Rehabilitation Equipment	Spot Cooler at Water Sampling Room

Fig.5.1-35

Current status

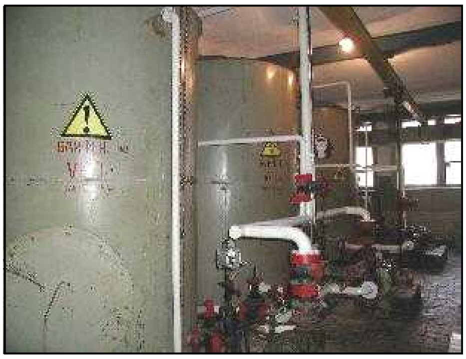
(1) The boiler sampling rack is contained in the container installed in the boiler house per each boiler.
(2) The door of a container entrance is usually locked and the inside of a container is very clean.
(3) However, because of the high surrounding temperature of the container and the installed manual analysis rack in the container, the temperature in the boiler sampling room is always very high at over 40°C.
(4) Although two sets of ventilation fans were installed for every container during Phase-I, there is no effect in temperature reduction.

Improvement plan

Spot air conditioners will be installed in No.1 - No.4 boiler sampling rooms for the purpose of reducing temperature. In Phase-II, No.5-No.8 boilers to be rehabilitated are scheduled to have spot air conditioners installed.

Rehabilitation Equipment	Substitute Chemicals for Ammonia and Hydrazine

Fig.5.1-36



Current status

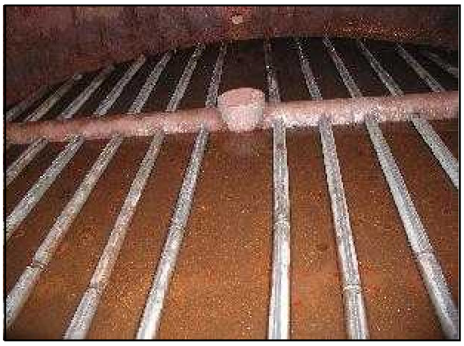
(1) The ammonia and hydrazine which are now used for feed water treatment are strong toxic chemicals. Also, internationally, there is a movement towards prohibition of use.
(2) TES4 is planning to introduce substitute chemicals if these are safe and cheap for feed water treatment.

Improvement plan

A study was executed about substitute ammonia and hydrazine chemicals. The result is shown in Ex 5.1-4.

Rehabilitation Equipment	Chemical Lining and Coating of Tubes and Tanks

Fig.5.1-37



Current status

(1) The tanks of water treatment equipment have remarkable damages of the lining, and these tanks also rust.

(2) TES4 has planned measures for repair and is implmenting them one by one. TES4 wishes for transfer of chemical protection technology and the repair method.

Improvement plan

The chemical protection technology over the corrosion is introduced in Ex 5.1-5.

Table 5.1-2 The Cause of Motor Burning in the Year 2000 and Improvement Plan

Cause	*The quantity of motors*	*Improvement Plan*
0.4 kV Motor		
Stick	15	Check of an installation situation、start check, Improvement of environment condition
Commutator damage	8	Enforcement of Quality Control
Overload	10	Check of motor capacity
Failure by water, steam, and humidity	6	Improvement of environment condition
Failure of cables	4	Replacement of cable
Coil	12	Enforcement of Quality Control
Shortage of repair cost	6	Early repair by preventive maintenance
Defect of motor winding	3	Enforcement of Quality Control
6.0 kV Motor		
Failure of winding	8	Enforcement of Quality Control
Failure of HV switchgear (OCB)	1	Maintenance of HV switchgear
Failure by water, steam, and humidity	6	Improvement of environment condition
Failure of stator	7	Observance of motor start rules, Enforcement of Quality Control
Failure of lead	1	Maintenance of lead
Failure of rotor	6	Observance of the restriction about the number of times of starting, Enforcement of Quality Control
Misoperation	2	Check of an operation procedure, Observance of operation procedure

Ex 5.1-1 Study of a Radiator Cooling Tower (Air-cooled Condenser)

1. Feature

(1) Radiator cooling towers have been in use since 1940 in Europe, and many of them are used on a scale of 10 MW (1 MW - 50 MW).

(2) Example: 300 MW × 2 Units × 25-year operation cost (Source: 1990 data for Thailand)

Feature		Wet Cooling Tower	Radiator Cooling Tower
Equipment cost	(MYen)	1,530	4,320
Maintenance cost	(MYen)	180	910
Operation cost	(MYen)	8,140	4,320
Cost Evaluation	(MYen)	9,850	9,550

2. Advantage

(1) Radiator cooling towers do not have evaporation of water compared with wet cooling towers (open type), so the circulation water that causes scale accumulation in the condenser tube does not accumulate.

(2) Radiator cooling towers do not have evaporation of water compared with wet cooling towers (open type), so the circulation water that causes scale accumulation in the condenser tube does not accumulate.

(3) The amount of the water used is limited to initial filling and supplement, which is drastically less than in wet cooling towers.

3. Disadvantage

(1) Installation and repair are expensive compared with wet cooling towers.

(2) Since the air temperature in summer is high, a water-cooled exchanger may be needed to assist in achieving the desired low temperature.

(3) Since the air temperature in summer is high, a water-cooled exchanger may be needed to assist in achieving the desired low temperature.

4. Conclusion

The cost of equipment of radiator type cooling towers is about 3 times that of wet cooling towers. In Thailand, equipment cost is equivalent wet cooling towers after it has operated for 20 years or more. Therefore, when installing for only 5 to 10 years operation, if the lifetime of the existing plant in TES4 is taken into consideration, it is inadvisable to adopt radiator type cooling towers.

Ex 5.1-2 Study of Condenser Tube Cleaning Equipment

1. Feature

(1) The cost of equipment of radiator type cooling towers is about 3 times that of wet cooling towers. In Thailand, equipment cost is equivalent wet cooling towers after it has operated for 20 years or more. Therefore, when installing for only 5 to 10 years operation, if the lifetime of the existing plant in TES4 is taken into consideration, it is inadvisable to adopt radiator type cooling towers.

(2) The tube cleaning equipment mentioned in (1) projects cleaning balls into the condenser inlet automatically during operation to remove dirt and foreign matter inside the tubes.

2. Possible application problems of TES4

(1) If a cleaning ball is discharged into the sea or a river (made of natural rubber) or worn out and exhausted while in use, decomposition absorption is carried out by nature. The water of TES4 receives the groundwater sent from the well as cooling water, and uses it to cool the condenser and others including the boiler make-up water and axial cooling water. Problems may occur from worn washing balls coming clogged in other water systems.

(2) The cost of equipment is about 200 M Yen／set. Further, cleaning balls need to be removed and approximately 10,000 replacements are required per turbine per year. The annual consumption cost is approximately 6 M Yen for 6 turbines (60,000 pieces).

3. Conclusion

Instead of installing condenser tube cleaning equipment in TES4, installing mechanical filter in the cooling water system and periodical cleaning for the cooling towers and condenser tubes is more effective.

Ex 5.1-3 Measure to Temperature Rise in Coal Yard

Coal stocking management methods for Mongolian brown coal to prevent temperature rise in coal yards during stocking are as follows.

Compacting sub-bituminous coal as soon as it arrives at a coal yard is effective in preventing stocked coal temperature. In principle, surface compaction is not performed after surface compaction. Coal receipt and surface compaction can be performed in turns or in parallel and neither method causes a rise of stocked coal temperature. Further, water spraying to prevent temperature rise can be omitted. If surface compaction is performed correctly, the temperature of the coal pile does not have to be monitored.

On the other hand, when surface compaction is not performed at the time of receipt and stocked coal temperature rises, surface compaction work is performed only within the portion where the temperature has risen. When the temperature of this portion was not lowered it had to be consumed.

Our company, which mainly uses bituminous coal, employs remote temperature supervision equipment when a temperature rise in coal stocked over a long period of time is suspected. When a temperature rise occurs, watering and compaction are performed in parallel with restacking stockpiles. Performing watering on its own is insufficient because the temperature rises quickly again.

Surface compaction is effective against temperature rise, particularly when this is performed immediately after receipt of the coal.. Watering the coal pile as measures against temperature rise is unnecessary.

In addition, there are large-scale coal yards where stackers/re-crammers are used having a limited number of bulldozers only for accidents such as crash restoration etc. It is difficult to increase the number of bulldozers for temperature rise in certain types of coal. Although a surface-active agent to prevent penetration of the air (which is a cause of temperature rise) inside piles has been studied, this may prove expensive and ineffective because it is washed away by watering to prevent coal dust scattering and rain so it is not in practical use.

Ex 5.1-4 Substitutive Chemicals for Hydrazine and Ammonia

1. Hydrazine

Hydrazine is classified as a human carcinogen by several organizations, such as the American Conference of Governmental Industrial Hygienists (ACGHI), International Agency for Research on Cancer (IARC), and the Ministry of Labor (Japan), and use of a substitute is progressing in industrial power plants leading food industries etc.

The substitute is expensive and is not adopted as electric power. It is necessary to observe a future regulation trend and the development situation of a substitute. It is necessary to use Hydrazine under management proper for the time being.

The specific properties of Hydrazine and substitutive chemicals are shown in table 5.1-3.

Table 5.1-3 A Specific Properties of Hydrazine and Substitutive Chemicals

Name of medicine	Hydrazine	Diethyl-hydroxyl-amine	1-Amino-pyrrolizidine	Calbo-hydrazid ˋ
Area using		EU	JAPAN	USA
Industries			Food, Paper mill	
Prod. form	Solution、Powder		Solution	Solution
Molecular formula	N_2H_4	$C_4H_{11}NO$	$C_4H_{10}N_2$	$(N_2H_3)2CO$
Molecular weight	32.05	89.14	86.14	—
De-oxygen				
1g/2.0Mpa	0.64g	0.20g	0.46g	Hydrazine equivalent
1g/7.5Mpa	0.46g	0.10g	0.38g	—
Corrosion proof	≦1mdd	≦1mdd	≦1mdd	Hydrazine equivalent
steam / feed water ratio				
150～200℃	0.1～0.2	10～20	0.6～0.8	—
		Corrosion proof in steam header pipes		
Heat stability	50%	≦5%	90%	
Fire protection Law application	4 - 3 risk class combustibility	4 - 3 risk class combustibility	4 - 3 risk class combustibility	N / A
Toxic substance classification	Toxic material	N / A	N / A	N / A
Poisonous to fishes (96h)	3.8mg/L	1184mg/L	112mg/L	190mg/L
Kind of fishes	Fathead-mino	Chub/48h	Carp	Bluegil
Oral toxicity (mouse)	53mg/kg	1828mg/kg	409mg/kg	5000mg/kg
Dermal toxicity (rat)	168mg/kg	—	1131mg/kg	2000mg/kg
Product price	100(base)	170	100	120
Required amount	100(base)	300	150	100
Total cost	100(base)	500	150	120

2. Ammonia

Ammonia does not have a substitute effective now. It is necessary to use it under management proper as a poison/toxic substance for the time being.

Ex 5.1-5 Chemical Lining and Coating

1. Introduction

For many years, gum resin, phenol resin, etc. have been used as organic lining materials to protect metal devices and the concrete structure from corrosion. A film of paint thinner than the lining (200 micrometers and under) also aids in corrosion protection and improves appearance. Recently, however, a heavy anticorrosion paint has been developed so the thickness distinction between paint and lining has been lost, and performance as an anticorrosive is important.

2. The classification of resinous lining

There are various classification methods, such as a kind of applied polymeric material, mechanism of coating formation, form of lining material, and lining method. Lining methods classified according to the form of the lining material, come into one of the three methods below.

(1) Either pasting up a plastic board or a film with adhesives fixes a film sheet, or carrying out a screw stop fixes a film sheet. And a film sheet fits the lining of a large-sized towers, pits, and devices. On-site lining is possible and it is applied to all fields. Practical use heat resistance is 150°C maximum.

(2) Aquiform resin is a method of adding liquefied or pre polymer with catalyst or an abridges agent. Lining strengthened by heavy corrosive protection paint and synthetic resin belongs to this category. Lining that is mix-kneaded with glass flakes or inorganic filler are called flakes lining and resin mortar lining, respectively. By making each resin into a matrix, the lining laminating to fiber cloths such as glass fiber and carbon fiber, is called FRP lining. These are heat-hardened resin, and although both normal temperature and heating hardening are possible, the heated resin has higher bridged density and improves corrosion resistance. Practical use heat resistance is limited to 150-200°C in liquid temperature and to 130-150°C in gas. Resin, such as phenol, furan, epoxy, unsaturated polyester, and vinyl ester, is used.

(3) Powdered resin is formed by heating and melting powdered polymer or the pre polymer to form a film. This method is to contact, into air current of powdered polymer, the heated lined body to the liquid spray lining by the liquid spray machine. There are the flow immersing method forming melting film, the dispersion method in which the polymer is soaked in a suitable solvent, and given by over heat melting after spray, and the electrostatic coating method etc. These are called plating coating so far.

3. Characteristic of Lining Materials

The materials to be used for corrosion-proof lining shall be excellent in chemical resistance. Since functionality, such as heat resistance, wear-proof nature, season-proof, and non-adhesives are required in many cases; it is necessary to select a material suitable for conditions.

Material Names	Acid resistance	Acid resistance	Organic solvent-proof	Max temp in use	Work cost
Gum resin	○	○	×	50°C	80
VCM/PVC resin	○	○	×	60°C	100(base)
Epoxy resin	△	○	×	90°C	200
Polyester resin	○	○	×	100~120°C	300
Furan resin	○	○	○	150~200°C	400
Stainless steel	×	○	○	>200°C	—

4. Conclusion

Work cost increases lining cost depending on the implementation methods, such as the polymer material used, heating hardening raising tolerance. It is important to check operating conditions such as temperature, and to select a suitable material and work method.