Catch every drop of Water wastage !!

Framework to Achieve Optimum Water Conservation in Thermal Power Plant

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Need of Water Conservation in Thermal Power Plant

- Thermal power station : Highly water intensive
- Most of State governments have resorted to multifold increase in water charges.
- Water conservation measure leads to :
  - ✓ Financial gain
  - ✓ Reduction in plant Aux. power consumption
  - ✓ Conservation of precious natural resources &
  - ✓ Improved environment
- Environmental norm for specific water consumption: 3.5 /2.5 m3 /MWh (max)
- Water conservation in thermal power plants critical for environmental management and sustainability
- Need is not only to be environment compliant, but to achieve optimum water conservation much below the environmental norms

How to achieve optimum water consumption in Power Plant?

How to achieve Optimum Water Conservation in Thermal Power Plant ?

Steps to achieve sustained optimum water conservation are :

- ✓ Management commitment with well laid water policy & monitoring mechanism: Most important requirement
- ✓ Awareness for need of water conservation for all in power plant : Ensure involvement
- ✓ Working mechanism to achieve Water conservation : Backbone in achieving water conservation
- ✓ Identifying & implementing “best practices for water conservation” : Stepping-stone for optimum water conservation
- ✓ Adopting “technical advancement” : Breakthrough achievement in water conservation

How to catch every drop of water wastage?

Management commitment for water conservation:

- ✓ Laid out policy &
- ✓ Monitoring mechanism

Management commitment : Water policy statement

“Committed to become one of the most water efficient power plant/company globally by generating more power per drop”

“Mantra” for Water Conservation: 3R Principle

- Power plant should follow 3 Rs principle i.e., Reduce, Reuse & recycle for water conservation
- First R, “Reduce,” emphasizes importance of reducing amount of wastage
- Second R, “Reuse,” powerful way to minimize waste and conserve resources
- Third R, “Recycle,” involves collecting and processing water to conserve natural resources
- Water consumption for Cooling water, coal & ash handling are significant.
  Therefore, scope for water conservation is also significant.

Low Lying Fruits: Reducing Water Losses from Overflows & Leaks

Plugging leaks and overflows.

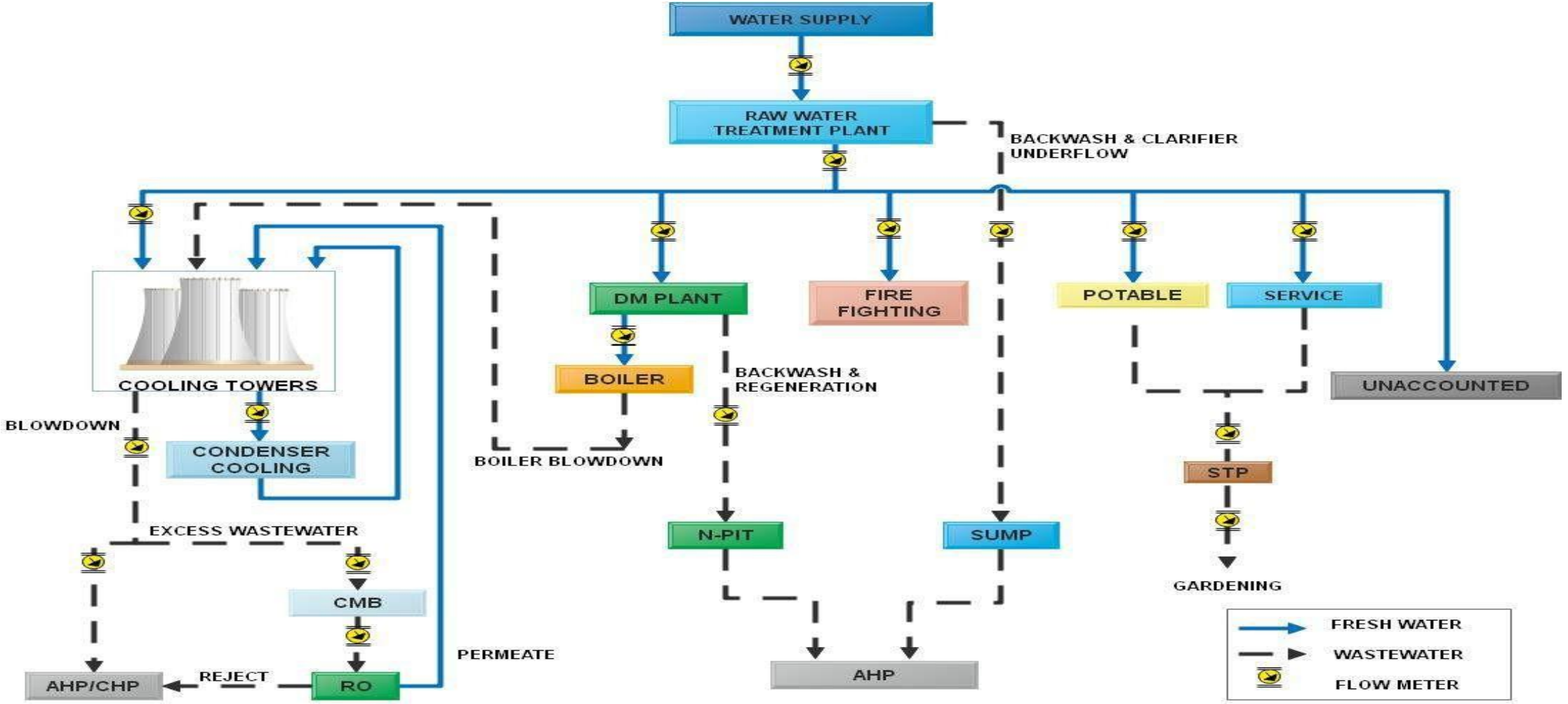
- Lot of water leaks from Valves, Flanges, Taps, fire fighting lines & nozzles, cooling tower basin etc.
- Overflows from cooling towers of AC plants, Air washers & Overhead tanks due to non-functioning of float systems are common feature in thermal power plants.
- Huge water leaks from condenser pipe ducts also noticed in some of plants.
- By bringing underground fire fighting lines to over ground, attending various water leaks, providing ball & cock float systems for overhead tanks & smaller cooling towers, water consumption can be reduced.

Structured mechanism for sustenance :

- Discussion in Daily planning meeting
- Periodic walkdown operation check shall indicate particularly leakages & overflow
- HODs & Management walk down also play important role :Demonstration of commitment

Second Mantra for Water Conservation : Water Monitoring Mechanism & Practices

Water metering at all water system & processes : “What get measured ,get managed”

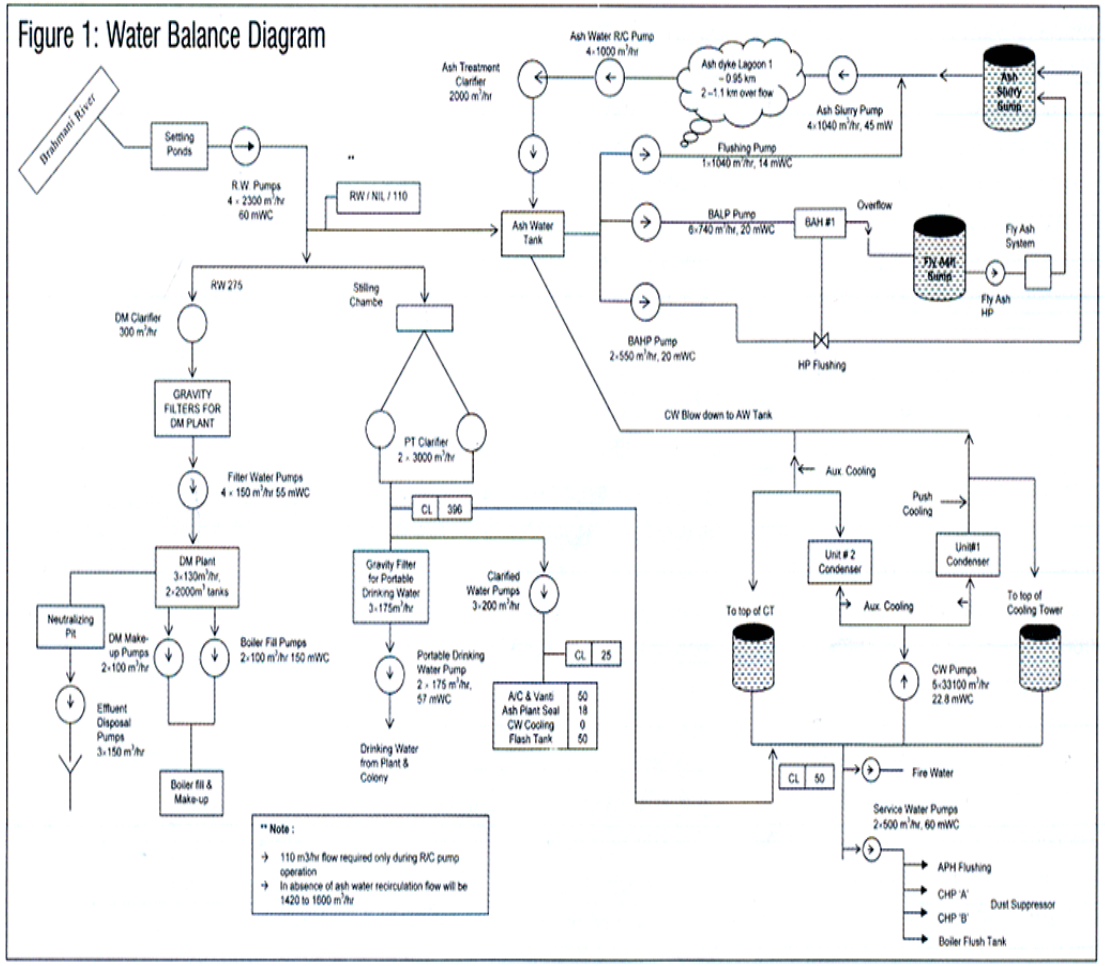


Second Mantra for Water Conservation : Water Monitoring Mechanism & Practices

- By providing water meter at all water system & processes: Water measurement in different system like Raw water , CT Make up , AHP, CHP, Fire water etc. on daily basis
- This indicate system/sub-system wise consumption pattern & deviation from standard/benchmark
- All deviation in water conservation pattern to be analyzed for timely corrective action & to be reviewed in daily planning meeting.
- Monitoring specific water consumption deviation on daily basis is key for success in achieving water conservation

Water Balance Study : An Audit Tool

- Water balanced study periodically is very effective audit tool, to be done,say monthly inhouse.
- Purpose of Water balance study:
  - ✓ Wastewater reuse and recycling opportunities
  - ✓ Regulatory compliance
  - ✓ Moving beyond compliance to achieve world class status
- Water balance study is primarily consisting of measurement & total water balancing of following:-
  - a) Raw water (from reservoir/river/canal etc.)
  - b) Clarified water for cooling
  - c) CT make up water
  - d) Aux. water for Ash handling
  - e) Fire water
  - f) Clarified service water
  - g) DM make up water
  - h) Portable water
  - i) Water for Coal dust suppression etc.
- Make system wise water consumption standards according to practical situation & examine water consumption periodically & take corrective action.



System Specific Water Audit : Detailed Auditing Tool

- Detailed specific water consumption yearly thru reputed third party & preparing action plan for achieving next level of water conservation.
- Methodology
  - ✓ Understanding overall water distribution
  - ✓ Field survey for leakages
  - ✓ Data collection design vs actual
  - ✓ Flow Measurements : Open channel velocity to be measured by turbine meter
  - ✓ Measurement of input electrical parameters like KWH, Kw, PF, Voltage, Current of all motors drive
  - ✓ Raw water & waste stream analysis
  - ✓ Understanding of critical control parameters and water quality requirements at users end
  - ✓ Identification of specific water saving projects
- Draw “SMART” action plan : Based on audit, finding action plan for implementation

Water balance study & System specific water audit are measures to achieve water consumption optimization which is base line to achieve water conservation

Third Mantra for Water Conservation : Adopting Best Practices

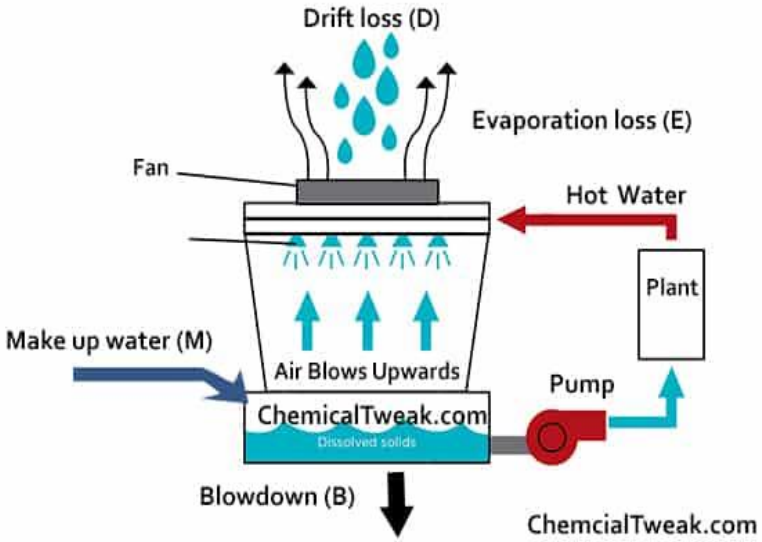
Best practices for water conservation

Increasing cooling tower efficiency

- Efficient cooling tower reduces cooling water wastages to some extent

Increasing cycles of concentration (COC)

- Maximum water loss in thermal power plants will be in the cooling towers, in form of evaporation, blow down & drift loss.
- This can be 70-85% of total water consumption.
- Since water is circulated many times in closed loop, concentration of dissolved solids increases over a period.
- Cycles of concentration (COC) is ratio of dissolved solids in circulating water to make-up water.
- By increasing COC, blow down quantity can be reduced. By external water treatment and adding water treatment chemicals, higher COC can be reached.
- By increasing COC from 2 to 5 in 500 MW unit, blow down quantity can be drastically reduced from 1050 M^3/hr. to 263 M^3/hr., which is a savings of 75%.



Cycles of Concentration

Pure water evaporates – minerals stay behind

$$CC = \frac{\text{Minerals (TDS) Tower Water}}{\text{Minerals (TDS) Make-up Water}}$$

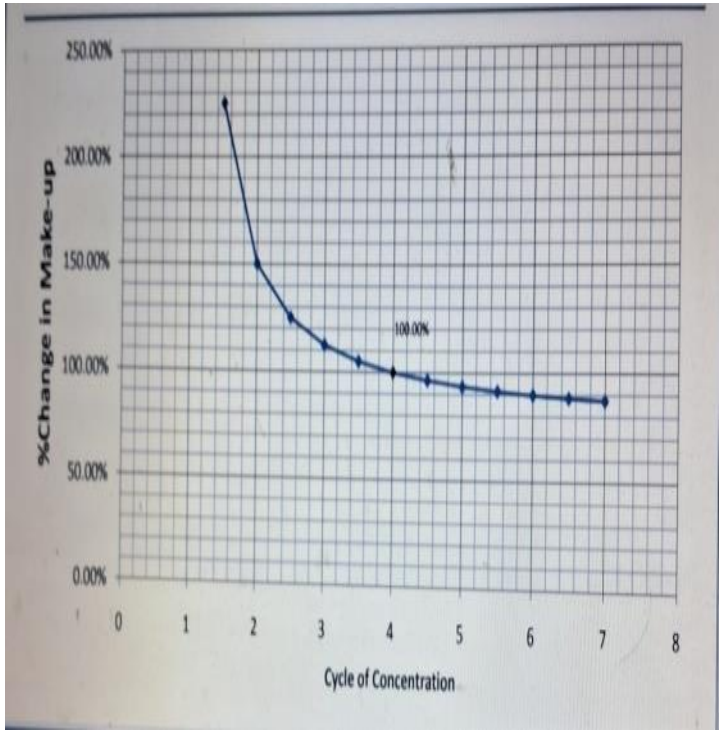
Adopting Best Practices for Cooling Water : Increasing COC

Increasing cycles of concentration (COC)

- Power plant are maintaining COC mostly up to 5-5.5 by advanced level chemical treatment adopting anti-sludging and antisepsis agents with better effect & acidification.
- To avoid problem from CW high COC extensive monitoring of online system Oxidation reduction potential(ORP) , daily monitoring of RSI,LSI,FRC, etc. to be adapted.

Caution with increasing COC further

- Higher COC : Greater concentration of dissolved solids in cooling water, increases scaling, corrosion potential of condenser tube, CT fouling, early probability of condenser acid cleaning
- Higher COC require :
  - ✓ Online condenser tube cleaning system in service
  - ✓ Cathode protection of CW ducts
- Best practice : Providing small prototype in parallel to Condenser & monitoring periodically for deposits.

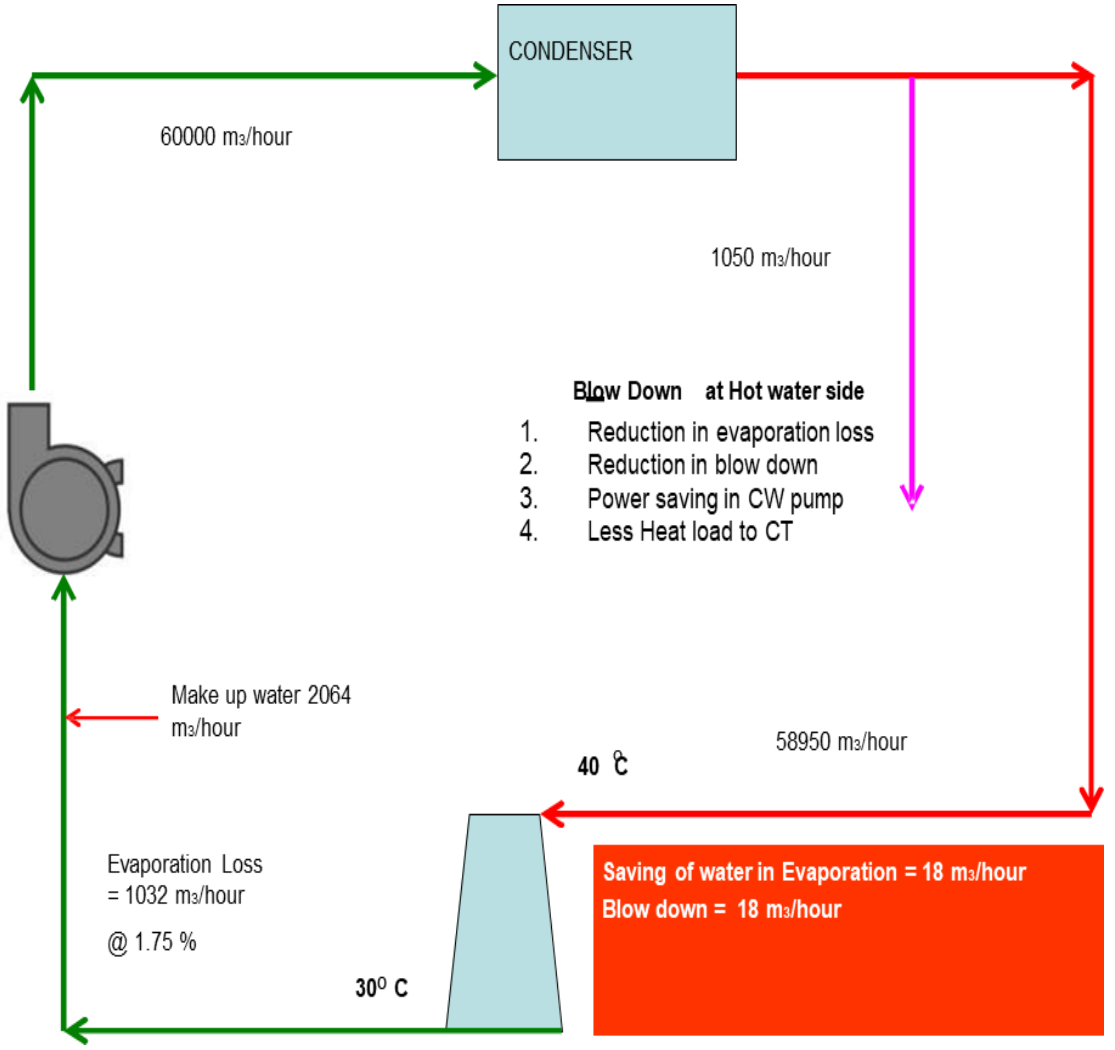


% Change in make up with COC

Adopting Best Practices for Cooling Water : Blow Down from Hot end

CW blow down from hot end

- Carryout blow down of CW system after condenser as it reduces Cooling water flow thru Cooling tower & reduces evaporation loss & blow down to some extent
- The study found that, approx. 23 to 36 M^3 /hr. of water can be saved in a 500 MW unit depending on COC.



500 MW Plant CW Blow down (Hot water side)

Best Practices for Re-use of Effluent

Best practices for effluent water re-use

✓ Cooling tower Blowdown to :

- Ash Handling Plant
- Service Water
- Coal Dust Suppression & spray
- Fire Water System make up
- Flue gas de- sulphuration (FGD) system
- Horticulture use in plant & Township

✓ DM Plant & CPU Regeneration Waste

- Used for Ash Sluicing.

✓ Back Wash Waste from Filters

- Recirculated to inlet of Clarifier and Water recovered

✓ Sludge from PT Plant & Service Water Treatment

- Sludge disposed to Ash Slurry Sump and decanted water recovered from Ash Pond

✓ Ash water recycling including from dyke & toe drain

✓ Re-circulation of CHP water for dust suppression & spray

✓ Sewerage : Used for Horticulture after treatment

Adopting Best Practices for Water Conservation Measures

Auto operation of Fire hydrant/sprinkler system

- Fire hydrant/sprinkler system should be in auto. Leakage/passing to be checked if Hydrant/Sprinkler pump come into service.

Optimizing ash water ratio

- Optimize High-pressure ash water for flushing both bottom ash/fly ash and trench jetting etc. & low-pressure ash water for bottom ash hopper filling etc.
- In 210 MW set, for every % ash water ratio reduction saving potential of 60 M^3/ hr. of water. & auxiliary power consumption reduction 0.2 MU/annum for every ash water ratio reduction in HP/LP ash water pumps & ash slurry series pumps..
- By water conservation measures, lean ash water ratios can be reduced to reasonable level of 1:8 from 1:20

Installation of effluent treatment plant (including N-pit)/STP

- Treated water in effluent water treatment plants can be used for gardening and plantation
- By installing sewage treatment plant in the township, treated water can be used for horticulture purposes

By adopting above best practice & monitoring mechanism in place 2.2-2.8 m^3 /MWh Specific Water Consumption can be achieved even in old Coal power plant

Adopting Best Practices for Water Conservation : ZLD & RO

Zero liquid discharge

- A typical thermal power plant will have a 3-4 main drains. All drains are water gets collected
- For use of plant drain water, storm water & plant process drains are to be separated
- Complete ash water recirculation system (AWRS) including toe drain water.
- For Coal, ash & oil in plant drain water proper settlement & separation pits at appropriate place
- Proper treatment of water for re-use.

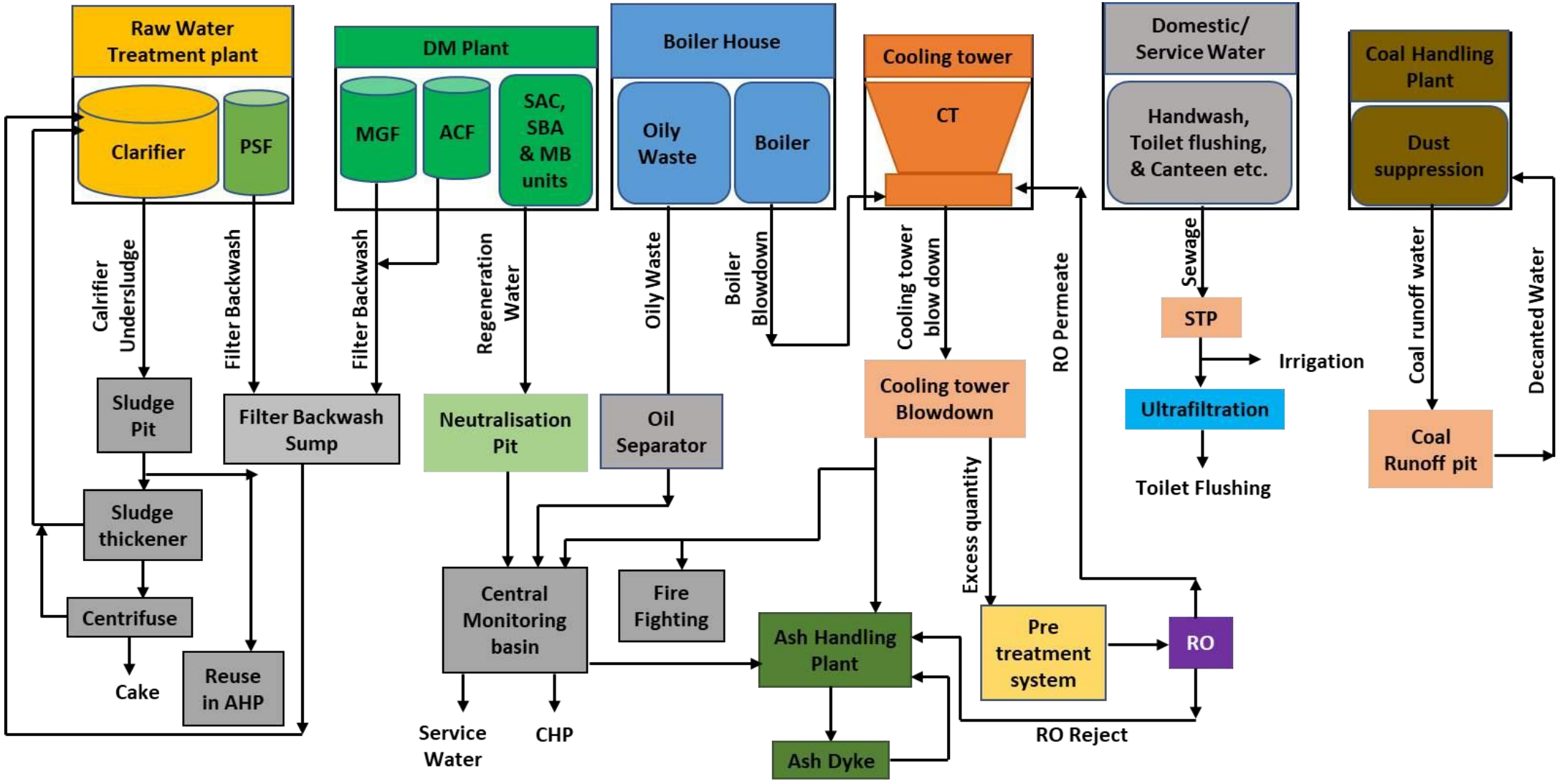
Reverse Osmosis (RO) Plant

- Reverse Osmosis (RO) Plant : To meet DM requirements for plant saving significant volumes of water.
- Reject water from RO diverted for water sprinkling on roads and coal stack yard

Online real time monitoring

- Install flow meters at prominent water supply & consumption points and connect them to real time monitoring or SCADA based water monitoring system to compute scientific & authentic water balance

Overall Wastewater Management at a Glance



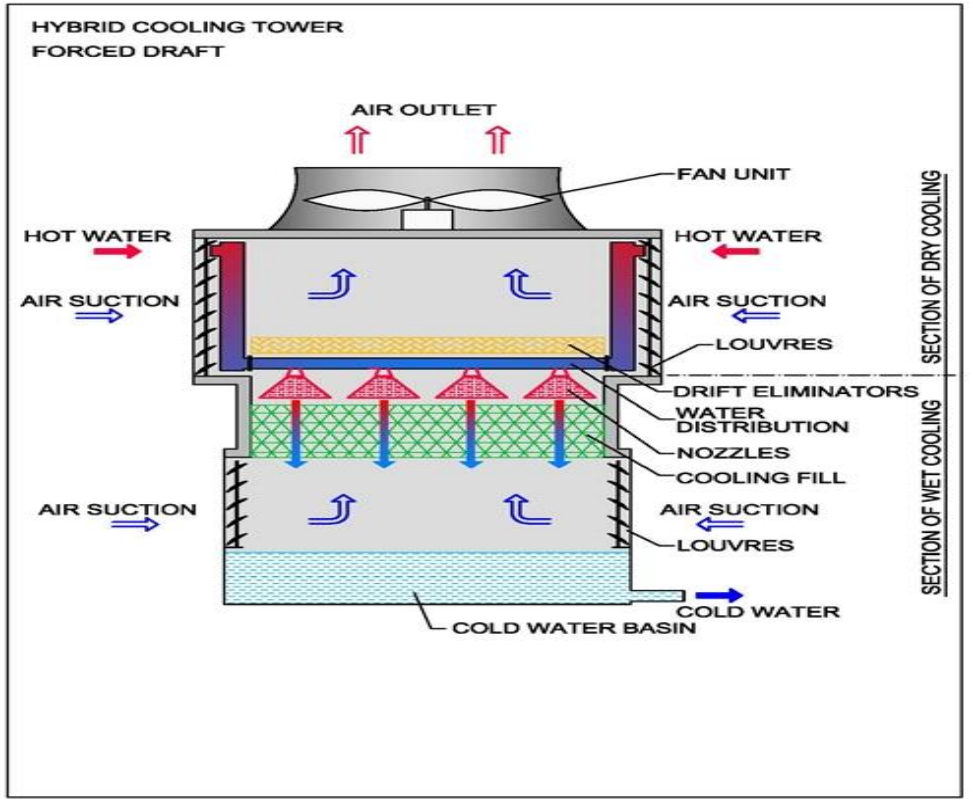
Adopting Technical Advancement for Achieving Breakthrough Water Conservation : Hybrid Cooling Towers

High concentration slurry disposal

- High-concentration slurry disposal (HCSD) method, being used by new plants, reduces ash-water ratio ~ 1:1 ~ 1:4.

Hybrid cooling towers

- Hybrid cooling tower : Hybrid cooling tower works with principle of wet cooling, whereas it is supplemented with dry cooling module.
- Purpose of dry module is to reduce cooling water temperature, using surrounding air before water enters wet section. Hot air from dry cooling is mixed with saturated air from wet section, thus eliminating the steam plume.
- Hybrid towers uses~ 50% less water than wet ones & improving efficiency
- These systems can switch between modes or operate both simultaneously, ensuring optimal performance while conserving water



Ultimately Adopting Technical Advancement for Achieving Breakthrough Water Conservation : Condenser Dry Cooling Technology

- Condenser dry cooling can be : Direct or indirect type
- In direct type, exhaust steam from turbine is condensed inside of ACC by air flowing past the outside of tubes.
- Condenser dry cooling : Reduces drastically.
- Challenges with Condenser dry cooling :
  - ✓ Increase in capital (say12% in typical case)
  - ✓ ACW cooling water requirement from wet cooling system
- Useful in case adequate water is just not available for power generation using wet cooling

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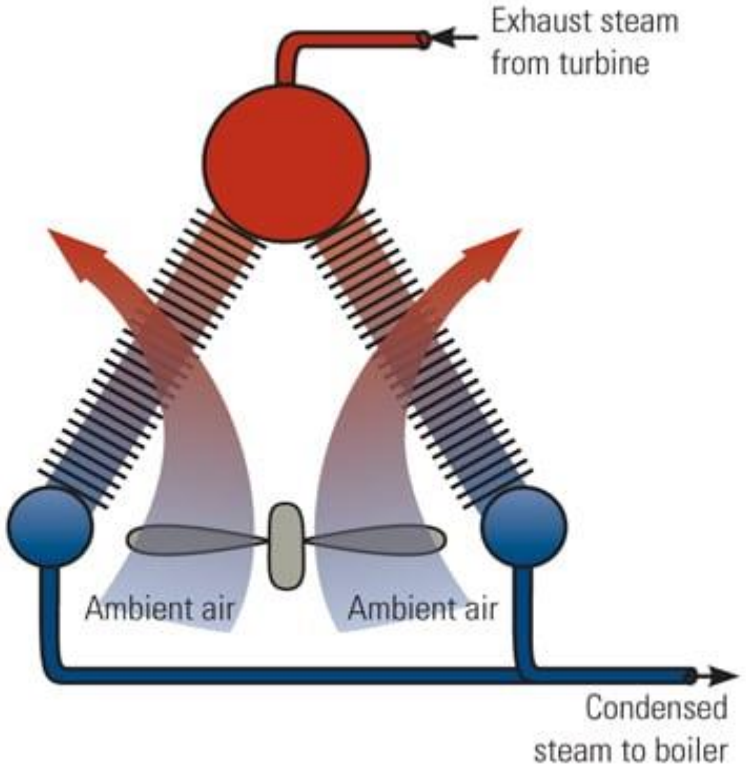
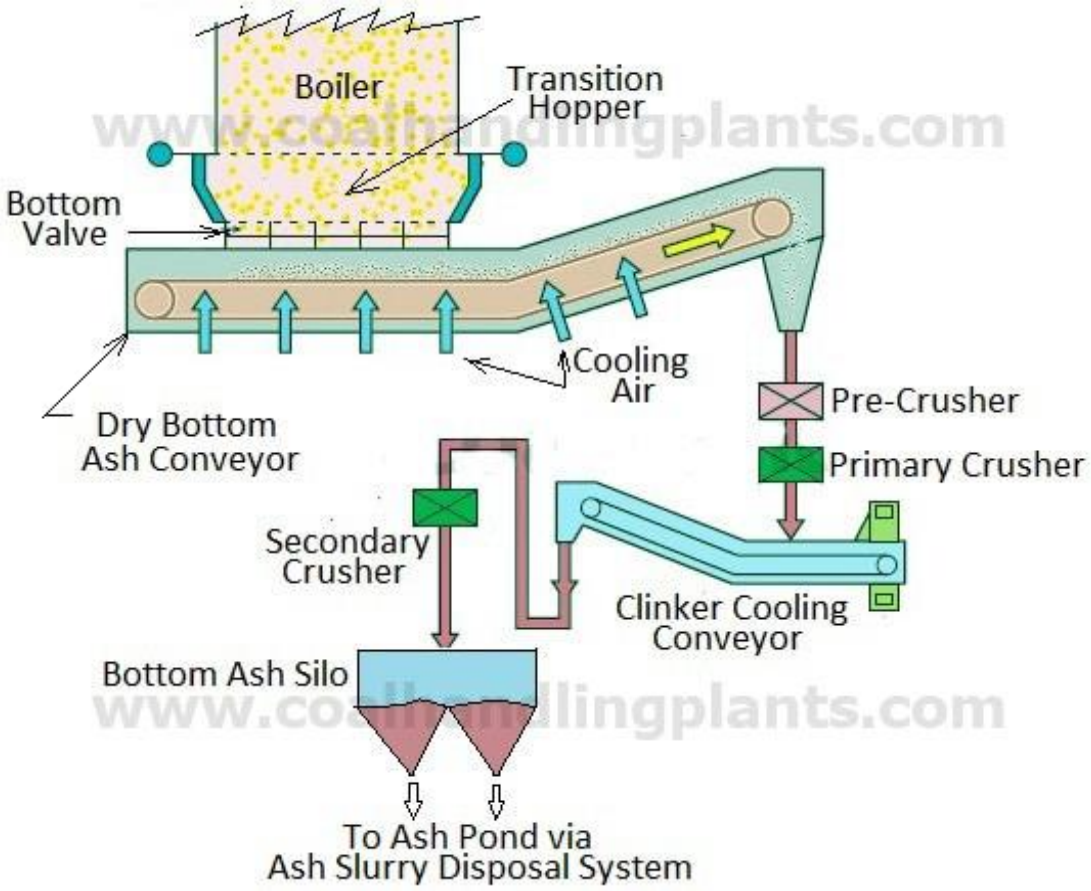


Ultimately Adopting Technical Advancement for Achieving Breakthrough Water Conservation : Dry Bottom Ash Evacuation System

Dry Bottom ash evacuation system

- Use of dry bottom ash handling system leads to significant water savings
- Since no water is used for bottom ash cooling and conveying, all ancillary equipment/systems (pumps, piping, dewatering bins, water treatment plants, etc.), which are mandatory for WBAH systems, are no longer necessary, and therefore all associated O&M costs are eliminated.
- Water consumption is limited to a minimum, only for dust control at the final discharge point.



Dry bottom ash handling system

Thanks for patience hearing !!

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