UF SYSTEM DESIGN, PROCESS CONTROLS & OPERATION

27 MAY 2016

SEMINAR ON X-FLOW ULTRAFILTRATION MEMBRANES - ISTANBUL

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UF DESIGN

WATER QUALITY REQUIREMENTS:

Turbidity (NTU)
Total Suspended Solids (mg/l)

Total Organic Carbon (mg/l C)
Chemical Oxygen Demand (mg/l O2)

Total Alkalinity (CaCO3)
Total Dissolved Solids (mg/l)
Total Hardness (mg/l CaCO3)
pH
Temperature (degC)

DESIGN FOR WORST CASE SCENARIO

UF DESIGN

PLANT CAPACITY vs WATER QUALITY

- DESIGN FOR WORST CASE SCENARIO
- 95%ile condition
- Turn down or less capacity during fluctuations

UF DESIGN

WATER QUALITY RESTRICTIONS:

Heavy metals such as Fe, Mn, Al < 0.1 mg/l
Phosphorus <1 mg/l
Ammonia <1 mg/l
Scaling potential <0.5

Oil & grease < 1 mg/l

(For Surface water & Seawater applications)
Chlorophyll < 1 mg/m3
Algae cell counts< 50,000 cells/liter
(high algae results is TEP – [Transparent Exopolymer Particles])

Free Chlorine<0.5 mg/l

UF DESIGN

REDUNDANCY

- Spare modules (future expansion or to handle worst case scenario)

Or

- Stand-by unit (maintenance)

- Main equipment (Feed/BW pumps, coagulant and CEB dosing pumps)

- DUTY + STANDBY

- CIP system for recovery cleaning

UF DESIGN

pH correction

LSI<0.5 to avoid scaling potential

Inline coagulation

Feed water coagulation might be required to enhance filtration, facilitate removal of solids and organics and consequently improve overall operation.

Dosing a minimum amount of inorganic coagulant will increase porosity and backwashability of the fouling layer on the membranes.

The coagulation philosophy is to create “pinflocs”, i.e. flocs of limited size. On the one hand these pinflocs have sufficient size to be retained by the UF membranes and to create a relatively open cake structure on the membrane surface.

UF DESIGN

UF Pre-screening

Strainer of 300 or 100 micron (for direct seawater intake)

With regard to strainer construction, the use of any material which could lead to membrane damage in case of strainer disintegration (e.g. stainless steel wire mesh material) must be avoided. The use of “wedge wire” type strainers (or similar), drum filters or disc filters is advised

Backwash pump strainer

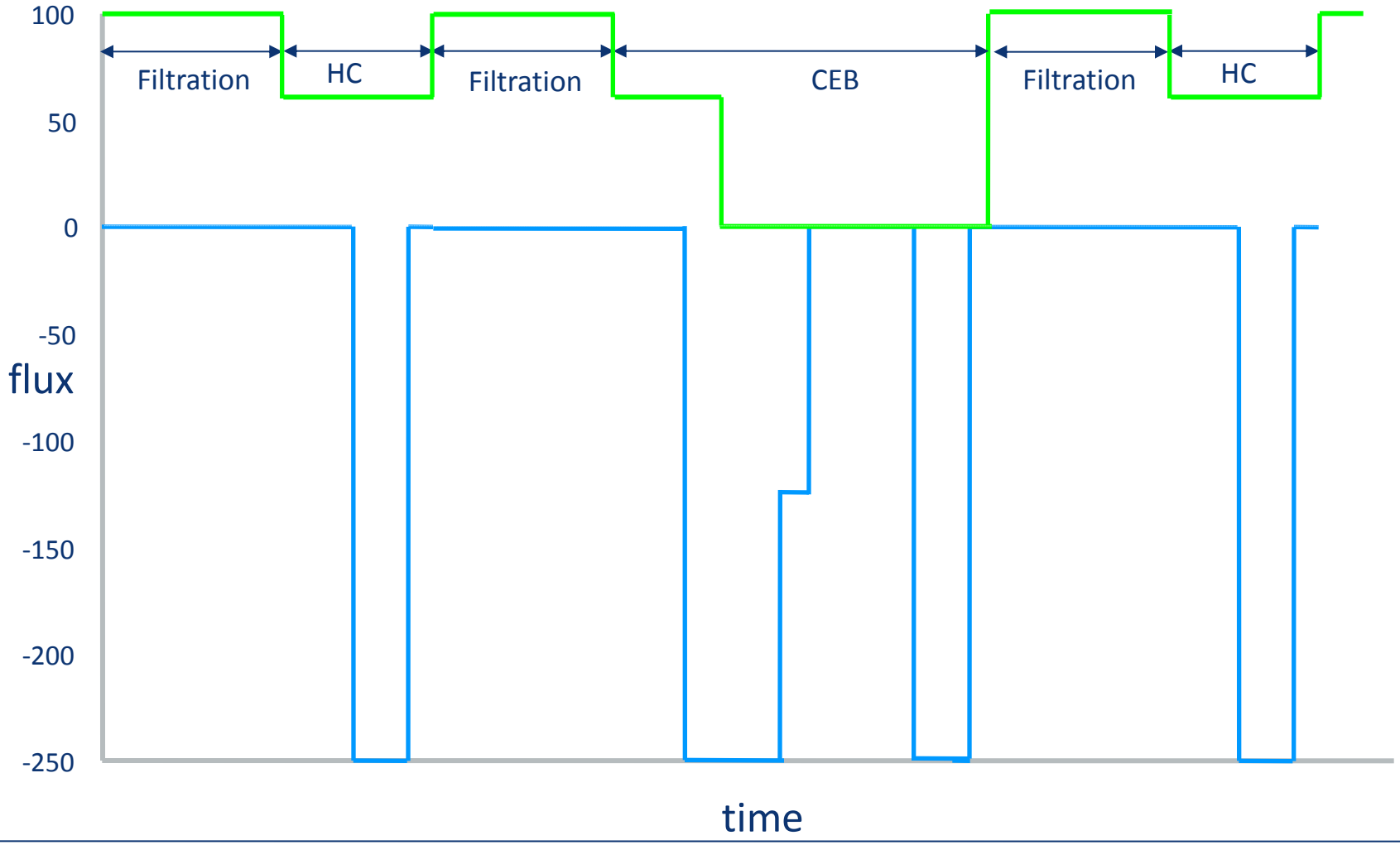
A protective 2 mm

UF Backwash tank

- **Offline BW tank – only to perform UF backwash/CEB**
- **Combined permeate & backwash tank – to perform UF backwash/CEB and continuous flow to downstream process.**

UF PROCESS CONTROLS

Fully automated process - Filtration ⇔ Backwash ⇔ CEB



UF PROCESS CONTROLS

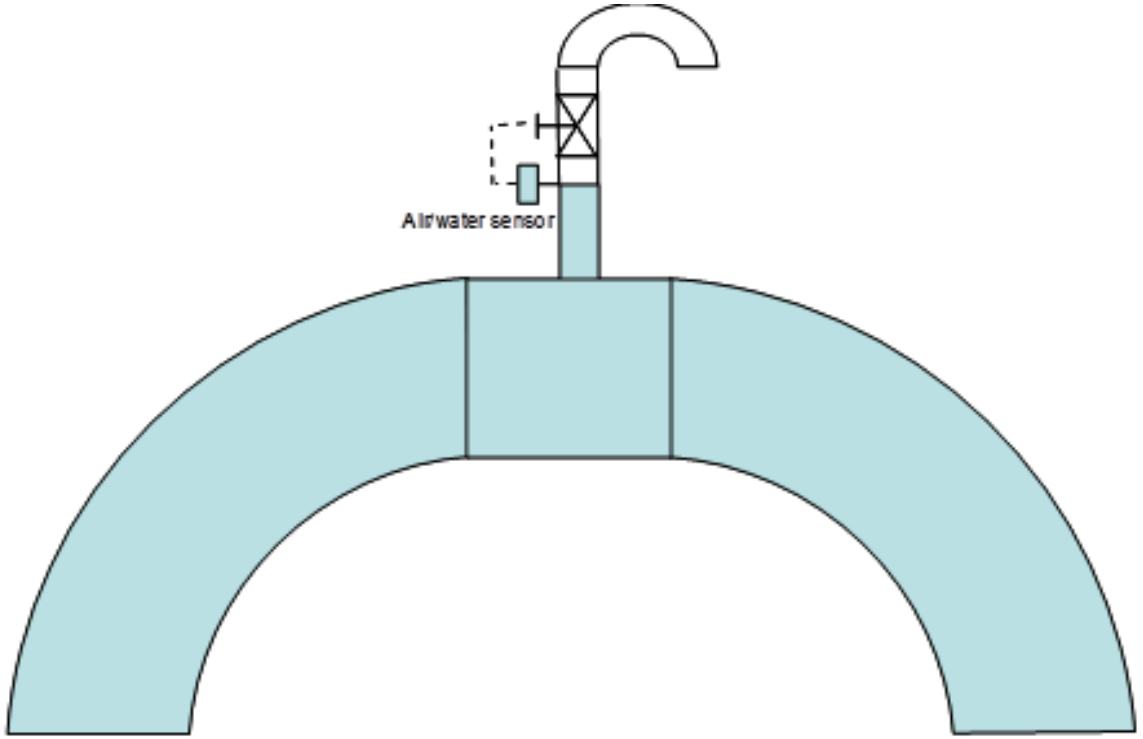
Automatic valve selection

- Pneumatic double acting with limit switches.
- Attention to be paid to actuator sizing/air.

UF PROCESS CONTROLS

Air venting

Air venting equipment should be mounted on the highest point of the lines supplying water to the UF (UF feed and UF backwash line), especially those points before entering the UF unit(s), e.g. the central feed line before going to the individual UF units.

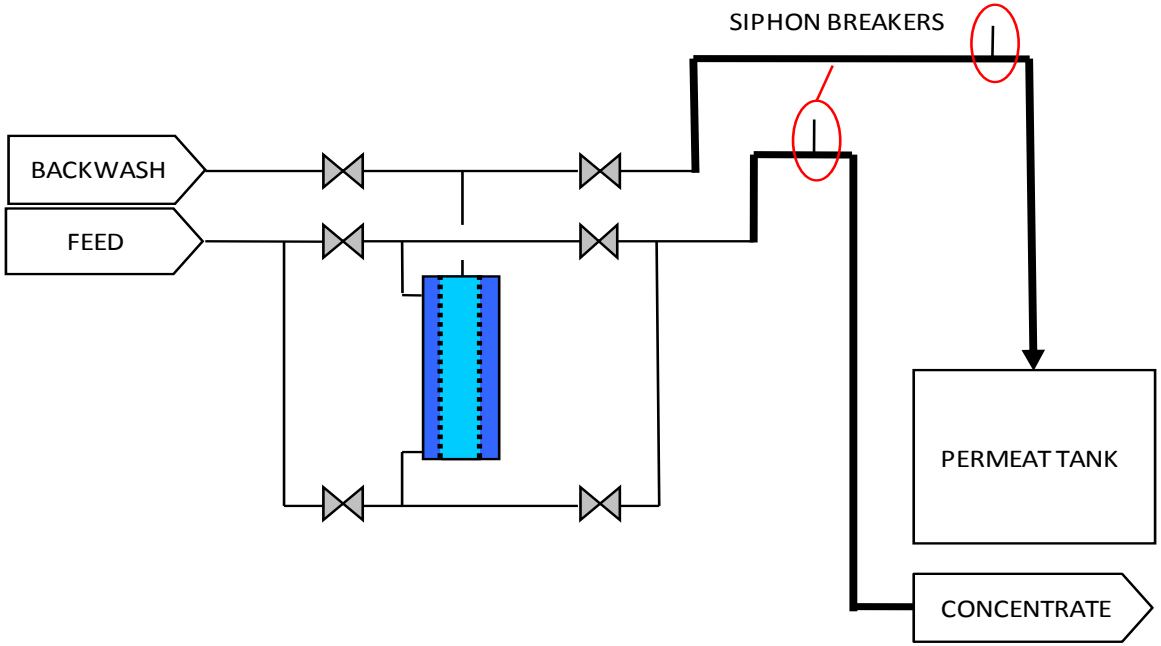


UF PROCESS CONTROLS

Siphon breakers

Siphon breakers must be used preventing negative pressures in the UF skid to avoid any potential damage to the UF membranes, no negative pressures are allowed at either feed, permeate, backwash or concentrate side of the UF units during both dynamic and static operation.

It is recommended having an open pipe at the highest point with a diameter of about ¼ of the main pipe (rule of thumb) and mount this pipe on a horizontal piece of the line (see sketches below).



UF PROCESS CONTROLS

Flow measurement and control

- Feed flow control to operate UF in design flux.

- Backwash flow (flux) is high (3 to 4 times higher than the feed flow (flux), and duration of the backwash is short (≤ 15 sec full backwash flow), frequency controlled backwash pumps are important because of the following reasons:

- Hydraulic resistance (TMP) of the membranes drops quickly and adequate, quick acting control is required to maintain the backwash flow (flux) at the required set-point.
- To ensure safe operation of the membranes (avoiding pressure shocks)

UF PROCESS CONTROLS

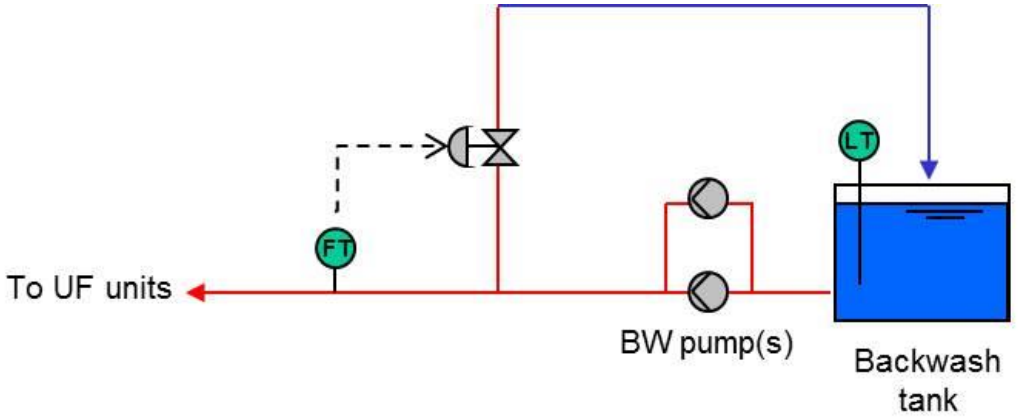
Alternate flow control without VSD/VFD

- Soft start/stop on BW pump
- Recirculation line from BW pump to BW tank with adequate flow control valve (no fluctuations allowed – so precise flow control valves are advised)
- BW flow meter to be installed in BW line to UF units

BASIC CONTROL SEQUENCE:

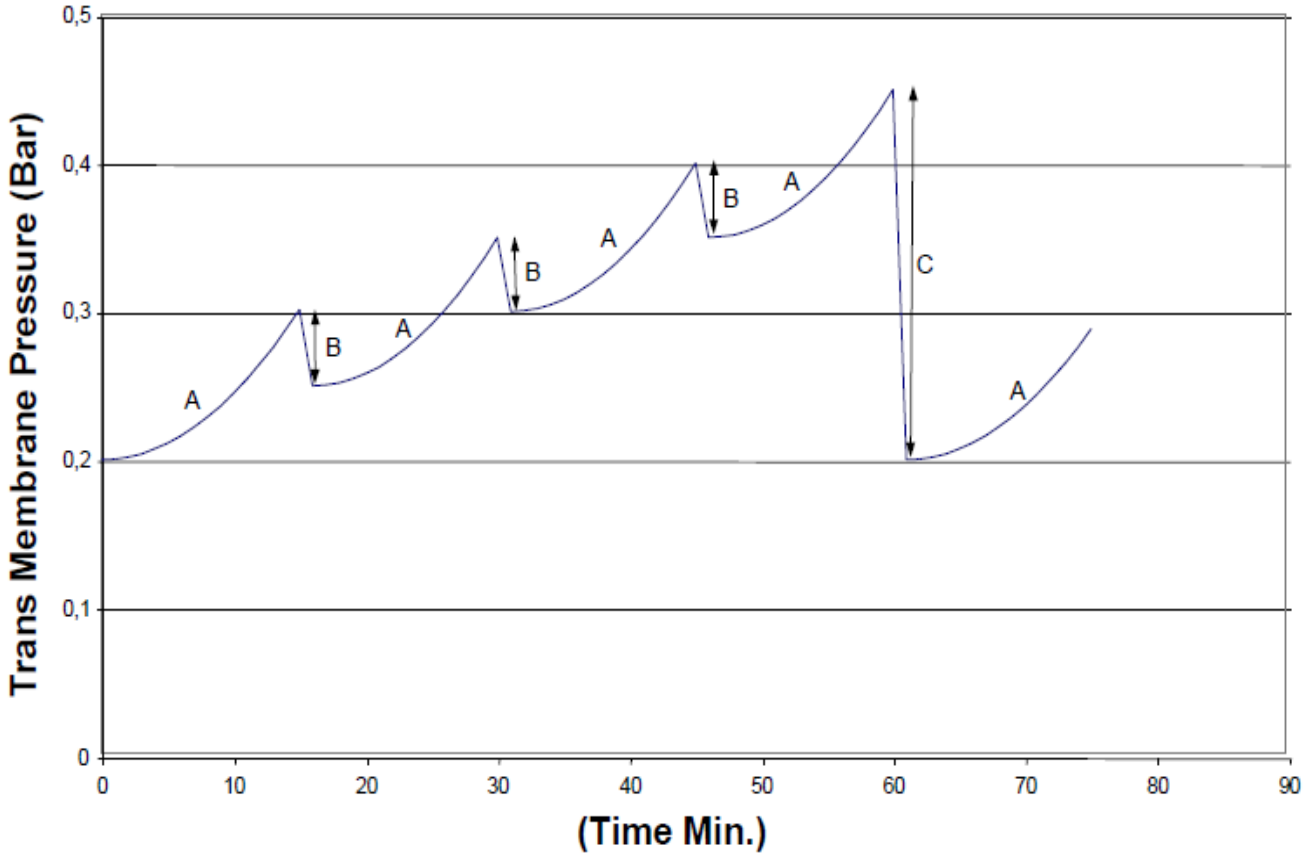
- Start BW recirculation over BW tank. (say 1 or 2 mins before end of filtration time to ramp up and achieve full flow)
- When BW pump is running at full flow, slowly open BW inlet of 1st UF unit → part of BW flow will go to 1st UF unit
- BW flow control is started → recirculation flow control valve is slowly throttled to achieve BW flow setpoint to 1st UF unit.
- BW sequence is for full train is completed as usual.
- After BW timer of last UF unit has elapsed →recirculation flow control valve is opened and BW routing last UF is closed
- BW pump is stopped

(above sequence is applicable for CEB flow)



UF PROCESS CONTROLS

Pressure and TMP measurement and control



A = Filtration
B = Hydraulic Clean
C = CEB

UF OPERATION

TMP range 0.2 to 0.8 bar

TMP restoration after CEB

CIP cleaning depending on the nature of fouling

UF OPERATION

Air Integrity Test

VIDEO

Single module bubble test

VIDEO

QUESTIONS?