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Innovative Power Enhancement Scheme In Extraction Condensing Steam Turbines of CPP

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IPPTA Annual Conference 2024

Fostering the Future of Energy & Environment in Pulp & Paper Industry

24th Feb 2024

Kolkata

BACKGROUND

MCW (Main Circulating Water) Pumps Optimization with Both Extraction Condensing STGs in operation

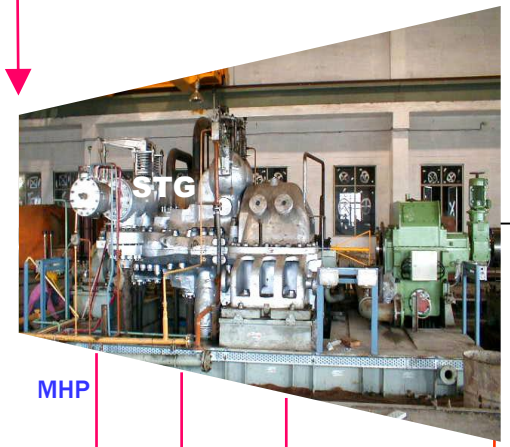
- One 150 TPH High Steam Pressure / Temperature (87 kg/cm2 / 510ºC) AFBC Boiler with Feed water temperature at 190ºC connected to 30 MW Multi-extraction (MHP, LP, LLP) Condensing (Water cooled condenser) Steam Turbo-Generator

- One 82 TPH Chemical Recovery Boiler (Steam Pressure / Temperature (64 kg/cm2 / 450ºC) along with 90 TPH Stoker fired Coal fired Boiler connected to 25 MW Multi-Extraction (MP, LP,LLP) Condensing (Water Cooled Condenser) Steam Turbo-Generator.

- Both condensers are related to cooling water in closed circulation connected to a Common Spray Pond.

AFBC & CRB HP COGEN BATTERY

AFBC Boiler



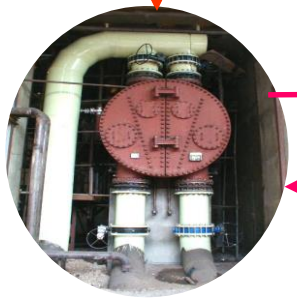
30 MW

MHP

LP

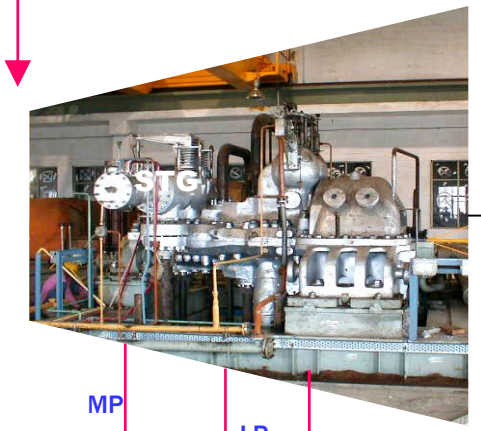
LLP

Condenser



Spray Pond

Recovery & Power Boilers



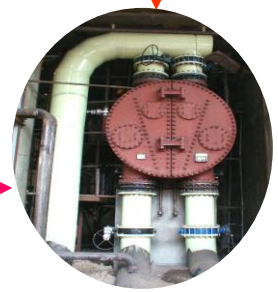
25 MW

MP

LP

LLP

Condenser



Spray Pond Mist System

MCW Pumps Optimization with Both Extraction Condensing STGs in operation

Standard Practice In All Steam Turbines With Condensers

- Constant Cooling water flow rate designed for Rated Condensation (max.) flow is being maintained all along –irrespective of exhaust steam condensing flows.

- Cooling water Pump(s) hence are designed for maximum condensing flow with design margin on flow & head necessitating constant high Auxiliary Power Consumption at all condensing loads of operation.

Innovative ECS Formulation & Implementation

- Innovative energy scheme is to go in for lowered cooling water flow at low condensing loads for effecting reduction in APC at lower condensing loads.

MCW Pumps Optimization with Both Extraction Condensing STGs in operation

Earlier

- Two MCW pumps of very high flow rate (5500 m3/h each) from M/s Flowmore, pumping had been in operation all along.
- As the requirement of Cooling Water flows for the 2 units are far less (~3800 m3/h) even at rated high condensing loads of 57 to 64 TPH, Power consumption is as high as 1.0 to 1.05 MW.

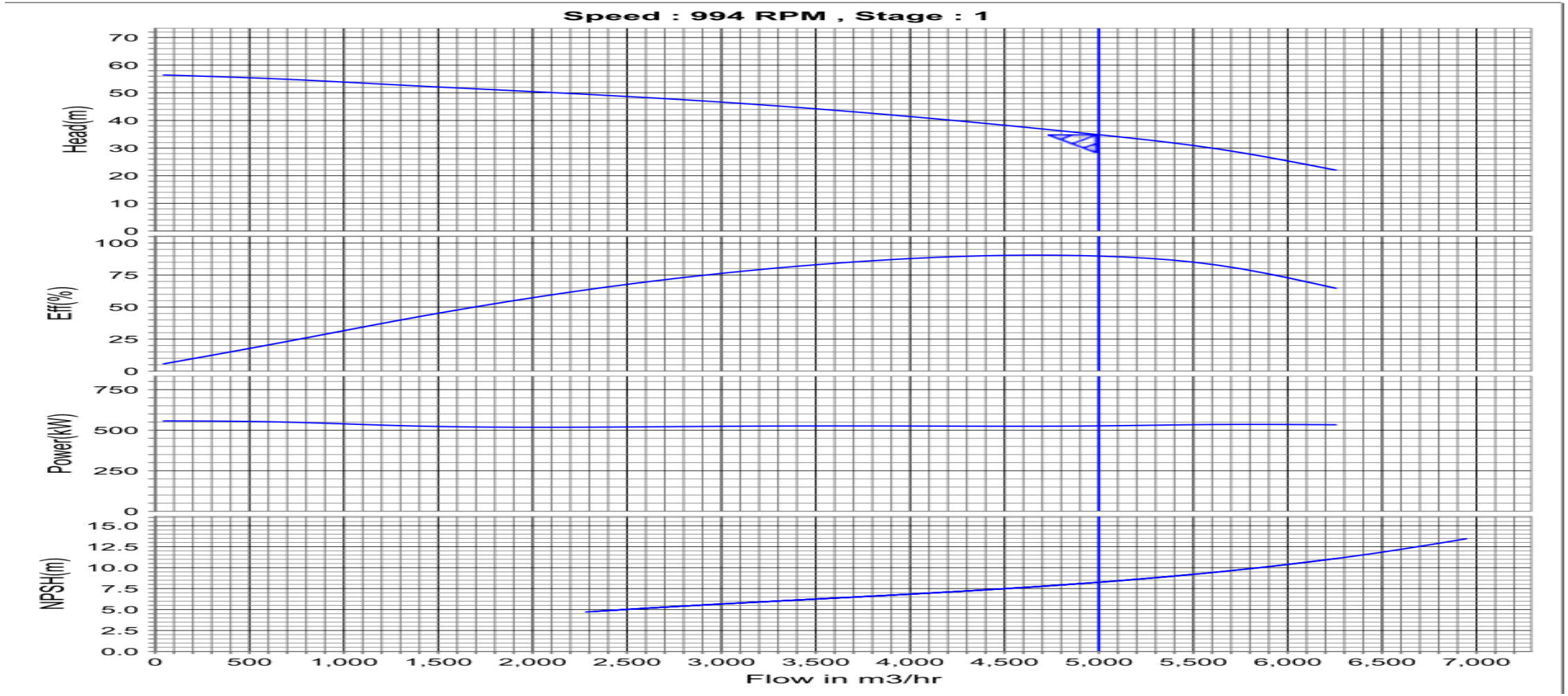
Now

- As the condensing loads in each of the turbines are much less , say around 25 to 30 TPH, it had been decided to operate One MCW pump feeding flows to both the condensers.
- As & when the condensing loads go up > 30/35 TPH on a sustained period, both the MCW pumps need to be operated.

MCW Pump Characteristics

FLOWMORE LIMITED

Family Chart



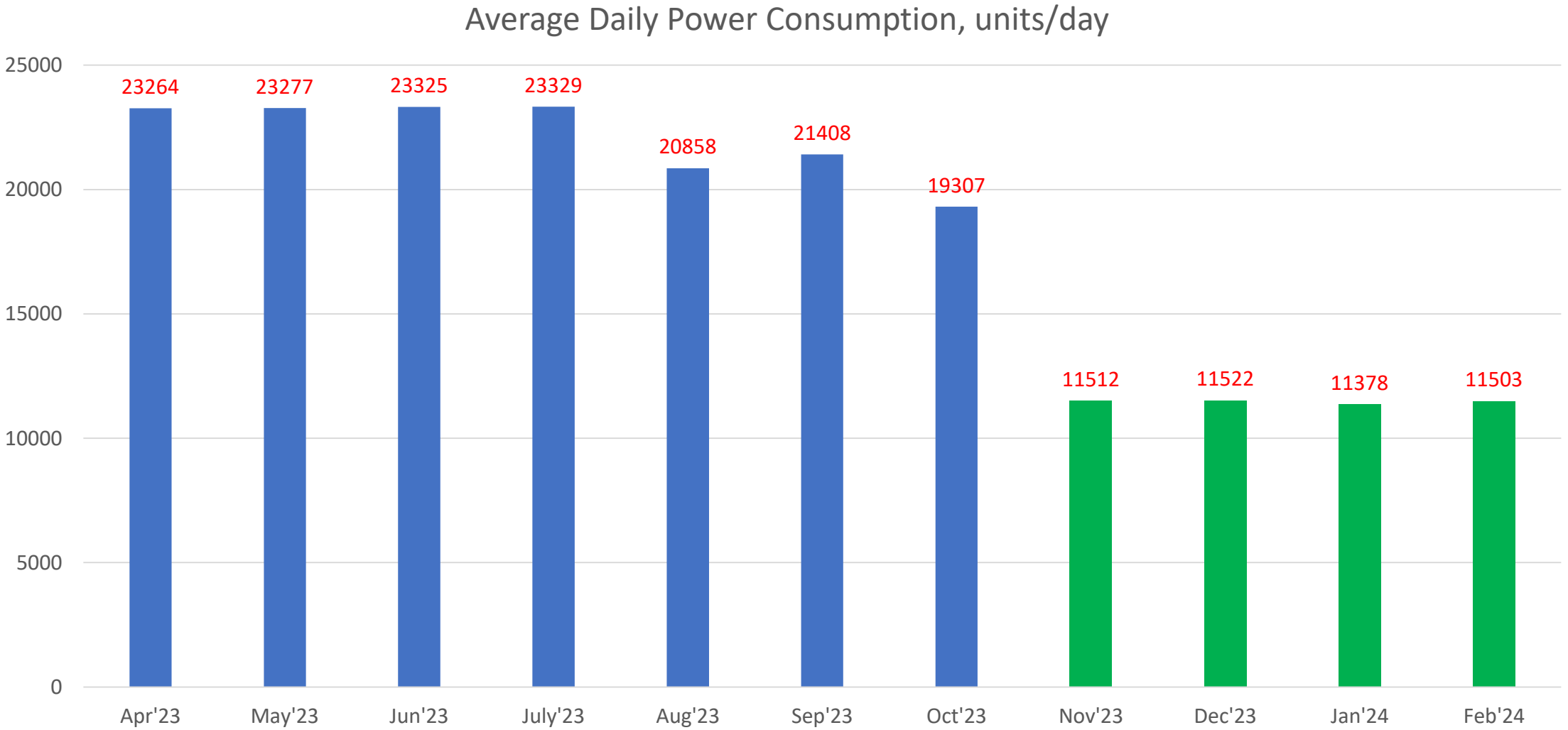
High Auxiliary Power Consumption (APC) of MCW Pumps in [Extraction] Condensing STG Battery

- Exhaust Steam Condensing Flows are being split between the Two Steam Turbines
- Constant flows (designed for rated condensation) in both the Condensers irrespective of condensing flows
- **Invariably in Cogen units, Extraction steam for process is very high with balance only for condensing steam**
- APC Very High at 1.05 MW with Two MCW pumps in operation even with Condensing flows < 50 % of rated value.
- Moreover, the MCW Pumps had been designed for 1.3 times Design load.

Cooling Water Flow Apportioning with 1 & 2 MCW Pumps

Parameter	30 MW STG	25 MW STG	Combined
Design -2 MCW pumps in operation			
• Condensing Steam flow	63 TPH	56 TPH	119 TPH [100%]
• Rated Cooling water flow	3829 m3/h	4135 m3/h	7964 m3/h
• MCW Pump 1 & 2 discharge flow	5000-5200 m3/h [135%]	5000-5200 m3/h [130%]	[130% to 135%]
• Total MCW discharge flow	10000-10400 m3/h		[130%]
With 1 off 2 MCW Pumps in operation			
• Operating Condensing steam flow	25 to 35 TPH	25 to 35 TPH	50 to 65 TPH [40% to 55%]
• MCW Pump flow discharge	5200-5400 m3/h		[65 %]
• MCW flow through each Condenser	2600-2750 m3/h [70%]	2600-2750m3/h [65%]	[65% to 70%]

Impact of 1 off 2 pumps on MCW Pumps Power Consumption



Energy Gains & Decarbonization

Auxiliary Power Consumption (APC) reduction & Net Heat Rate Improvement

- Reduction in MCW pump power consumption …….. : **0.51 MW**
- Reduction in APC achieved is of the order of ……: **2 %**
  [0.5 MW out of ~24 to 26 MW total power generation].
- Alongside Turbine Net Heat Rate had lowered by ……: **~ 2 %.**

Carbon Emission Reduction

Through effecting power consumption reduction of ……: **12380** units/day ,
Carbon Emission Reduction accrued is ……:~ **500 tCO2e**/month .

Impact on spraying relating to lowered cooling of warm water

With 1 off the 2 MCW Pumps running, the flow is halved.

- This results in flow through each of the spray nozzles reduced by ~ 50 %.
- Hence the velocity of warm water discharge is reduced by 50 %.
- This shall result in poor spraying into finer mist/droplets.

The cooling water flow distribution from the 2 Condensers need to be distributed uniformly through the Spray nozzles covering the entire Cooling tower Basin for effecting better cooling.

- Hence is the need for adjusting the flows through spray nozzles [with alternate set of Spray Nozzles closed] & the same is being implemented.

CONCLUSIONS & ADVISORY – WAY FORWARD

- With Cooling water flow lowered distribution through stoppage & running of 1 of 2 CW Pumps , significant APC reduction / Energy savings are being achieved on a sustained basis.

- With this demonstration, stage is now set for varying the cooling water flow in line with varied turbine exhaust steam condensing flow by going in for proposed Energy efficient smaller CWP with VFD in place.

- Through the help of VFD in place, it can cater to all condensing loads –high (35 to 50 TPH), medium (30 to 35 TPH) & low (20 to 30 TPH).

- **CROSS-SECTOR KNOWLEDGE EXCHANGE**

- **This innovative concept can be extended to all steam turbines – Industrial as well as Thermal Power Plants for achieving lowered APC (Auxiliary Power Consumption)**

Thank You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