



# Best Practices Ultrafilter Machines

Spiral UF Elements  
[www.ufsc.com](http://www.ufsc.com)



# Ultrafilter Systems Performance

- What impacts permeate the most?
  - Paint bath chemistry?
  - Paint bath flow rate through UF element?
  - Pressure drop across paint bath inlet to outlet manifold?
  - Ultrafilter element membrane material?
  - Paint bath temperature?



# Ultrafilter Basic Principles

- Paint Flow Rate Through UF Element
  - Permeate increases with flow then drops
- Pressure Drop Across Membrane
  - Permeate increases with  $\Delta P$  then drops
- Paint Bath Temperature
  - Permeate increases with drop in viscosity
- Fouling caused by increasing gel layer



# $\Delta P$ Across Paint Inlet & Outlet Manifolds

- Too high
  - Make sure inlet valve is 100% open
  - Too much flow? Is a bypass closed?
  - Throttle close the paint outlet manifold valve to get the desired pressure
  - Minimum  $\Delta P$  in most cases is 20 – 25 psi
- Too low
  - Resolve pump or piping (i.e. blockage) issues
- Zero == No paint bath flow!
  - Pump flow dead headed downstream from UF unit
  - Immediately open downstream valve preventing paint flow
- Pressure gauges must have guards installed and tested by a gauge house.



# Low Permeate Contributors

- Is lip seal turned up?
- Is membrane fouled?
- Is paint flow low?
- Is permeate rate below 70% of baseline?



# UF Membrane

- Most UF membranes use a PDVF polymer
  - UF membrane is created by casting a thin layer polymer over a paper substrate.
  - Pore size distribution is affected by materials of use and manufacturing techniques
- Manufacturing defects
  - Seam sealing
  - Permeate tube to membrane sealing
  - Occasional membrane formula errors
- Membrane defects rarely from
  - Paint temperature
  - Paint chemistry
- Use UF Element vendor who gives you best technical service and system advice



# Paint Pumps

- Limit tip speed to 100 ft/second to avoid paint shear which may create paint fragments that can increase gel formation on the UF membrane
- Use soft starts (or VFD) to avoid water hammer on un-attended re-starts, allow 3 - 5 minutes for full pump rpm
- Consider reducing UF paint return piping size to provide necessary back pressure
- Eliminate entrained/trapped air in the paint



# Maintain Proper Paint Flow Rate

- Low paint flow is most common cause of low permeate
  - Magnetic flow meter will save time and money in diagnosis
  - Check pump condition
    - Check actual discharge pressure vs. pump curve
    - Use clamp-on ammeter to check motor currents
  - Check for closed or throttled valves
  - Are valve handles mounted incorrectly?
  - Check for blockage in piping including UF prefilters
- High paint flow may cause
  - Membrane leaves to open and block paint flow through element
  - Lead to increased  $\Delta P$  & plugging of pore openings
- Never stop flow of paint to the UF unless you are willing to flush all Elements as part of a normal shutdown.



# Record Process Variables

- UF Element
  - Daily permeate rates
- UF Machine
  - Inlet and outlet paint manifold pressures
  - Paint flow
  - Temperature
- E-coat Paint
  - Per paint vendor recommendations



# Normal Valve Positions

- All UF Module isolations valves are Open
- Inlet paint manifold valve is Open
- Outlet paint manifold valve is Throttled
- Permeate Valves are always Open & not Throttled



# Normal Pressures

- Paint outlet manifold is  $\frac{3}{4}$  - 1 Bar (10 -15 psi)
- $\Delta P$  is 1.4 – 1.7 Bar (20 – 25 psi) minimum
- Permeate pressure < 60% of paint outlet manifold pressure



# Paint Pre-filtration

- Use duplex bag filter system
- Change bags at  $\Delta P$  of  $\frac{1}{2}$  Bar (5 – 7 psi), or 2% - 3% restriction of flow with magnetic paint flow meter
- Use only glazed or sintered polypropylene filter bags with a plastic snap ring.
- Avoid dead legs in the piping design
- 10 - 25 micron size is recommended for every filter vessel on E-coat paint



# Monthly Permeate Flushing

- Permeate flush and weekend soak 1 UF Element/week each month
  - Reduces gel coat build up
  - Postpones & helps eliminate need for chemical cleaning
  - Saves purchase of chemical cleaners and disposal costs
  - Decreases chance of chemical cleaners entering paint bath
  - Eliminates labor associated with cleaning
- When flux rate reaches 80% of baseline rate chemically clean UF elements according to UF element manufacturer instructions.



# Chemically Cleaning

- Was there a particular contaminate found in the paint?
- Work with paint vendor to use appropriate materials to clean the suspected foulant



# Paint Temperature

- Paint temperature affects permeate production
  - Lower temperature reduces permeate rate
  - Higher temperature increases permeate rates
  - High paint bath temperature can cause paint solids to precipitate and clog UF membrane channels
- Keep record of paint bath temperature
- Keep heat exchanger, temperature sensors, and source of cool water in good repair



# Replenishment Paint

- Use static mixer
- Add opposite of UF feed intake
- Keep %NV steady through-out the day
- Use an amp hour paint feeder



# Starting and Stopping Paint Flow

- Starting Paint Flow - If there is no paint flow
  - Open permeate before other valves
  - Open paint manifold outlet valve, always have a route for paint to flow
  - Slowly Open paint inlet manifold valve last
- Stopping Paint Flow - If there is paint flow
  - Close paint manifold inlet valve first in a quick smooth turn
  - Quickly Close paint manifold outlet valve in the same fashion
  - Close permeate valve last (never any back pressure)



# When Bad Things Happen

- If there is paint in the permeate – close off permeate valve and keep paint flowing until there is a replacement
- Take pictures and log events that can help determine root causes of short UF life



# Best Practices, Summary

- Install magnetic flow meter on UF paint feed
- Use only permeate, or buffered DI/RO water for UF Element flushing
- Permeate flush UF elements 1x per month
- Maintain steady: paint %NV, paint pH, and temperature
- Install Amp-hr paint feeder for steady % NV in paint bath and more even replenish additions
- Operate valves in proper sequence
- Never back pressure UF membrane