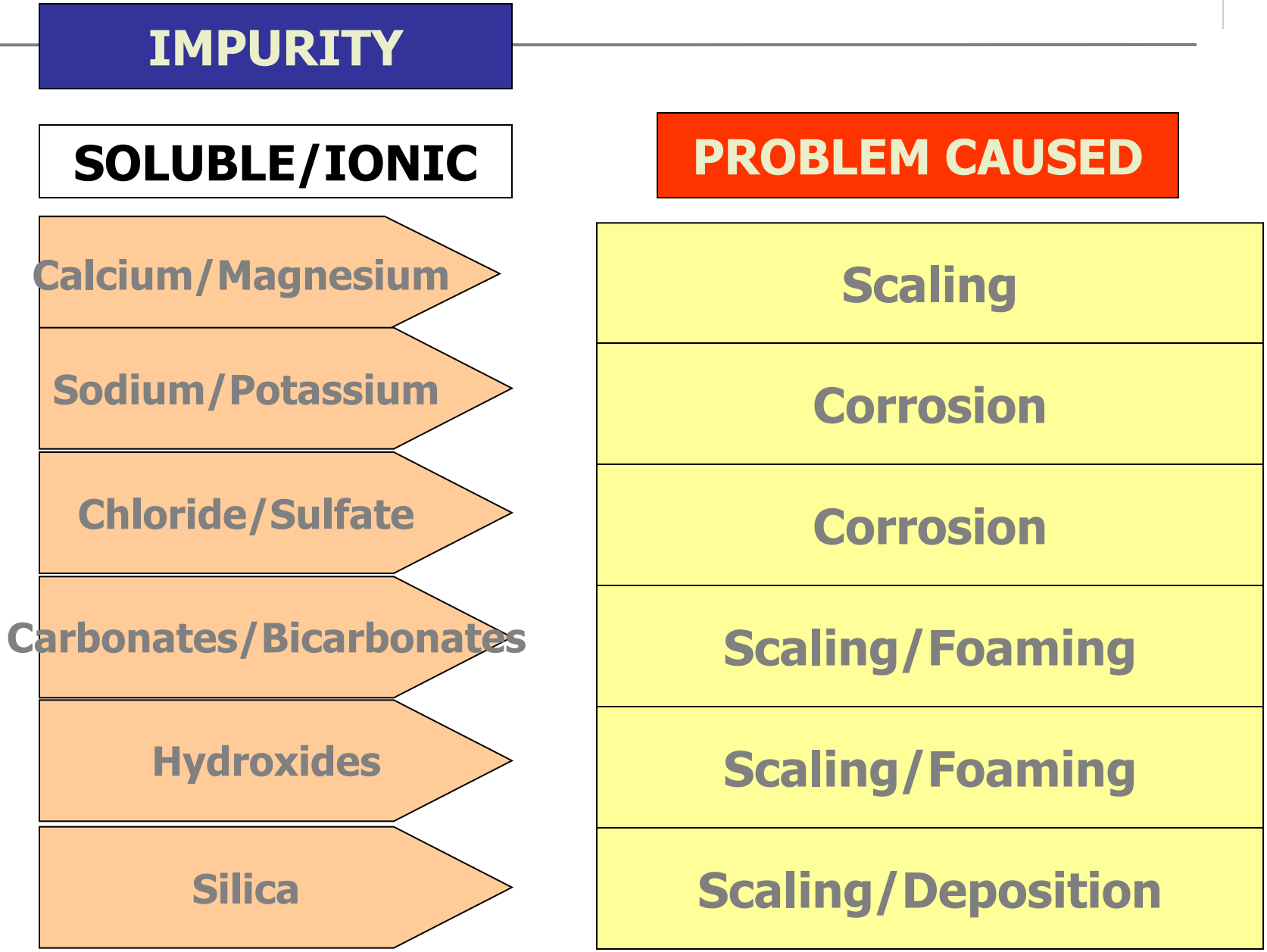
Boiler Water Treatment

Contents

- ✓ Water Chemistry w.r.t. Boiler
- ✓Problems associated w.r.t. Water chemistry
- ✓Objective and importance of boiler water treatment
- ✓ Various programs in boiler water treatment
- ✓ Dosing of chemicals and monitoring

Water Chemistry

IMPURITY		PROBLEM CAUSED
GASEOUS		
Dissolved Oxygen	→	Pitting Corrosion
Carbon Dioxide	→	Condensate Corrosion


IMPURITY
SOLUBLE/IONIC
PROBLEM CAUSED
Calcium/Magnesium
Scaling
Sodium/Potassium
Corrosion
Chloride/Sulfate
Corrosion
Carbonates/Bicarbonates
Scaling/Foaming
Hydroxides
Scaling/Foaming
Silica
Scaling/Deposition

IMPURITY	PROBLEM CAUSED
INSOLUBLE/NONIONIC	
Suspended Solids/Silt	Fouling
OTHERS	
Oil/Organics	Foaming / carryover

Water- impurities related problems in Boiler

SCALING

Location - Boiler water tubes

INADEQUATE MAKE UP WATER QUALITY

SCALING

SCALE FORMING IONS
Ca ++,Mg ++,CO3--,HCO3 --,SiO3

$$Ca + 2HCO_3 \rightarrow CaCO_3 + H_2O + CO_2$$
$$Ca + SO_4 \rightarrow CaSO_4$$
$$Ca + SiO_3 \rightarrow CaSiO_3$$
$$Mg + SiO_3 \rightarrow MgSiO_3$$

- OVER HEATING OF TUBES
- REDUCTION OF HEAT TRANSFER
- CALLS FOR SHUT DOWN
- RESTRICTION OF WATER FLOW

CONTAMINATED CONDENSATE LEAKAGE
OF TURBINE CONDENSORS/ PROCESS LEAKS

CORROSION

LOW pH
DISSOLVED OXYGEN

METAL LOSS,PITTING
LOSS OF PROTECTECTIVE OXIDE FILM
(DESIRED PROTECTECTIVE FILM IN BOILER IS MAGNETIC IRON OXIDE, Fe_3O_4. OXYGEN DESTRUCTS THE PROTECTIVE OXIDE FILM)

$$Fe_3O_4 + O_2 \rightarrow 6\ Fe\ 2O_3$$

Oxygen pitting of a boiler feedwater pipe.

Economizer tube severely damaged by oxygen.

CORROSION

HIGH CAUSTIC ALKALINITY

CAUSTIC CORROSION / EMBRITTLEMENT

$Fe_3O_4 + 4NaOH = 2\ NaFeO_2 + Na_2FeO_2 + H_2O$

(Sodium ferroate)

$Fe + NaOH = Na_2FeO_2$(Sodium Ferrite) $+ H_2$

CORROSION

CARBONDIOXIDE

CONDENSATE CORROSION

BICARBONATES + HEAT ➡ CO_2

$CO_2 + H_2O$ ➡ H_2CO_3 (CARBONIC ACID)

$Fe + H_2CO_3$ ➡ $Fe(CO_3)_2$

Boiler tube shows effect of acid attack.

CARRYOVER

MECHANICAL

- HIGH WATER LEVEL
- INCOMPLETE SEPARATION
- OF STEAM& WATER
- HIGH STEAMING RATE
- BOILER DESIGN
- UNEVEN FIRE DISTRIBUTION
- LOAD FLUCTUATIONS

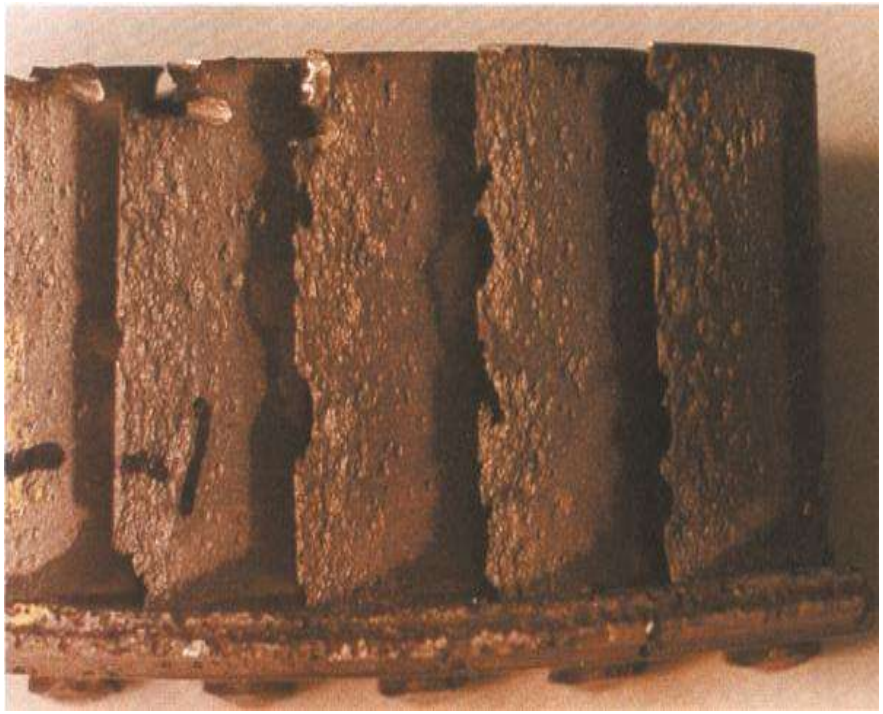
EFFECT

- AFTER BOILER DEPOSITS
- PLUGGED VALVES AND TRAPS
- DEPOSITION ON TURBINE BLADES

CHEMICAL

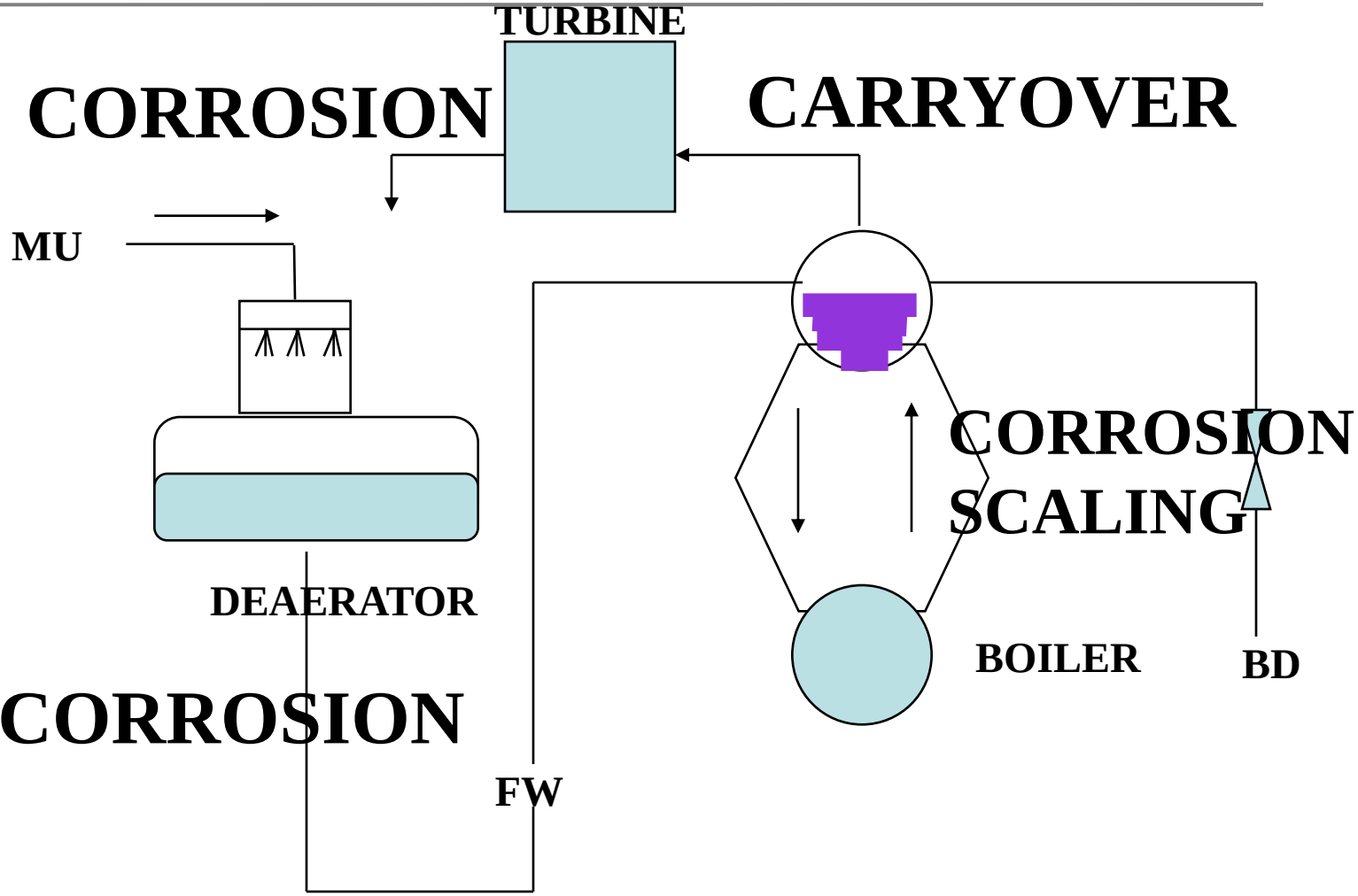
- HIGH TDS (TOTAL DISSOLVED SOLIDS)
- HIGH ALKALINITY
- LEAKAGE OF OIL / ORGANICS

TURBINE DEPOSITS



Corroded blades

Deposits on turbine before cleaning



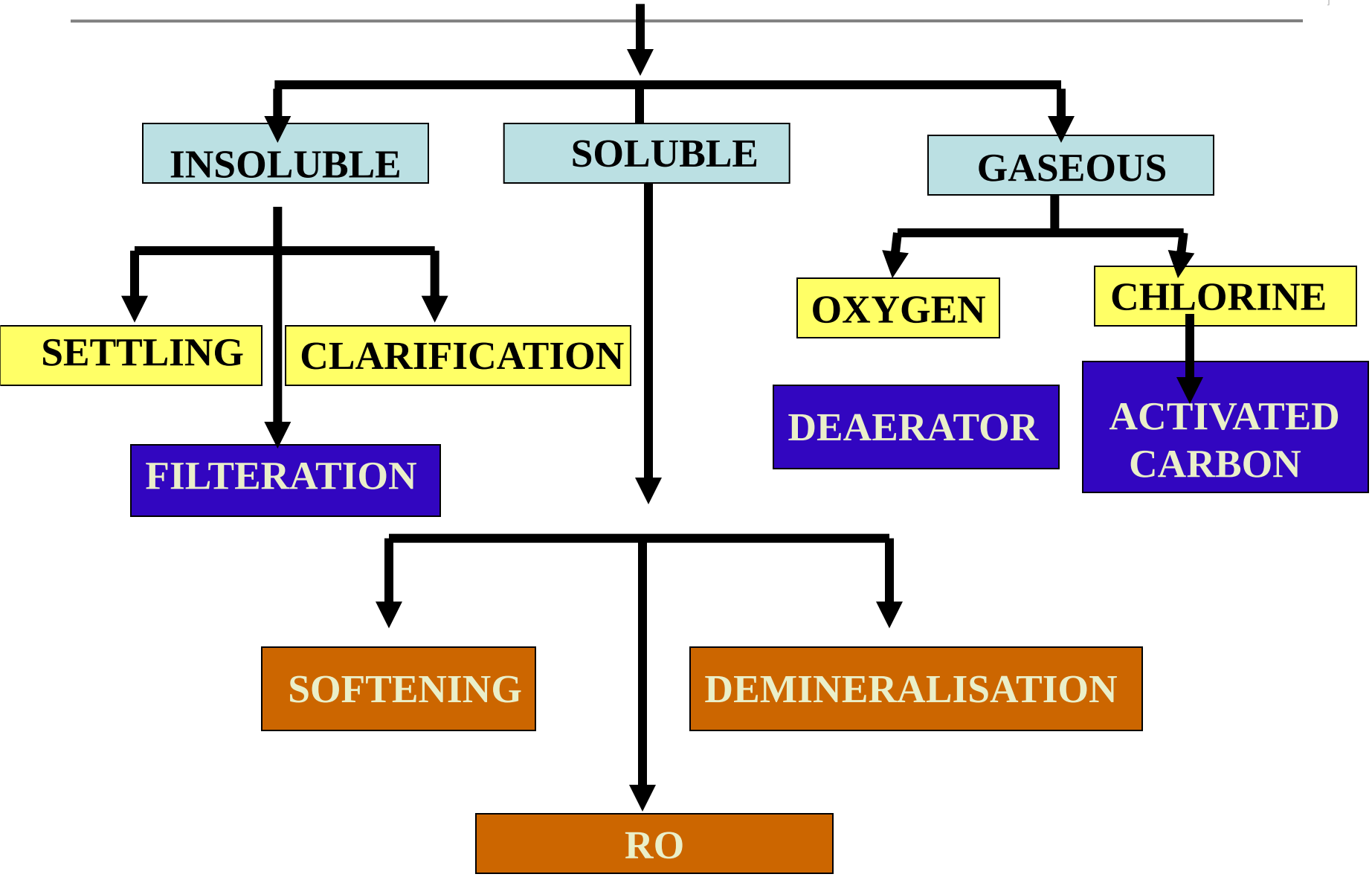
WATERSIDE PROBLEMS IN BOILER SYSTEM

Types of boiler feed water treatment

- **External treatment**

- **Internal treatment**

EXTERNAL TREATMENT



INTERNAL TREATMENT - OBJECTIVE

Malfunctioning In External Treatment

- RO / FILTERS / DM PLANT / DEAERATOR

- Change in Inlet Water Quality
- Increase in Inlet Water Quantity
- Decrease in Resin Exchange Capacity
- Improper Regeneration of Resin

Internal Treatment - Need

External treatment is supported with internal treatment


To take care during upsets in water quality


To maintain the BFW/BW & Steam quality as per specified norms.

INTERNAL TREATMENT- INSURANCE

- **TO MINIMISE REPLACEMENT COST**
  Very low compare to replacement cost of equipment

- **TO AVOID POOR HEAT TRANSFER DUE TO SCALING ISSUES**
  Increases Fuel Consumption / Cost of Steam

- **TO AVOID PRODUCTION LOSS**

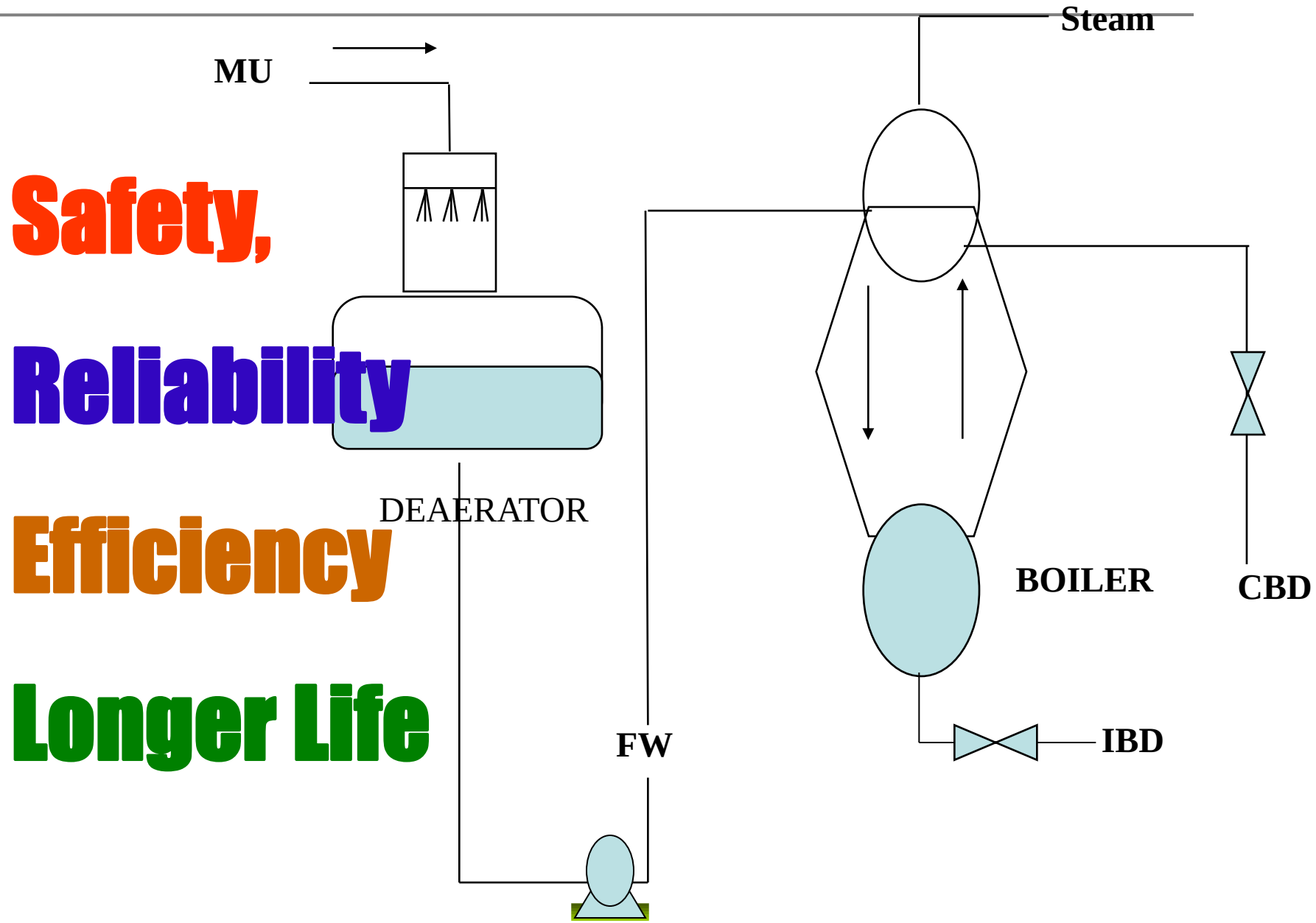
Internal Treatment

Safety,

Reliability

Efficiency

Longer Life



Internal Treatment - Various Programs

- **Phosphate Hydroxide Program**
- **Polyphosphate-Polymer Based**
- **Coordinated Phosphate control**
- **Oxygen scavengers**
- **Neutralizing amines**
- **All volatile treatment**

Oxygen Scavenger

Features of oxygen scavenger

- Oxygen scavenging
- Metal Passivator
- Volatile compound
- Organic Treatment

Blend of Neutralizing Amines

Different types of Amines

- **Morpholine**
- **Cyclohexylamine**
- **Diethyl-aminoethanol (DEAE)**
- **Methoxypropylamine**
- **Amino Butanol**
- **Dimethyl amino ethanol (DMAE)**

Function of Neutralizing Amines

- to maintain the pH of the feed water
- to maintain the pH of condensate water’

Ensuring corrosion protection of pre (feed water section) and post boiler (condensate water system)

While selecting any neutralizing amine program, three factors are to be considered.

- **Distribution ratio-** It indicates how much of the amine will go with the steam and how much remains in the condensate.

- **Basicity-** It indicates the capacity of the amine to neutralize the acidity

- **Thermal Stability-** Is a measure of ability of the amine to be used in modern high temperature and pressure boilers without degradation.

Usually a blend of 2 or 3 different types of amines are used to provide protection to entire condensate system.

Standard boiler water treatment

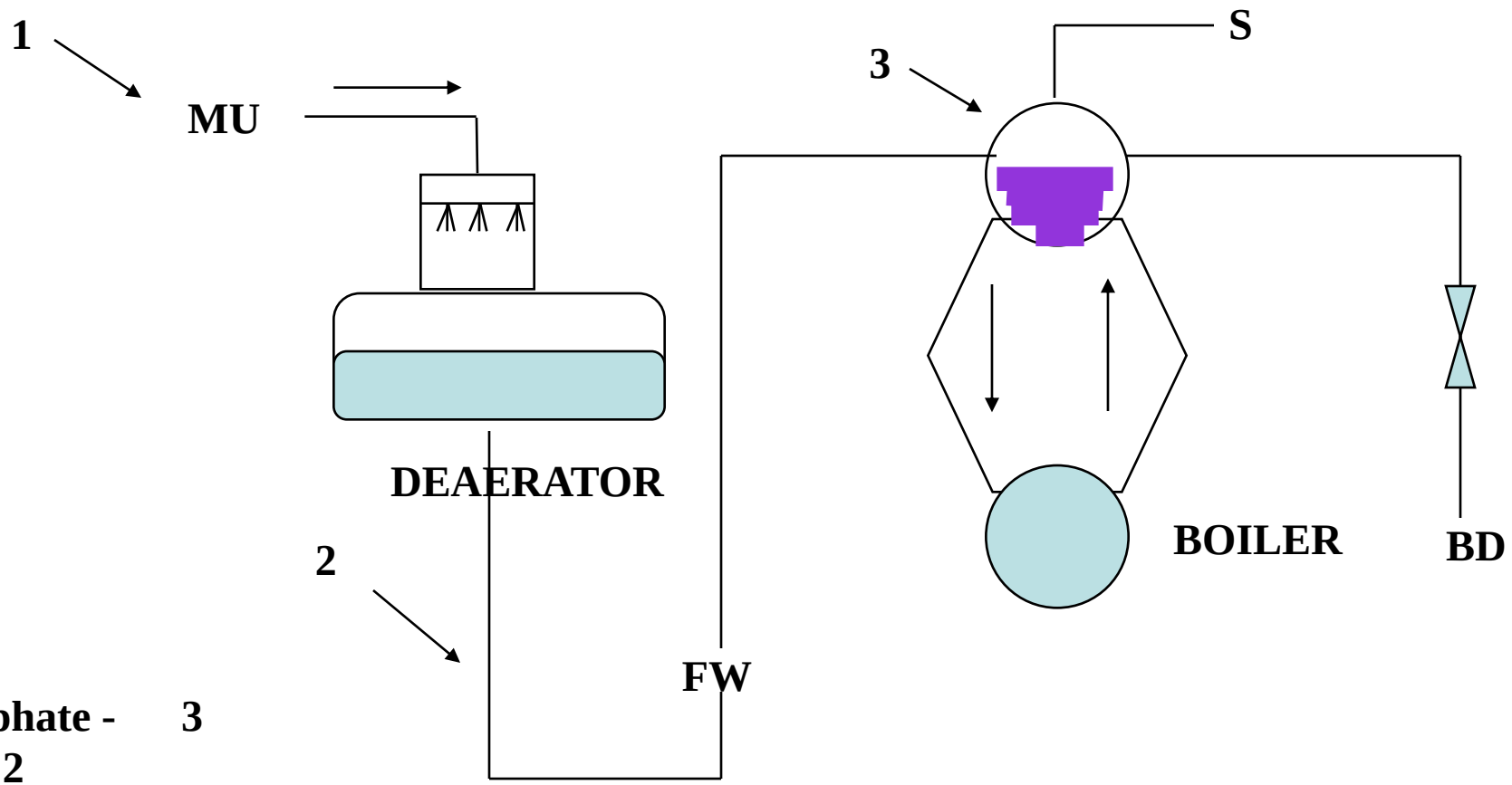
Combination of

- Tri Sodium Phosphate + Di Sodium Phosphate
- Oxygen scavenger
- Neutralizing amine

DOSAGE

- **OXYGEN SCAVENGER**
  - Based on Feed water temperature
- **SCALE / CORROSION INHIBITOR**
  - Based on PO4 residual to be maintained in boiler/ on blowdown
- **NEUTRALIZING AMINE**
  - Based on pH of BFW/BW/Condensate water

Boiler Treatment recommended Chemical Feed Points



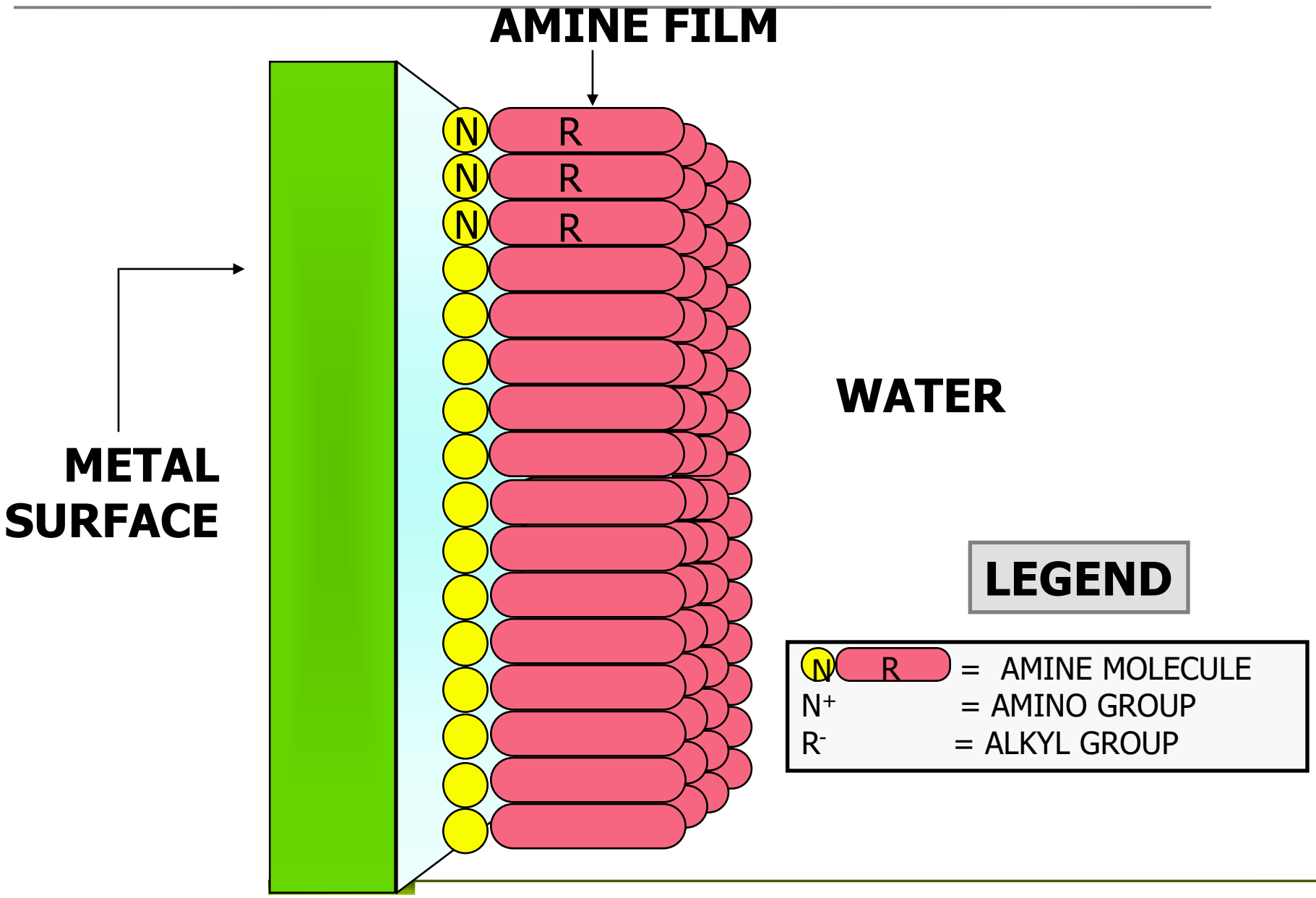
Phosphate - 3
OS - 2
Amine - 1 or 1 and 2

ALL VOLATILE TREATMENT

FUNCTION OF AVT

- **Filming amine**
- **Dispersing amine**
- **Neutralization amine**

PROTECTIVE FILM BARRIER



NEUTRALIZING REACTION

$R - NH_2$	+	H_2CO_3	----->	RNH_3	+	HCO_3	
Neutralizing amine		Carbonic acid		Amine		Bi-carbonate	

BENEFITS OF AVT

- Forms Protective Film preventing O_2 pitting
- Neutralizes CO_2 completely & prevents carbonic acid Corrosion
- Disperses loose corrosion deposits

BETTER

- Can be dosed through LP dosing section
- Ease in monitoring - less parameters
- Liquid formulation - ease of handling

Elimination of Phosphate

EASIER

LIMITATIONS OF AVT

- Primarily used in Power boilers where make water is 99% steam condensate (Pure water)
- High purity Feed water is mandatory – MB-DM Make up and non-contaminated condensate
- Increases load on CPU and reduces life of Resin
- Excess level of Ammonia – accelerate Copper corrosion
- Low boiler water pH (8.4 to 8.8) - chances of Silica carry over to turbine
- No protection from Chloride attack as no buffer alkalinity is available
- Non –acceptance of pH range of 8.4 to 8.8 by boiler manufacturer
- No authenticated recommendation by boiler manufacturers, Boiler Regulatory Authorities.

Dosing Procedure

- All the chemicals are to be dosed on continuous basis (24 hrs) with the dilution in water .

- Recommended 10 % dilution. However, it can vary according to dosing system capacity

- All the dosages are based on feed water quantity

Qty required in kg /day = $\dfrac{\text{Dose in ppm X FW quantity in MT X 24}}{1000}$

Blow-down

- **CBD (Continuos blowdown)**

- To remove concentrated water continuously
- Located in the area of highest boiler water concentration

Preferred way of blowdown as minimal loss of water and heat recovery of heat content by use of blowdown flash tank

- **IBD(Intermittent blowdown)**

- To remove sludge from the boiler
- Located in the bottom part of lowest boiler drum

One has to select the appropriate chemicals from mentioned list to use it as program

The selection of the program would be based on

- **Boiler pressure**
- **Application of the steam**
- **Feed water pre-treatment**
- **Feed water quality**
- **Boiler operating conditions (like feed water temperature, % blow down, etc.)**
- **Customer requirement**

Monitoring

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Monitoring of the treatment consists of

- Drawing and analyzing all the water samples including condensate water for defined parameters at decided interval on continuous basis
- Based on the analysis, take necessary actions to maintain the desired water parameters in defined limits
- Record the analysis and actions taken
- In case of upset in the treatment, frequency of analysis to be increased till system comes to normal

WATER ANALYSIS

- **Correct frequency of water analysis**
- **Follow standard analytical procedures**
- **Calibration of instruments**
- **Correct sample analysis**
- **Accurate water analysis**
- **Corrective steps incase of upset**

Parameters to be analyzed

- pH
- Conductivity/TDS
- Phosphate
- Sulfite/Hydrazine
- Silica
- Alkalinity
- Chloride
- Iron
- Residual Amine (incase of AVT)

Preservation

• **Wet preservation** (Boiler under shut for approx. less than month)

- By maintaining Sodium Sulfite @ 200 ppm in water and pH 10.5 in case of low pressure boiler

- By maintaining Hydrazine @ 200 ppm in water and pH 10.5 in case of high pressure boiler

• **Dry preservation**

After complete drying either of the following desiccants to be used

- Quicklime @ 6 lb / 100 ft3 of boiler volume
- Silica gel @ 17 lb / 100 ft3 of boiler volume
- Activated alumina @ 27 lb / 100 ft3 of boiler volume