for pretreatment.
  16. To supply dilute phosphoric acid for pH control;
    - a. ~~Open valves 8102 V 02, 04 to open the main supply line.~~
    - b. Make sure that PRV-8103-03 is set to 15 PSI.
    - c. At the HMI, start the Dilute Phosphoric Acid Metering Pump 1 (PM-8103).
    - d. The phosphoric acid system for pH control is ready for use.
  17. Monitor the tank level using LI-8102-02.
    - a. If the level of the tank drops below 20%, refill the tank with fresh solution prepared in the Phosphoric Acid Mix Tank (TS-8101) in step E.8.
    - b. **If the level is higher than 85 % turn off the phosphoric acid transfer pump (PA-8102).**

**Make sure the  
hose FH-8102-01  
is connected and**