



Best Practices Ultrafilter Machines

Spiral UF Elements
www.ufsc.com



Ultrafilter System Performance

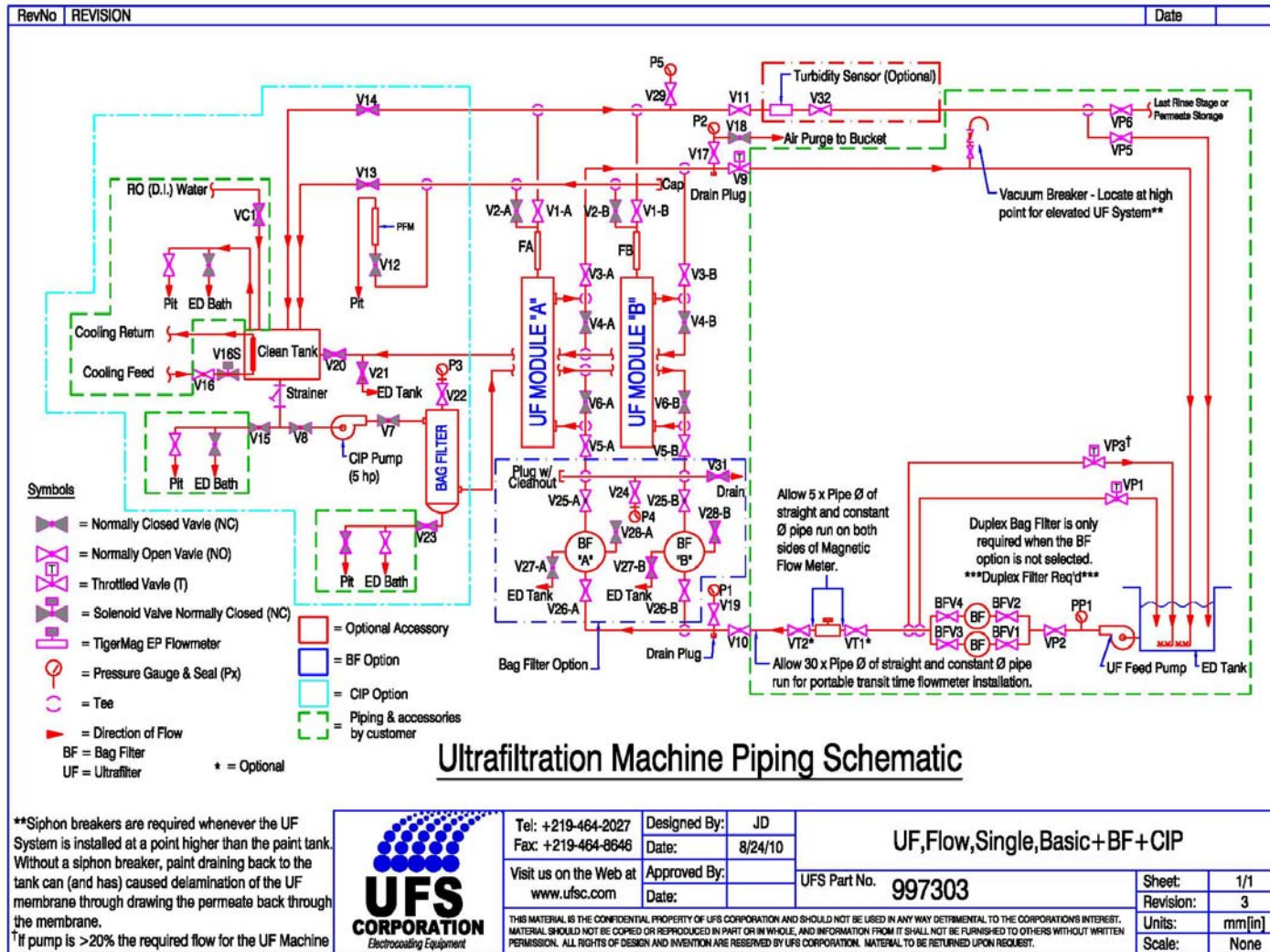
- What do you think impacts permeate production the most often?
 - Paint bath chemistry?
 - Paint bath flow rate through UF element?
 - Pressure drop across paint bath inlet to outlet manifold?
 - Ultrafilter element membrane material?
 - Paint bath temperature?



Answer

- In many cases the reason for low permeate production is low paint feed flow to the UF Element.

TruFlux Paint Schematic





Ultrafilter Basic Principles

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



ΔP 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 ΔP 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 in the Permeate

- Paint solids should not be able to pass into the permeate since its size is much larger than the UF pore size.
- So how does paint get into the permeate?
 - Poor O-ring in the permeate adapter
 - Glue seam manufacturing defect
 - Membrane de-lamination caused by siphoning
 - Hydraulic shock from aggressive re-start of paint feed pump.



How to drain paint from UF

- When the UF is to be turned off, the paint needs to be removed from the UF system.
- Best practice is to use DI water and push out all of the paint, then pack the UF Elements in DI water. Change the water every 7 days or sooner.



Loss of Power

- When power is lost, the UF Feed pump stops and the paint begins to drain back to the E-coat tank (if above).
- A siphon breaker will stop the harmful siphoning
- This siphoning (of the paint) can create tears in the fragile and show up as paint in the permeate.



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 ΔP & 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)
- ΔP 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 ΔP 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 tapered manifolds to keep paint flow between 8 and 12 ft/sec. Use Long sweep elbows to avoid abrupt direction changes
- Use only permeate, or buffered DI/RO water for UF Element flushing, Permeate flush UF elements 1x per month
- Chemical clean when at 80% of baseline
- Maintain steady: paint %NV, paint pH, and temperature
- Use bag filters with plastic snap rings to prevent blow-by
- Install Amp-hr paint feeder for steady % NV in paint bath and more even replenish additions
- Operate UF paint & permeate valves in proper sequence label/color code each valve
- Use an Operators Checklist located on the UF machine for training and standardization of operation under different scenarios
- Never back pressure UF membrane