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Development of Maintenance Strategy to Improve Performance of Natural Draft Cooling Tower

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Abstract- Cooling tower is an important part of power plant. The efficiency of power plant is directly depends on the effectiveness of cooling tower. In cooling tower scheduled maintenance and shutdown maintenance is a problem which affects its effectiveness and performance of cooling tower. In cooling tower shutdown maintenance required in every 2 to 3 year periods at this period the whole plant will be shutdown, and require 28 to 35 days maintenance so that cooling tower will be in its best working condition. In every cooling tower manufacturer provide the scheduled maintenance check list so that the worker will perform their maintenance as per given instruction. In present work optimization of shutdown maintenance strategy is done so that the time elapsed in maintenance will reduce and the requirement of man power will be reduced.

Index Terms- Cooling tower, Maintenance strategy, Optimization, Scheduled maintenance, and Shutdown maintenance

I. INTRODUCTION

Cooling towers are heat rejection devices used to transfer waste heat to the atmosphere. Cooling towers are an integral part of many industrial processes [1]. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed circuit dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature [2].

In natural draft cooling tower, the circulation of air in the tower is due to the difference in pressure between the inside air and outside air of the cooling tower. The bottom of the tower is open so that the air flows from the downward to the upward direction. This paper is focused on the shutdown maintenance of Natural draft cooling tower. Evaporative heat rejection devices such as cooling towers are commonly used to provide significantly lower water temperatures than achievable with "air cooled" or "dry" heat rejection devices

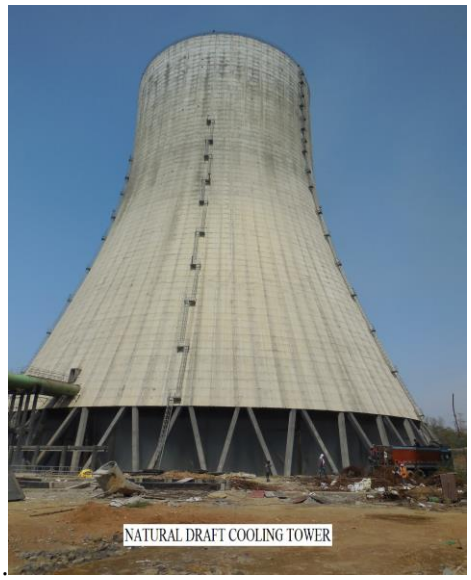

Figure 1: Natural draft cooling tower

The natural draft cooling tower has long been associated with thermal power plants to discharge waste heat to the atmosphere. Nowadays, with the growing environmental concern this type of tower is more and more considered as a valuable solution due to its quiet operation, longevity and its ease in maintenance and fuel savings. With capacity reaching hundreds of megawatts, any under-performance of cooling tower means additional cooling equipment for the cooling water to the turbine condenser to ensure the thermal efficiency is maintained [3].

Optimization is an act, process, or methodology of making something as fully perfect, functional or effective as possible. Optimization's aim is to determine the best solution to a problem under a given set of constraints. Design and optimization of thermal systems are commonly inspired by the thermodynamic properties, investment and maintenance cost of system equipments. The basis of most engineering decisions is economic. In the study of thermal systems, one of the key ingredients is optimization, and the function that is most frequently optimized is the potential profit [4].

Various types of cooling tower: Cooling tower is broadly classified into four groups.

1. Classification based on build
2. Classification based on heat transfer method
3. Classification based on air draft
4. Classification based on air flow pattern

Further classification based on air draft:-

a. Atmospheric tower
b. Natural draft tower
c. Mechanical draft tower [5].

II. RESEARCH ELABORATIONS

A. Cooling Tower Shutdown Activity

Cooling tower shutdown maintenance is very complex and time consuming. This problem is occurs when proper sequencing procedure is not used in shutdown maintenance. Shutdown maintenance of cooling tower is occurs when the component of cooling tower are not performing their functions properly causes the performance of cooling tower reduces. When we use the proper sequence of shutdown maintenance activity then we can reduce the complexity in maintenance activity and achieve the less time with minimum labour. When these maintenance activities are unplanned then it increases the overhauling cost of a cooling tower in terms of labour cost and time consumption.

The below data is taken from power plant. These activities are carried out at the time of shutdown maintenance of cooling tower.

S No.	Component used	DAYS																							
		1	2	3	4	8	9	11	12	13	14	16	17	18	19	20	21	22	23	25	26	31	32	34	35
1	Screen assembly																								
2	Monorail assembly																								
3	Slide(stop) gate																								
4	Butterfly valve																								
5	Hot water duct																								
6	PVC Distribution pipe																								
7	Adapter arm																								
8	Nozzle																								
9	Sprinkler																								
10	PVC U-channel																								
11	GRP (Glass reinforced polymer) grid																								

12	Fill (PVC V-bar)																							
13	Cold water basin																							
14	RCC structure																							
15	X legs																							

Table-1 Cooling Tower Shutdown Maintenance Activity Chart

B. Cooling Tower Shutdown Maintenance Activity Details In Power Plant

In power plant various types of activity involve in the shutdown maintenance of cooling tower. Labour required in shutdown maintenance activity are depends upon the type of activity is to be done. The cost of labour is depends upon the number of labour and their skills. Skilled labour performs their task more efficiently with minimum time.
Labour Cost (Skilled labour) = 400 Rs.
Labour Cost (Semi Skilled labour) = 300 Rs.
The table shows the activity i.e. number of activity which is to be performed in the cooling tower, day shows the number of days required to do a certain activity, labour shows the number of labours involve to complete the activity, cost of labour shows the labour cost associated with particular activity and types of labour shows which type of labours are involve in the activity i.e. skill or semi skill.

Activity	Day	Labour Required	Labour cost	Types of Labour
1-3	1	7	2100	Semi Skilled
4	2	4	3200	Skilled
5	5	7	10500	Semi Skilled
6	3	5	4500	Semi Skilled
7	2	3	1800	Semi Skilled
8	3	5	6000	Skilled
9	2	2	1200	Semi Skilled
10	2	4	3200	Skilled
11	2	4	3200	Skilled
12	3	5	6000	Skilled
13	6	8	14400	Semi Skilled
14	3	4	3600	Semi Skilled
15	1	2	600	Semi Skilled
Total	**35**	**60**	**60300**	

Table-2 Cost and Labour Involve In Cooling Tower Shutdown Maintenance Activity

This shutdown maintenance activity charts represents the cost and activity of a cooling tower shutdown maintenance activity. Charts shows how much cost is associated with a particular activity involve in maintenance of a cooling tower used in power plant.

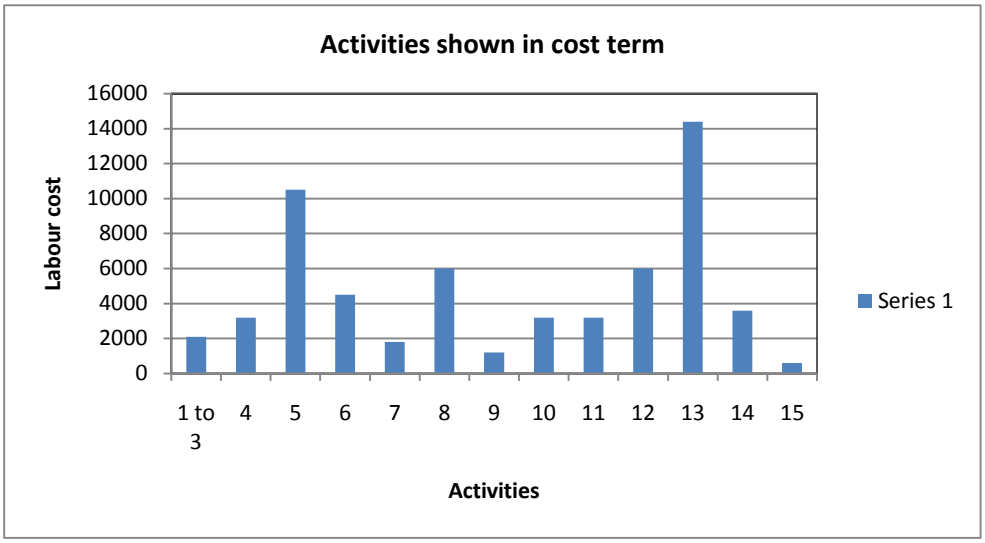

Chart-1 Cost Vs Activities of Cooling Tower Maintenance

III. FINDINGS

A. Optimization of Cooling Tower Shutdown Activity:-

Optimization of cooling tower activity can be achieved by starting those activities together that's assembling or disassembling does not affect the one another. When we start these activities together then it saves the time in terms of lost in production and cost in terms of labour.

This table shows the reduced time of overhauling activity thus saves the time and labour cost.

S No.	Component used	DAYS																
		1	2	3	4	6	7	9	10	11	14	15	16	17	18	19	21	23
1	Partition assembly																	
2	Monorail assembly																	
3	Slide(stop) gate																	
4	Butterfly valve																	
5	Hot water duct																	
6	PVC Distribution pipe																	
7	Adapter arm																	
8	Nozzle and Sprinkler																	
9	PVC U-channel																	
10	GRP (Glass reinforced																	

	polymer) grid																	
11	Fill (PVC V- bar)																	
12	Cold water basin																	
13	RCC structure, X legs																	

Table-3 Optimization of Cooling Tower Shutdown Maintenance Activity

Activity	Day	Labour Required	Labour cost	Types of Labour
1-3	1	7	2100	Semi Skilled
4-6	8	5	16000	Skilled
7-8	5	4	8000	Skilled
9-10	2	5	4000	Skilled
11-13	7	8	22400	Skilled
Total	**23**	**29**	**52500**	

Table-4 Optimum Cost and Labour Involve In Cooling Tower Shutdown Maintenance Activity

This chart represents the cost and activity of a optimize shutdown maintenance of cooling tower. All the activity shows in the bar represents that these activity is started simultaneously. Simultaneous starting of these activities overcomes the time to complete the maintenance and save the cost in terms of labour and time.

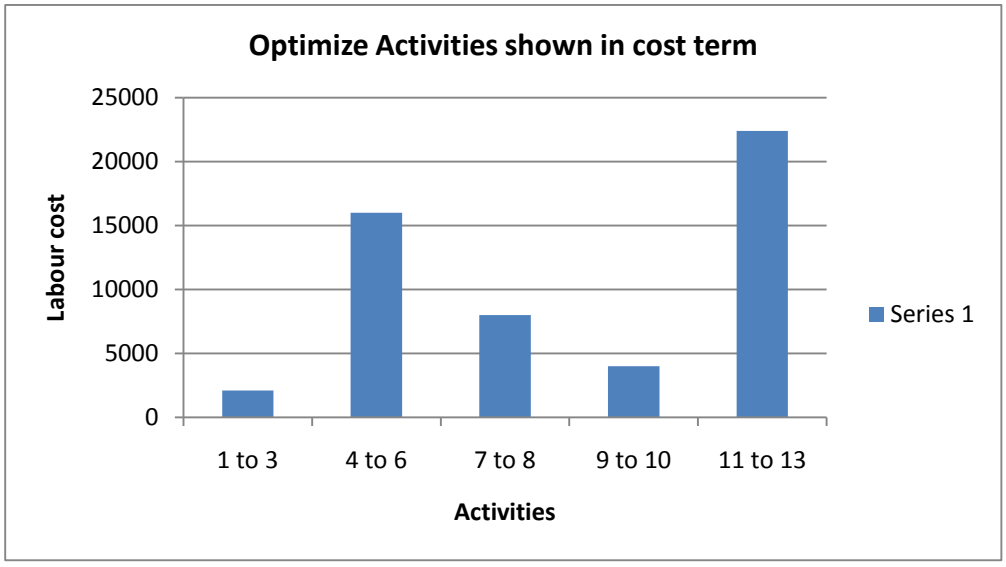

Chart-2 Optimize Cost Vs Activities of Cooling Tower Maintenance

B. Cooling Tower Shutdown Maintenance Cost Saving:-

This chart shows the save in cost of cooling tower shutdown maintenance activity. The previous cost of shutdown maintenance of cooling tower is 60300 Rs. and optimum cost is 52500 Rs.

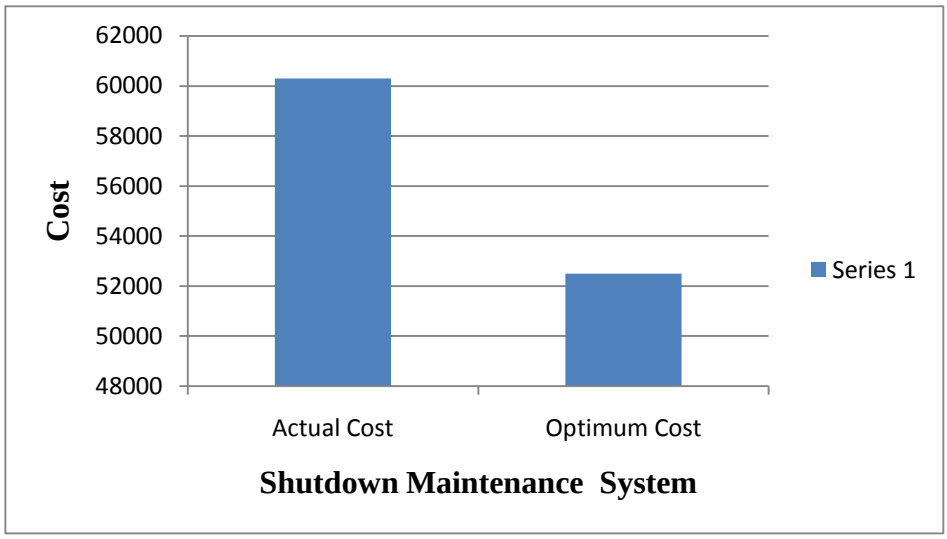

Chart-3 Cooling Tower Shutdown Maintenance Cost Saving

Cost Saving = (Actual Cost – Optimum Cost)*100/ Actual Cost

= (60300 - 52500) * 100 / 60300

= 12.93%

Hence we can save the cost up to 7800 Rs. i.e. 12.93%.

C. Cooling Tower Shutdown Maintenance Time Saving:-

This chart shows the save in time of cooling tower shutdown maintenance activity. The previous time of shutdown maintenance of cooling tower is 35 days and optimum time is 23 days.

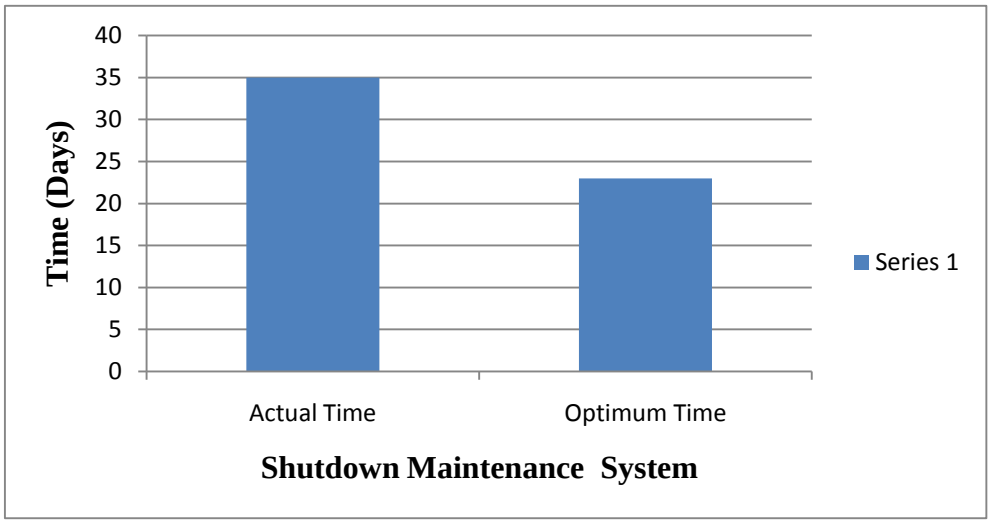

Chart-4 Cooling Tower Shutdown Maintenance Time Saving

Time Saving = (Actual Time – Optimum Time)*100/ Actual Time

= (35 - 23) * 100 / 35

= 34.28%

Hence we can save the time up to 12 days i.e. 34.28%.

IV. CONCLUSION

1) The most important part of the cooling tower is the mechanical equipment, to which the operator must devote the most attention in order to maintain optimum cooling tower production. Downtime and associated losses can be prevented by proper operation and maintenance. Preparation of shutdown maintenance schedule makes the proper inspection of cooling tower. This shutdown maintenance schedule reduces the instant failure of the cooling tower thus enhances the

life of cooling tower components. Proper water treatment of cooling tower as per scheduled maintenance also reduces the uneven biological growth, scaling and corrosion.

2) For cooling tower shutdown maintenance activity data Collected from the cooling tower maintenance manual. Which will help in proceeding that how to do our maintenance work and what is the sequence of cooling tower shutdown maintenance preceding?
3) After the thorough study of maintenance manual, optimization of shutdown maintenance strategy is done so that the time elapsed in shutdown maintenance is reduced.
4) After the thorough study of maintenance manual, optimization of shutdown maintenance strategy is done so that the cost associated with maintenance (labour cost) is reduced.
5) In cooling tower maintenance we save 12.93% labour cost which is associated with shutdown maintenance activity. In shutdown maintenance activity we also save the requirement of labour for the activity.
6) In cooling tower maintenance we save 34.28% time which is associated with shutdown maintenance activity. In shutdown maintenance activity we merge some of the activity on the basis of their uses and the sequence in the shutdown maintenance activity chart. So that the overall performance of cooling tower is increases and the efficiency of power plant also increases.

REFERENCES

[1] Alok singh, S P S Rajput, "Thermal Performance Evolution of 2-D CFD Model of Natural Draft Wet Cooling Tower", International Journal of Scientific & Engineering Research, Volume 3, Issue 3, March -2012.
[2] Randhire Mayur A., "Performance Improvement of Natural Draft Cooling Tower, International Journal of Engineering Research and Reviews (IJERR)", Vol. 2, Issue 1, January-March 2014.
[3] Chi-Ming Chu, Md. Mizanur Rahman, Sivakumar Kumaresan, "Effect of cold inflow on chimney height of natural draft cooling towers", Nuclear Engineering and Design 249 (2012) 125–131
[4] Hasan Ozcan, Kemal Ozdemir, Hakan Ciloglu, "Optimum cost of an air cooling system by using differential evolution and particle swarm algorithms", Energy and Buildings 65 (2013) 93–100
[5] B Bhavani Sai, I Swathi, K S L Prasanna, K Srinivasa Rao, "DESIGN OF COOLING TOWER", International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May -2013.

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