**Title: OPERATION OF REVERSE OSMOSIS PLANT  
SECTION : ENGINEERING**

1. **Objective:**

The objective of this document is to establish a step by step written procedure for the RO plant which will be helpful to operate the plant smoothly and to avoid any damage or malfunction.

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1. **Scope:**

This sop is applicable to the operation of ultra-filtration, RO plant, and mixed bed of RO plant. It also includes charging of mixed bed & replacement of filters and membranes.

1. **Reference:**

WHO Technical Report, Annexure II (water for pharmaceutical use)

USP Standards: General Chapter (645) Water Conductivity

1. **Responsibility:**
   1. Executive HVAC & Utilities is responsible to prepare and revise the SOP.
   2. RO Plant Operator is responsible to follow the SOP.
   3. Manager Utilities & Projects is responsible to provide training to the concerned staff.
   4. Senior General Manager Engineering is responsible to check the implementation of SOP.
   5. QA (documentation) is responsible for checking compliance and controlling of SOP.
2. **Definitions:**
   1. CEB: Chemical Enhancement Backwash
   2. UF: Ultra Filtration
   3. RO: Reverse Osmosis
   4. pH: pH is ameasure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution.
   5. PPE: Personal protective equipment
3. **Materials & Equipment:**

N/A

1. **Precautions:** 
   1. Wear proper PPE before carrying out any operation that involve hazardous chemicals.
2. **Procedure:**
   1. **Operation of Ultra Filtration Plant:**
      1. The treated water is feed to the UF plant from the treated water tank and after getting the UF product, the water is now stored in the UF product tank. The UF system use here as feed water of the RO plant.
      2. Ultra filtration system is the combination of Disc filter and ultrafiltration membranes, which is used to remove fine silt and turbidity in the water and minimize the chance of any damage of membrane and improve the life of RO filtration plant.
      3. Before the start-up, verify the feed water tank level.
      4. Open the main supply and wait for HMI display.
      5. Press start button pump and feed treated water supply to UF, immediately the UF plant will go on normal flushing for 40 seconds.
      6. After the Flushing plant will start servicing and after 1800 seconds it will complete one cycle and after each cycle, the plant will perform backwash for 45 seconds and so on.
      7. After completing 20 such cycles CEB-1 starts in which it first dose sodium hydroxide and sodium hypochlorite for 75 seconds and soak for 600 seconds followed by rinsing of 40 seconds and then forward flushing of 40 seconds.
      8. Then starts CEB-2 in which it sucks hydrochloric acid for 75 seconds and soaks for 600 seconds followed by rinsing of 60 seconds and then forward flushing of 60 seconds.
      9. After that, it again starts from the first cycle.
      10. Ensure that all routine checks are conducted as per logbook “Daily Log sheet of Ultrafiltration Plant ENO/5/083” at interval of one hour.
   2. **Operation of Reverse Osmosis Plant:**
      1. Water from UF product tank feeds to the RO plant for the treatment. During the treatment process UF water passes from 5µ micron filters and further boosts through the high-pressure pump and passes from RO membranes. The water is now stored into the RO Product tank as an RO water.
      2. Before the start-up, verify the feed water (UF) Tank level.
      3. Open the main supply and wait for HMI display.
      4. Press the start button it will start 1st flushing for 120 seconds and then comes on servicing mode.
      5. If the plant stops for any reason (whether RO product tank is full or feed water (UF) tank at a low level it will go on 2nd flushing for 60 seconds.
      6. After 8 hours’ service (480 minutes) 3rd flushing starts for 60 seconds and the cycle is repeated.
      7. Ensure that all routine checks are conducted as per logbook “Daily Log sheet of Reverse Osmosis Plant ENO/5/084” at interval of one hour.
      8. **Sanitization of Reverse Osmosis Plant:**
         1. Sanitization of RO system to be carried out by using hot water on Yearly basis or whenever required in the following manner:
         2. Switch OFF the RO Plant.
         3. Close product valve.
         4. Open rejection valve.
         5. Close drain line valve.
         6. Change system from auto to manual mode in PLC.
         7. Turn ON CIP circulating pump.
         8. Make sure complete hot water maintained at (80°C ±5°C).
         9. Keep circulating for 15 minutes and during circulation drain from sample points so that hot water would sanitize the sampling point as well.
         10. Again turn ON the pump and start circulating for 02-03 minutes.
         11. Open drain valve and drain hot water and start the system.
         12. Check the pH of RO water it should be neutral (5-7 pH at 25°C)
         13. Inform quality control to collect the water sample from the sampling point for approval.
         14. Always mention in remarks section in “Log Sheet for Operation of Reverse Osmosis Plant

ENO/5/084” of yearly sanitization of RO membranes.

* + 1. **Replacement of Cartridge Filters & Sartorius Filters:**
       1. Cartridge filters will be replaced if differential pressure exceeds 12psi or after every 2 months & Sartorius filters will be replaced after every 2 months. This frequency is defined by manufacturers.
       2. Always mention in remarks section in “Log Sheet for Operation of Reverse Osmosis Plant

ENO/5/084” of filters replacement.

* + 1. **Replacement of RO Membrane:**
       1. RO membranes replaced whenever the TDS of water crosses 150 ppm, in this case the mixed bed column needs to be re-charged more frequently. Thus indicating a need to replace RO membranes. If rejection rate drops below 1.4 m3/h (Standard rejection rate: 1.8 m3/h) or permeate drops below 2.7 m3/h (Standard permeate rate: 3 m3/h), in the former case membrane will rupture whereas in the latter case membrane will choke.
       2. Always mention in remarks section in “Log Sheet for Operation of Reverse Osmosis Plant

ENO/5/084” of membranes replacement.

* 1. **Operation and Charging of Mixed Bed:** 
     1. RO water enters from the inlet distributor at the top of the vessel, water passes through the resin bed is collected by the strainers located in the bottom, and exits the unit through the service outlet. When the ion leakage from the resin bed approaches an unacceptable level (product quality starts to decrease) a regeneration procedure must be performed. The cat-ion and anion resins are separated by the backwash procedure. This leaves cat-ion resin at the bottom of the vessel and anion resin sitting on top. The two resins are regenerated in a normal fashion: sodium hydroxide is fed from above, and hydrochloric acid is fed from below. Both chemicals are removed from the vessel at the interface between the two resins.
  2. **Operation of Mixed Bed:**
     1. Before starting check the RO Product tank level.
     2. Open the valves 1 & 11 and drain water for a few minutes until Conductivity is maintained.
     3. Online Conductivity must be NMT 1.3µs/cm after mix bed. If online conductivity goes beyond 1.0µs/cm during the process then mix bed’s feed pump will shut off automatically.
     4. Open valve 1 & 2 and store water in the DI storage tank and circulate water in a loop at (80°C ±5°C).
     5. Before the utilization of purified water for the production processes, QC personnel will draw a sample from a sample point after mix bed and will proceed as their testing procedures.
     6. If results of the sample is not satisfactory then QC will re-sample the purified water for the testing and if results are still not satisfactory then RO operator will drain the loop tanks and proceed for charging of mix bed as mentioned in procedure 8.5.
     7. To ensure that loop wouldn’t go below 78°C, an alarm is attached with loop temperature system with the set alert limit of 78°C. Corrective measures will be done to ensure that loop temperature will reach above 78°C. Production will be stopped if temperature falls below 75°C.
     8. The quantity of water supplied to be logged in the logbook at the end of shift.
     9. Ensure that all routine checks are conducted as per logbook “Daily Log sheet of Purified water ENG/5/013” once before starting the production processes.
  3. **Charging of Mixed Bed:**
     1. **Backwash**
        1. Open valve No.03, 04 and start mixed bed feed pump for 5 minutes.
     2. **Chemical Injection:**
        1. Store 20 liters of NaOH 50% concentrated in a drum.
        2. Store 25 liters of HCL 33% concentrated in a drum.
        3. Open valve 9, 9A, 9B, 9C, 10A, 10B, 10C, and chemicals will inject through venturi to the mixed bed column.
     3. **Slow Rinsing:**
        1. After complete injection of chemicals, close valves 9A, 10A and wait for 25 minutes to complete the procedure.
     4. **Fast Rinsing:**
        1. Open valves 01, 03, 09 and “ON” mixed bed feed pump, wait for 25 minutes to complete the procedure.
     5. **Drain Down:**
        1. “OFF” mixed bed feed pump, open valves no.07, 08 and wait to empty the mixed bed.
     6. **Air Scouring:**
        1. Open valve no.06 & 08 and inject air of 6.5 bar from valve no.6 and continue till resins start to fluidize.
     7. **Final Rinsing:**
        1. Open valves no.01, 02 and 11, start the mixed bed feed water pump & check conductivity and TOC from a sampling point through testing from QC Lab.

1. **Training:**

Training will be imparted to the concerned personnel prior to implementation and will be documented on QAG/5/142.