Modern Water Management-basic Track Boilers

HORIZON
ACADEMY
INDUSTRIAL TRAINING ACADEMY

Horizon
Chemical
For Special Chemicals

Steam boilers are more sensitive to water impurities than the human stomach

Content :

- Definition of steam boilers
- Boiler Systems
- Uses of steam boilers
- Types of boilers
- boiler treatment why?
- Problems in boilers
- Boiler analysis
- Boiler cleaning

Definition of steam boilers

- A boiler is an enclosed vessel that convert water to steam under controlled conditions of temperature & pressure

Boiler Systems

- **feed water system** The two sources of feed water are: (1) Condensate or condensed steam returned from the processes and (2) Makeup water (treated raw water) which must come from outside the boiler room and plant processes.
- **steam system:** the steam system collects and controls the steam produced in the boiler. steam is directed through a piping system to the point of use. throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges
- **fuel system:** the fuel system includes all equipment used to provide fuel to generate the necessary heat. the equipment required in the fuel system depends on the type of fuel used in the system.
- **deaerator** to remove gases

Uses of steam boilers

- Heating
- As a Raw Material
- Motive Force
- Cleaning/Disinfection/Sterilization

Uses of steam in industry

- Nuclear Power Stations
- Refineries
- Petrochemicals/fertilizers/basic chemicals
- Pharmaceutical Industries
- Paper mills
- Food & beverage

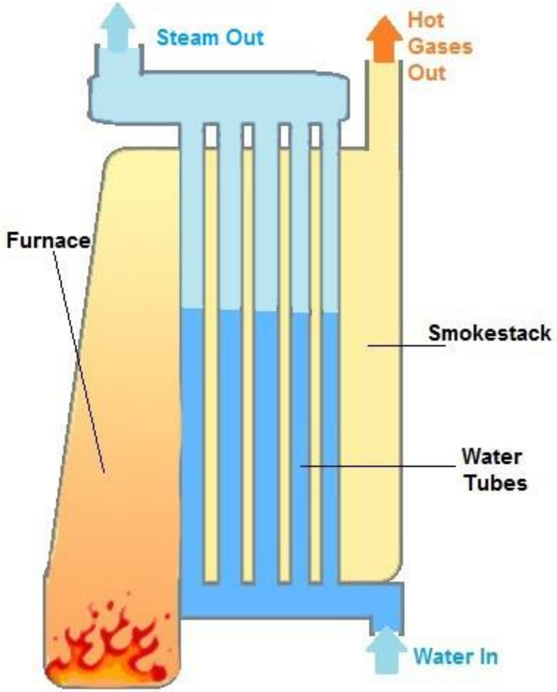
Types of boilers

- **1.According to production to:**
- Steam boiler
- Hot water boiler

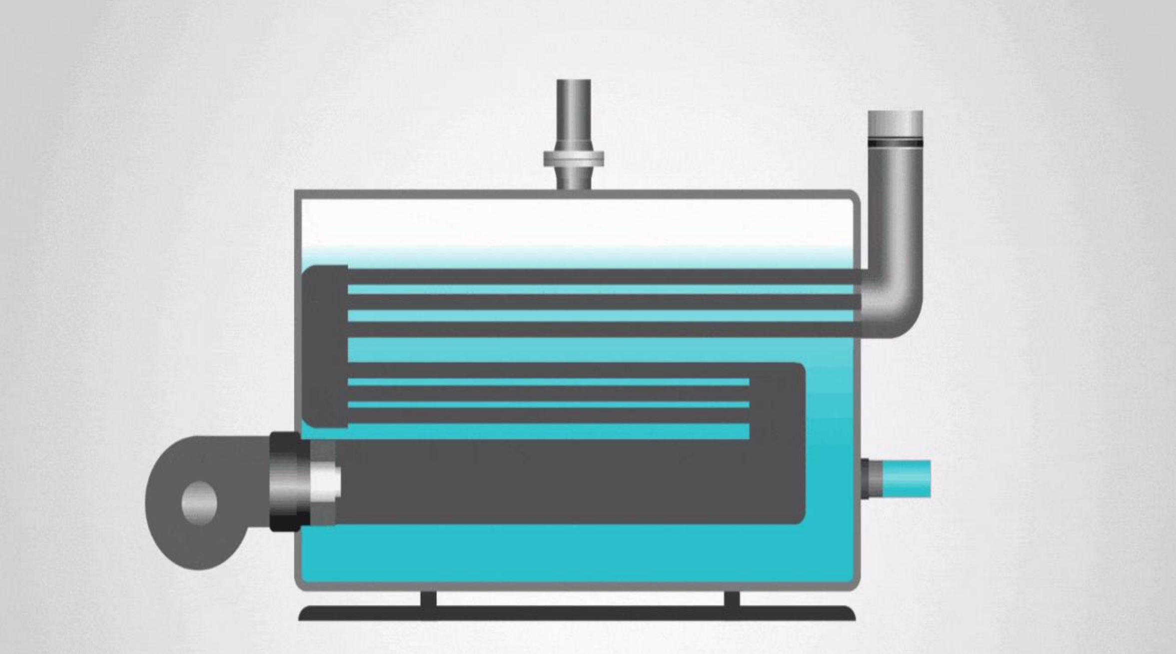
- **2.According to designing of boiler:**
- Fire tube
- Water tube

- **3.According to working pressure :**
- low pressure boiler
- High pressure boiler

Water tube boiler



fire tube boiler



- **Fire tube or “fire in tube” boilers** ; contain long steel tubes through which the hot gasses from a furnace pass and around which the water to be converted to steam circulates ,fire tube boilers, typically have a lower initial cost, are more fuel efficient and easier to operate, but they are limited generally to capacities of25 tons/hr and pressures of 17.5 kg/cm2

- **water tube or “water in tube” boilers** in which the water passes through the tubes and the hot gasses passing outside the tubes, these boilers can be of single- or multiple-drum type. these boilers can be built to any steam capacities and pressure and have higher efficiencies than fire tube boilers.

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	Fire tube boiler	Water tube boiler
1	In this type, the hot flue gases are present inside the tube and water surrounds them	The water is present inside the tubed and the hot flue gases surrounds them
2	The operating pressure is about 25 bar	The operating pressure is about 165 bar
3	The steam generation rate is low	The steam generation rate is high
6	The overall efficiency is up to 75%	The overall efficiency is up to 90%

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8	It can work on fluctuating loads for short time	It can work on fluctuating loads all time
9	Less bursting chance	More bursting chance
10	Due to bursting, there is a greater risk of damage to the boiler	Bursting doesn’t produce any major destruction to the whole boiler
12	Low operating cost	High operating cost
13	Can be operated with less skilled person	A skilled person is required to operate
14	Low maintenance cost	Low maintenance cost
15	It is suitable for small power plant	It is suitable for large power plant


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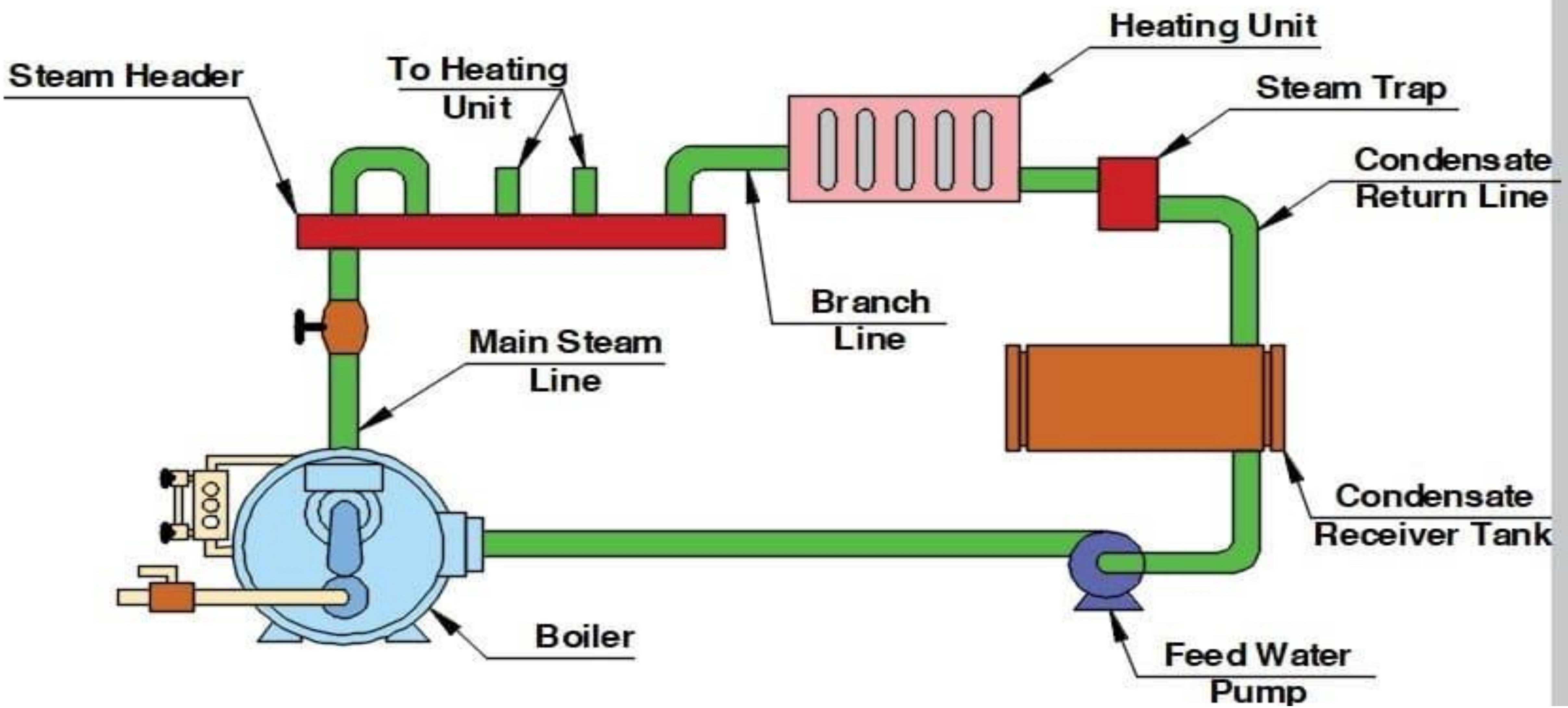
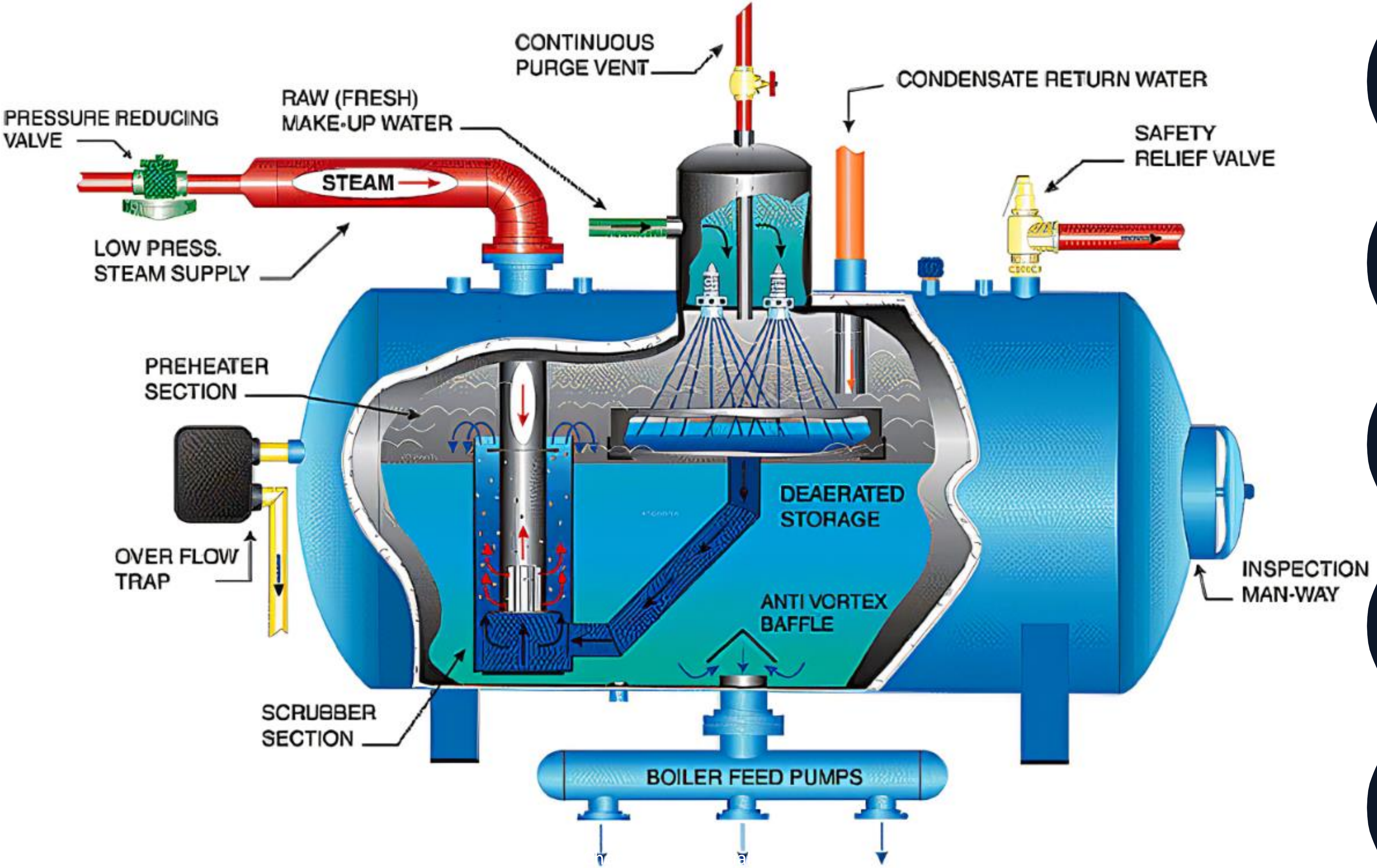
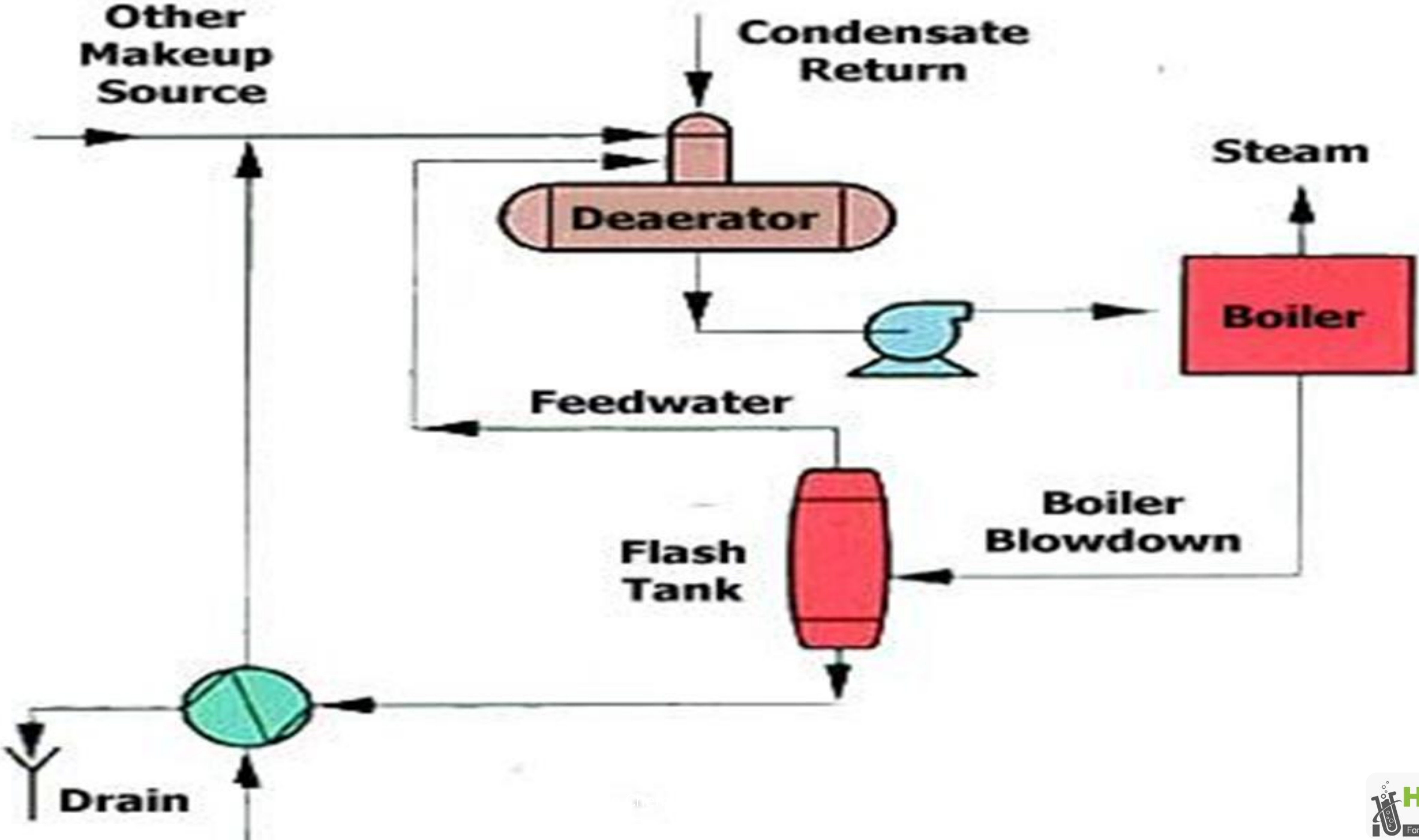
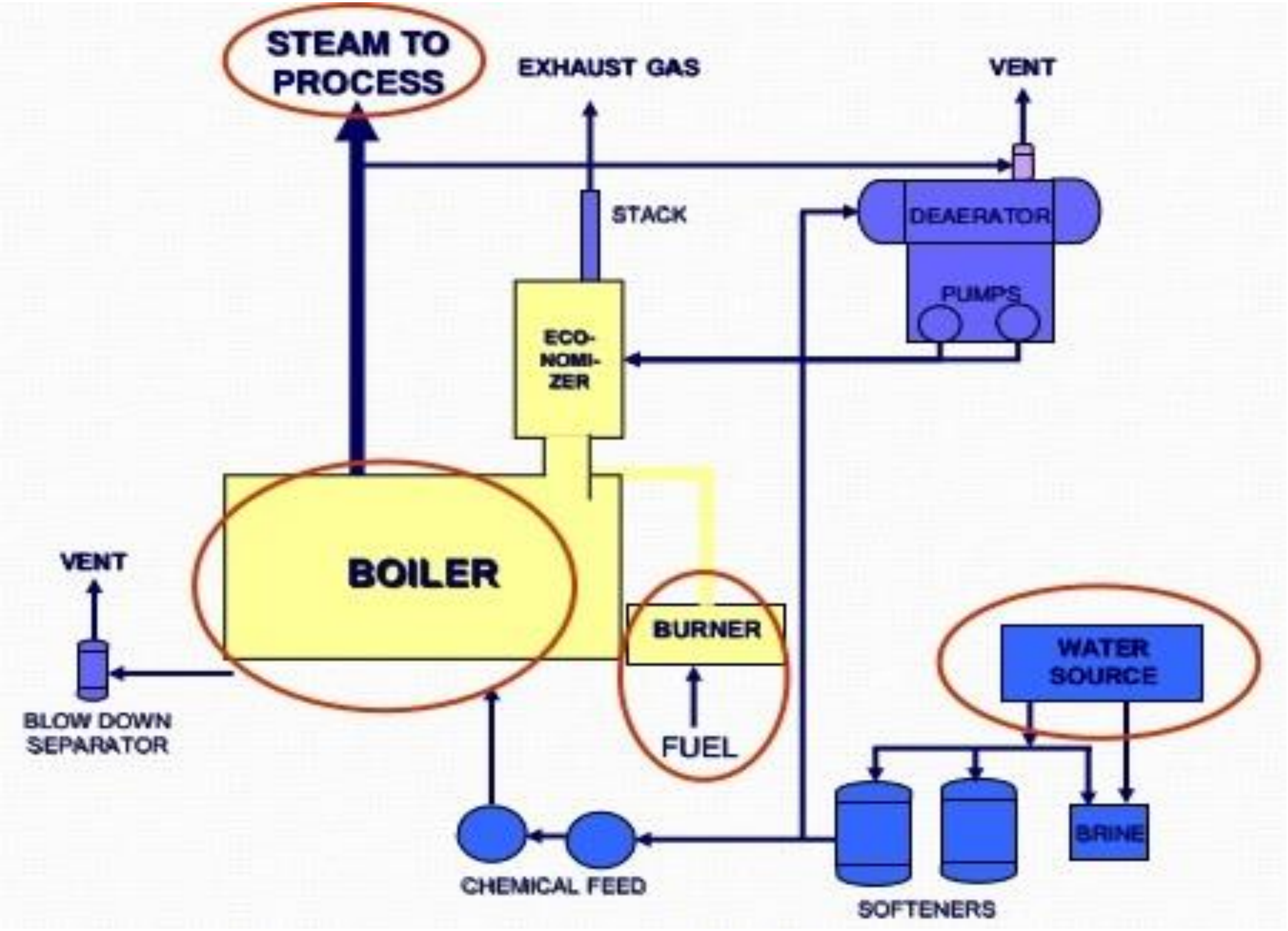
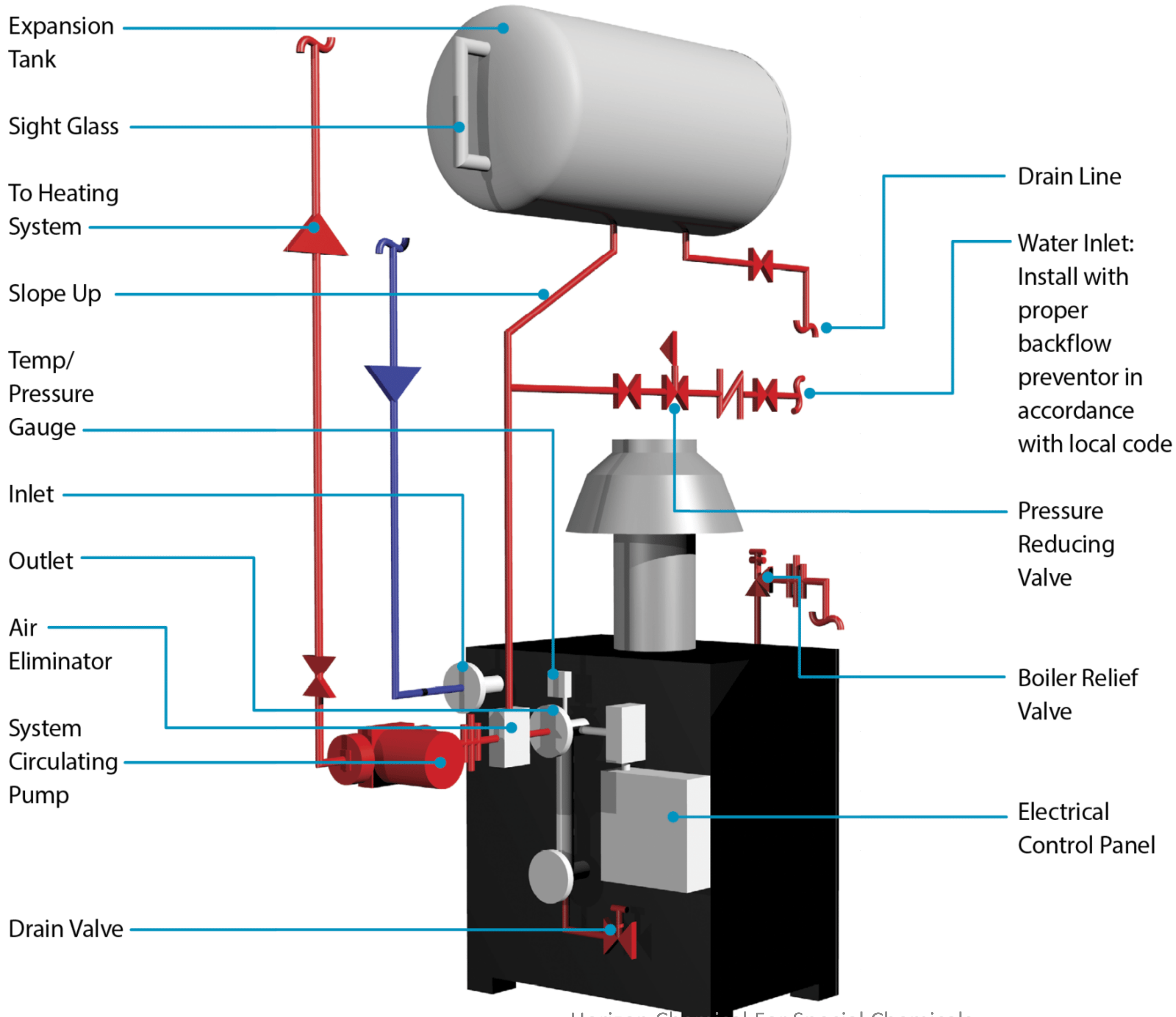
Steam Boiler




CONTINUOUS PURGE VENT
CONDENSATE RETURN WATER
RAW (FRESH) MAKE-UP WATER
PRESSURE REDUCING VALVE
STEAM
SAFETY RELIEF VALVE
LOW PRESS. STEAM SUPPLY
PREHEATER SECTION
DEAERATED STORAGE
OVER FLOW TRAP
INSPECTION MAN-WAY
ANTI VORTEX BAFFLE
SCRUBBER SECTION
BOILER FEED PUMPS


Other Makeup Source
Condensate Return
Deaerator
Steam
Boiler
Feedwater
Flash Tank
Boiler Blowdown
Drain


STEAM TO PROCESS
EXHAUST GAS
VENT
STACK
DEAERATOR
PUMPS
ECO-NOMI-ZER
VENT
BOILER
BURNER
WATER SOURCE
BLOW DOWN SEPARATOR
FUEL
BRINE
CHEMICAL FEED
SOFTENERS



Expansion Tank

Sight Glass

To Heating System

Slope Up

Temp/ Pressure Gauge

Inlet

Outlet

Air Eliminator

System Circulating Pump

Drain Valve

Drain Line

Water Inlet: Install with proper backflow preventor in accordance with local code

Pressure Reducing Valve

Boiler Relief Valve

Electrical Control Panel

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boiler treatment why?

- when water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. this causes the boiler to be extremely dangerous equipment that must be treated.
- for every 10°c rise in temperature, chemical reaction rates double

Problems in boilers

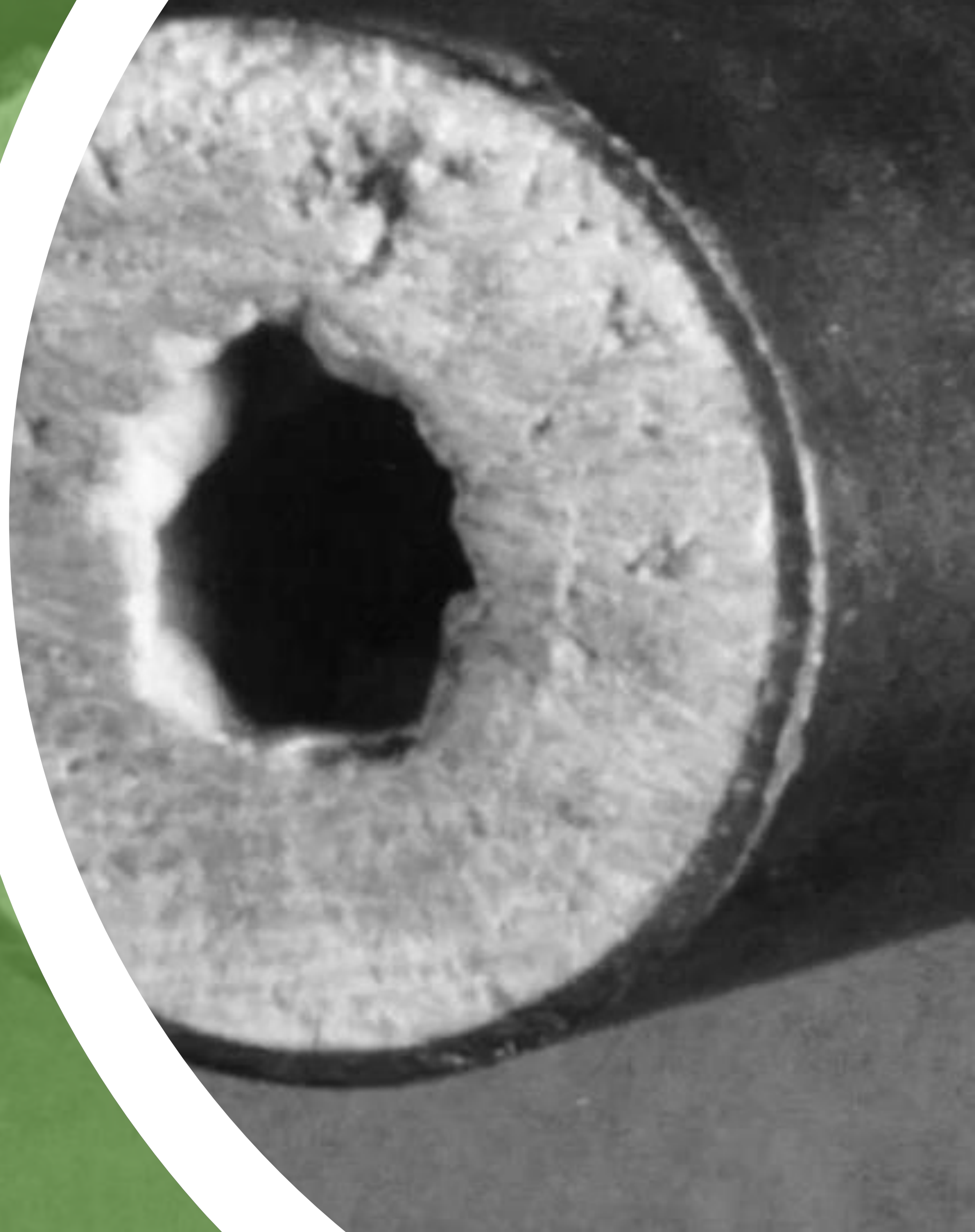
1. Scale
2. Corrosion
3. Deposition /fouling
4. Carryover

1.Scale

The deposition of sparingly soluble salts, usually as hard deposits which interfere with heat transfer and fluid flow

Scale can lead to:

- Loss of efficiency
- Higher fuel consumption
- Blockages
- Tube failure
- In severe, case explosions!



Types Of Scales

1- water born scales

1.1Mainly Ca , Mg

(CaCo3, CaSo4, CaSio3, MgO, MgSo4 , Mg(OH)2)

1.2 silica

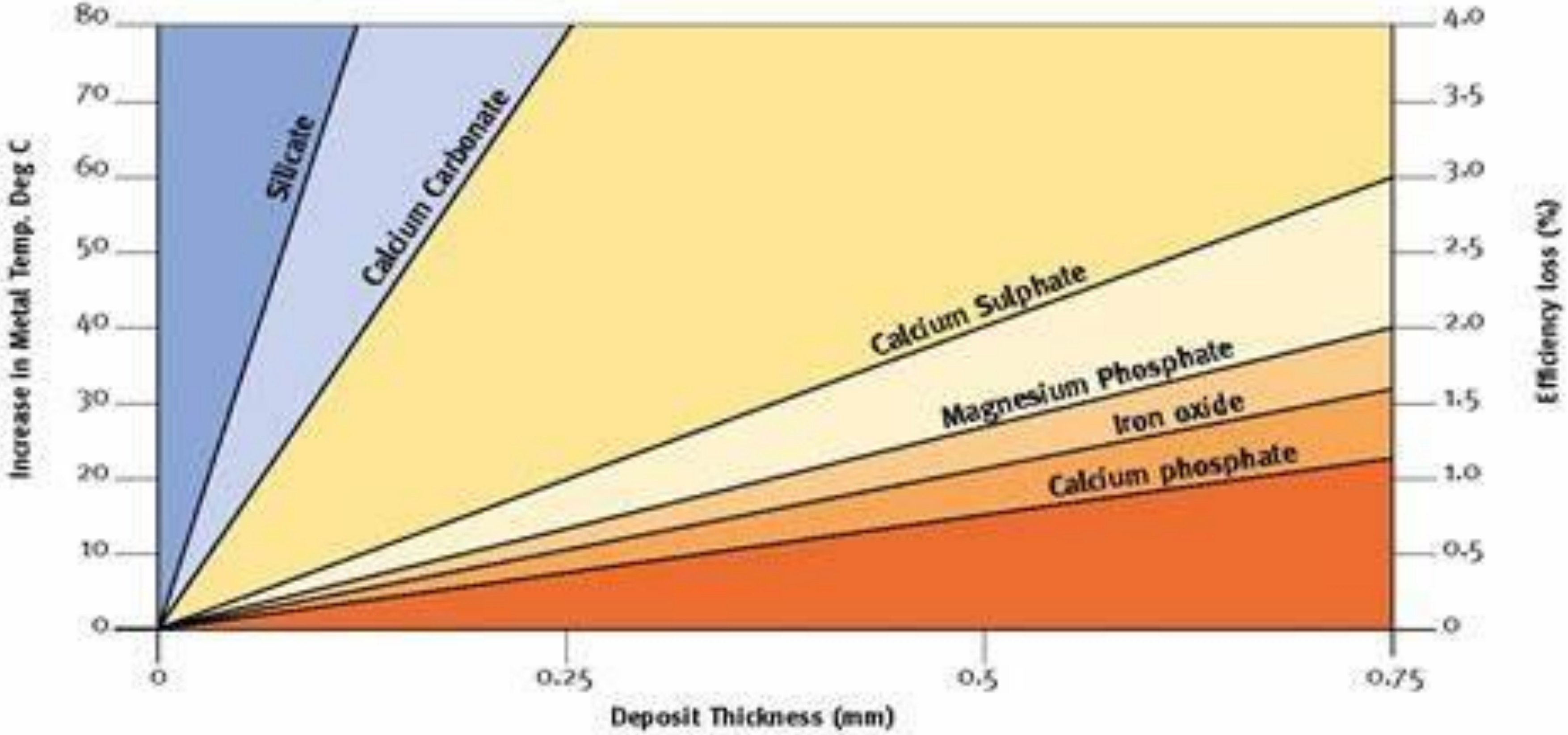
1.3 iron oxide

2. Fouling

Corrosion product come from auxiliaries (deaerator –condensate line –soft.)

Extract from Good Practice Guide 221

Improving boiler energy efficiency through water treatment



Graphical Representation of the effects of scale on boiler efficiency

Chemical constituents of boiler scale can be any one or a combination of all of the above

Scale Impact On Boiler Performance

1-Bad heat transfer

2-Decrease in boiler performance

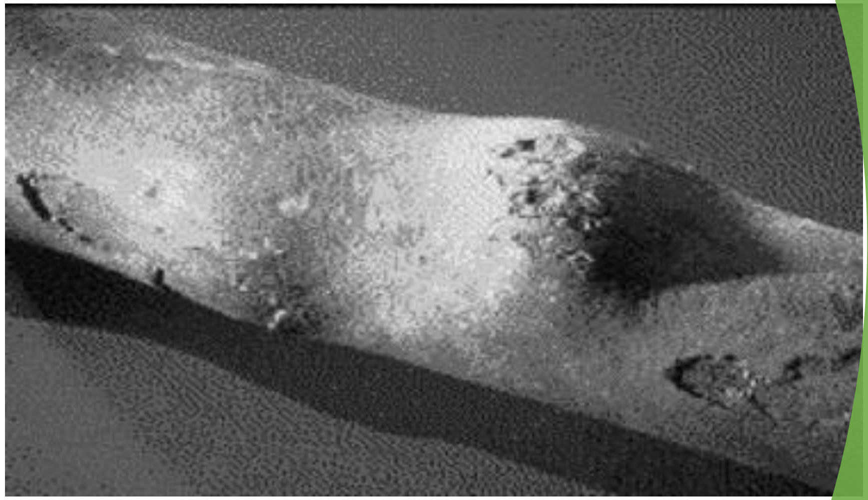
3-Low flow rate

4-Higher fuel consumption

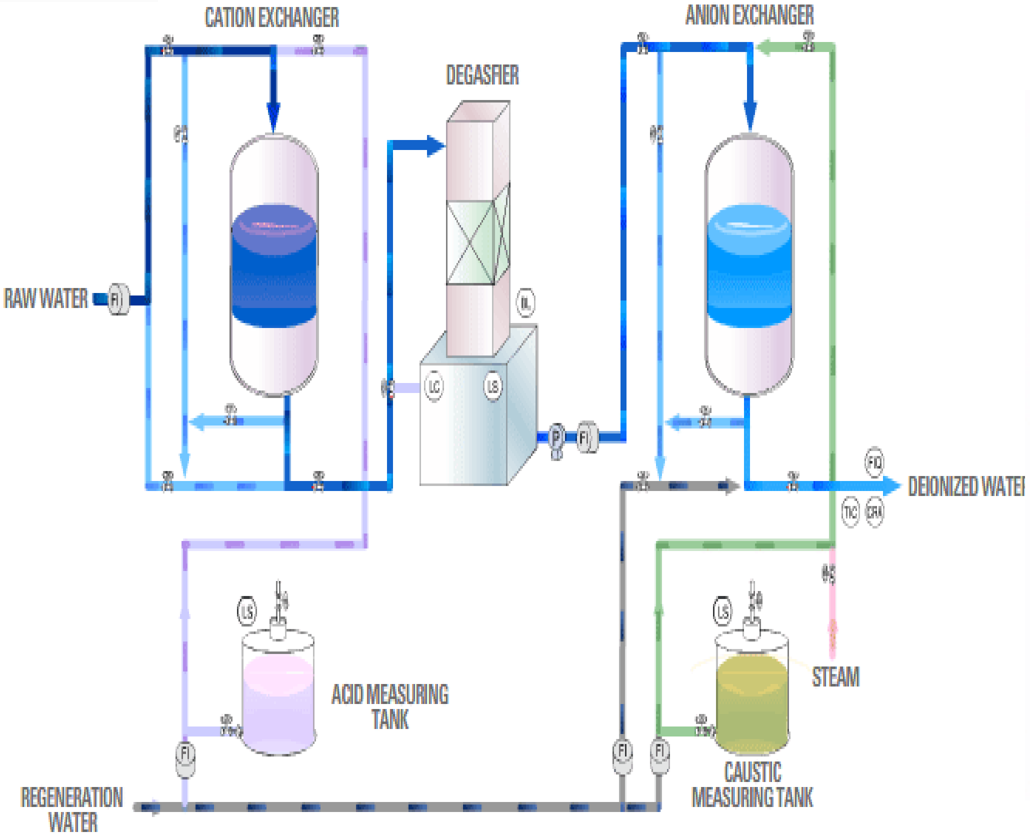
5- over heating (iron bent at 480C)

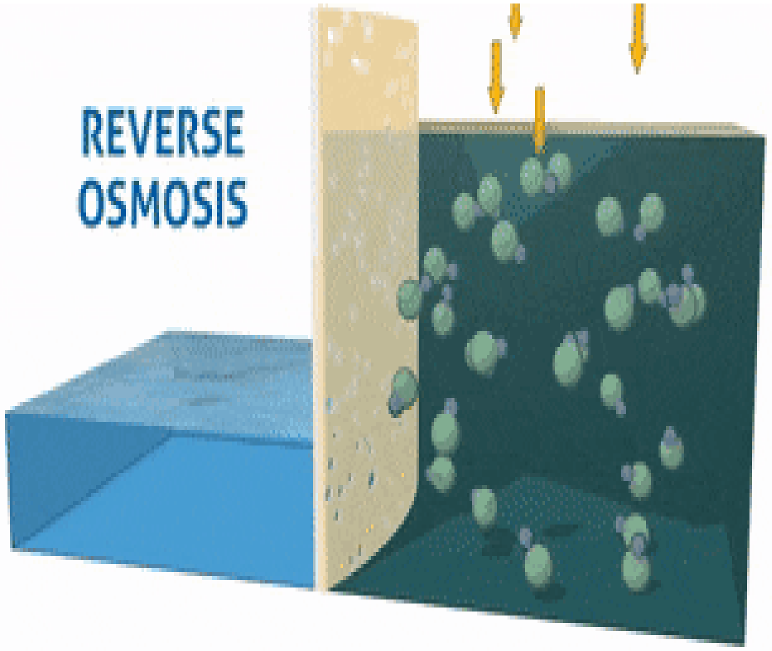
6-under deposit corrosion

7- higher maintenance cost & production stoppage



Scale treatment (pretreatment –first defense line)





Scale Treatment (Internal Treatment –Second Defense Line)

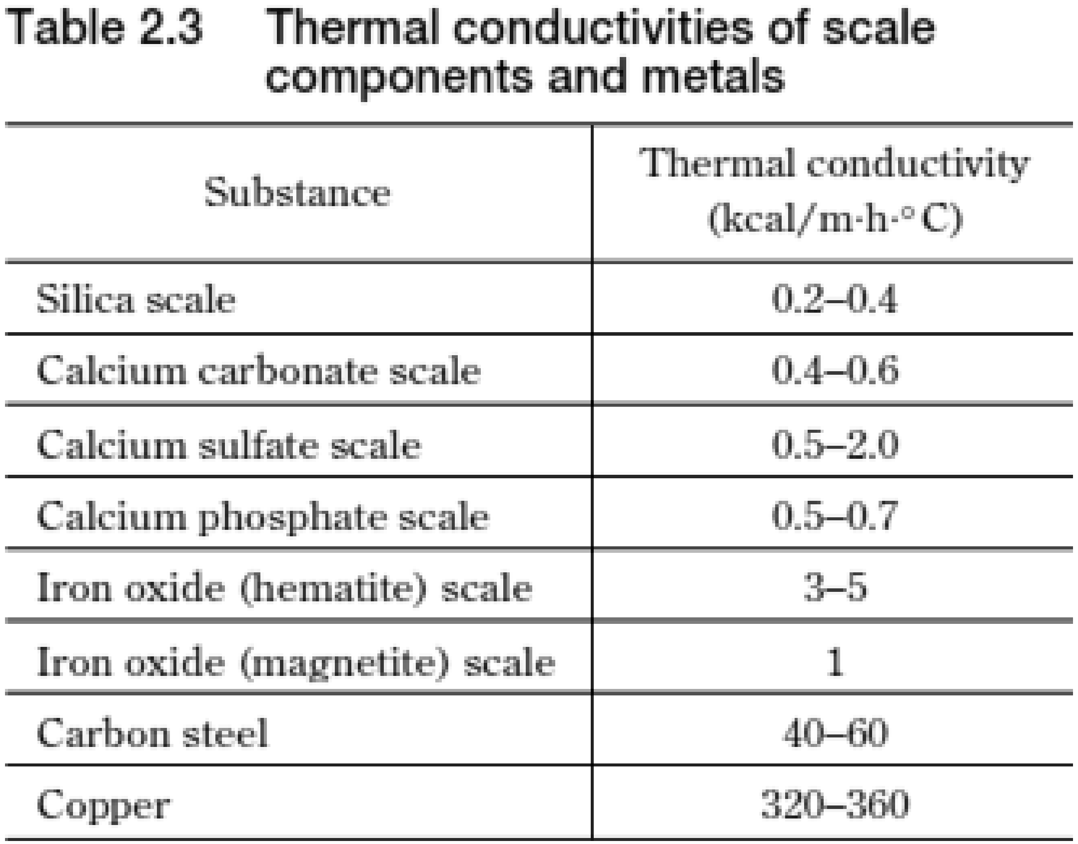


Table 2.3 Thermal conductivities of scale components and metals

Substance	Thermal conductivity (kcal/m·h·°C)
Silica scale	0.2–0.4
Calcium carbonate scale	0.4–0.6
Calcium sulfate scale	0.5–2.0
Calcium phosphate scale	0.5–0.7
Iron oxide (hematite) scale	3–5
Iron oxide (magnetite) scale	1
Carbon steel	40–60
Copper	320–360

1- Precipitation way

1.1. Using carbonate

1.2. Using phosphate

2- Non precipitation way

2.1 chelate (EDTA.NTA)

2.2. supplementary (polymers)

Scale Treatment (Internal Treatment – Second Defense Line) Precipitation Using Carbonate

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Method :

-converting hardness in the boiler to insoluble precipitate ,then discharged with blowdown.

-By adjusting alkalinity of the boiler, the calcium salts are converted in the form of carbonate and magnesium in the form of hydroxide

Other additives synthetic polymer -tannins, lignin, starches and a wide variety can be used to improve the mobility of the precipitates and thus enhance their removal by bottom blow-down

(1) $Ca(HCO_3)_2 + Na_2CO_3 \text{ -----}\rightarrow CaCO_3 + 2NaHCO_3$

(2) $2NaHCO_3 + \text{Heat} \text{ -----}\rightarrow Na_2CO_3 + H_2O + CO_2$

(3) $MgCl_2 + 2NaOH \text{ ---}\rightarrow Mg(OH)_2 + 2NaCl$

Limitations

Since the carbonate break-down increases with temperature the phosphate cycle was developed for use at higher pressures.

Scale Treatment (Internal Treatment – Second Defense Line) Precipitation Using Phosphate

Method :

-converting hardness in the boiler to insoluble precipitate ,then discharged with blowdown.

-By adjusting alkalinity of the boiler the calcium salts are converted in the form of Phosphates and magnesium in the form of hydroxide

Other additives synthetic polymer -tannins, lignin, starches and a wide variety can be used to improve the mobility of the precipitates and thus enhance their removal by bottom blow-down

$3Ca\ (HCO_3)_2 + 2Na_2PO_4 \longrightarrow Ca_3(PO_4)_2 + 3Na_2CO_3 + 3H_2O + 3CO_2$

$3Ca\ SO4 + 2Na_2PO_4 \longrightarrow Ca_3(PO_4)_2 + 3NaSO_4$

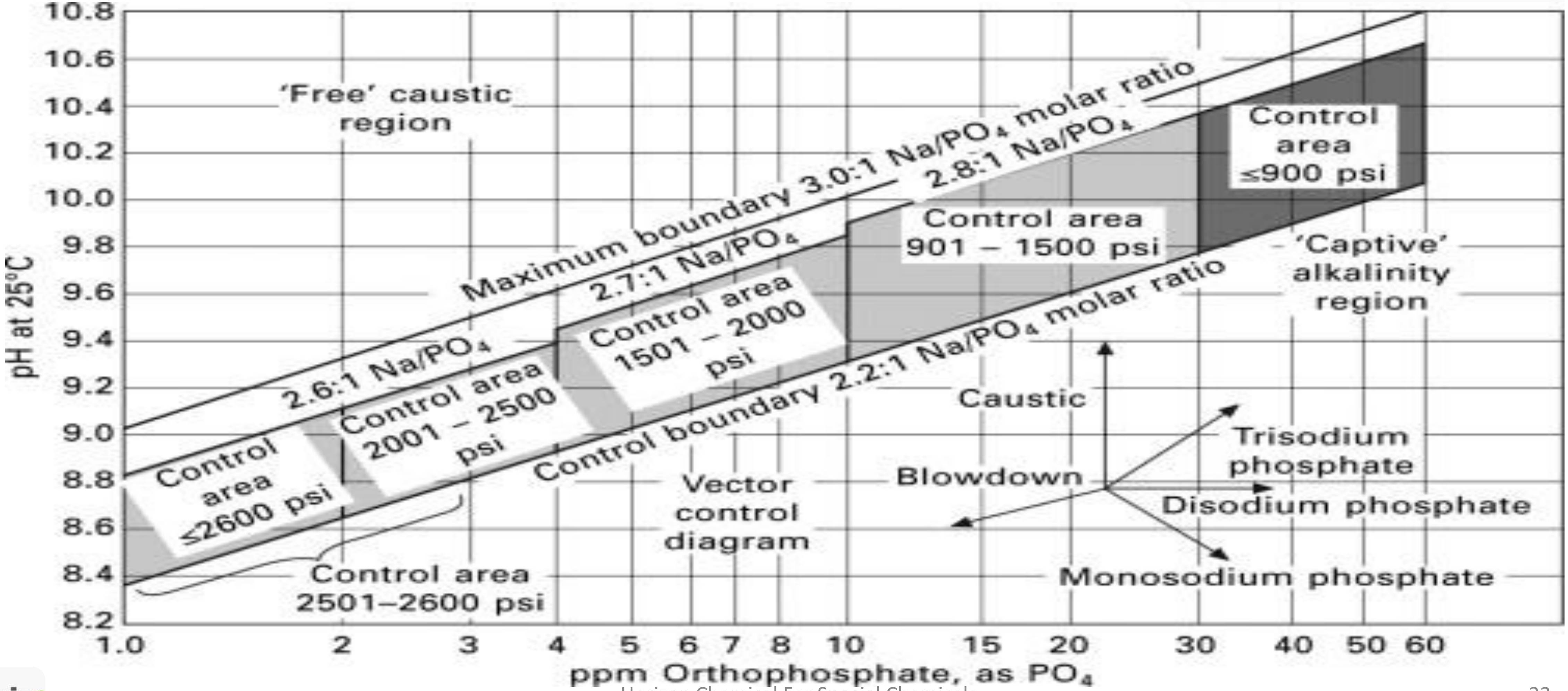
$Na_2CO_3 + H_2O \longrightarrow 2NaOH + CO_2$

$MgCl_2 + 2NaOH \longrightarrow Mg(OH)_2 + 2NaCl$

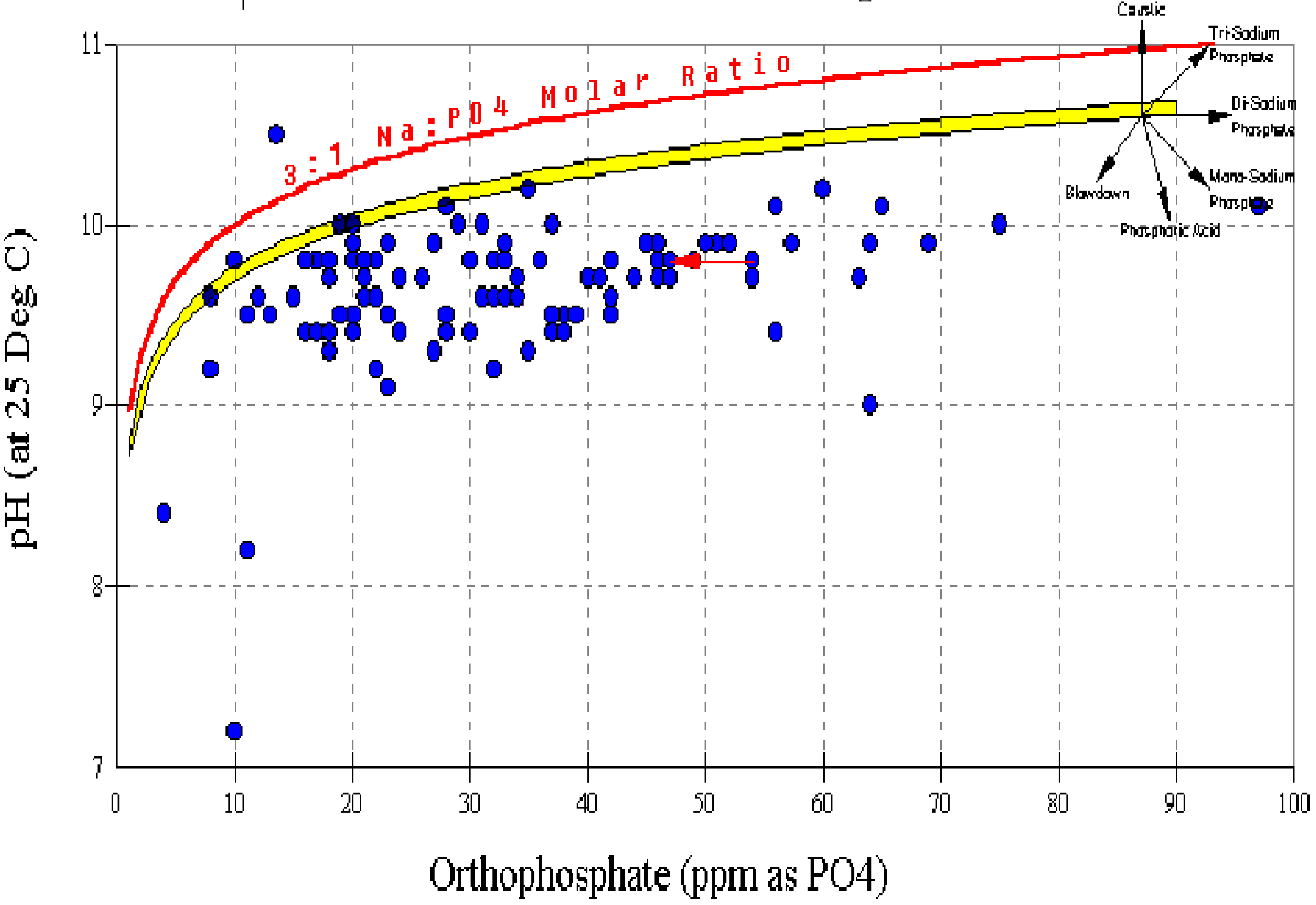
Limitations

Since the carbonate break-down increases with temperature the phosphate cycle was developed for use at higher pressures.

Equilibrium and congruent phosphate treatment



pH/PO4 Control Graph



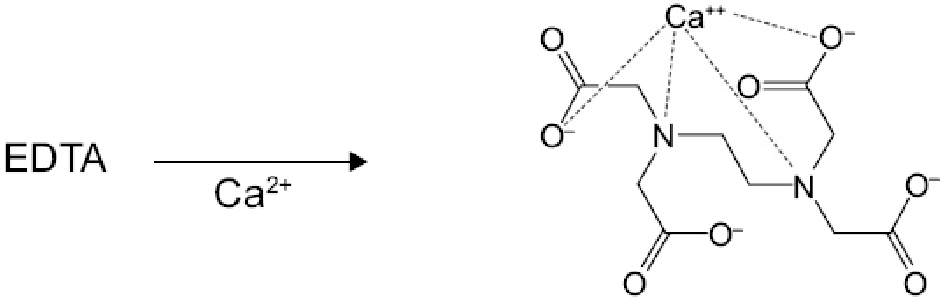
Scale treatment (internal treatment – second defense line) Non precipitation way

Chelate :

- (EDTA) or nitrilo tri acetic acid (NTA) can be used as chelating agents which form strong soluble complexes with calcium and magnesium and prevent scale formation

Limitations

- **hardness less than 1.5 PPM**
- **pressure less than 90 bar.**
- **Improper dosage will cause corrosion problems inside the boiler**

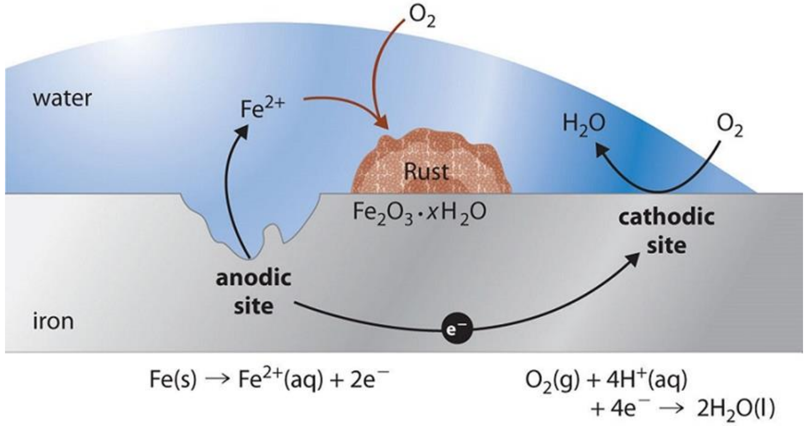


Calcium-EDTA

Preventing silicate deposits

- Silicate deposits consists of complex salts of calcium, magnesium, iron, aluminum or combination of these.
- Eliminate calcium
- Scale is prevented by keeping silica in solution by maintaining silica to caustic alkalinity ratio of 0.3: 1 in the boiler water $Na_2[SiO_2(OH)_2]$
- This method is suitable for boilers up to 40 bar

2.Corrosion



$$Fe \rightarrow Fe^{2+} + 2\,e^- \text{ (Anodic)}$$

$$2\,H_2O + O_2 + 4\,e^- \rightarrow 4\,OH^- \text{ (Cathodic)}$$

$$Fe^{2+} + 2\,OH^- \rightarrow Fe(OH)_2 \text{ (Chemical)}$$

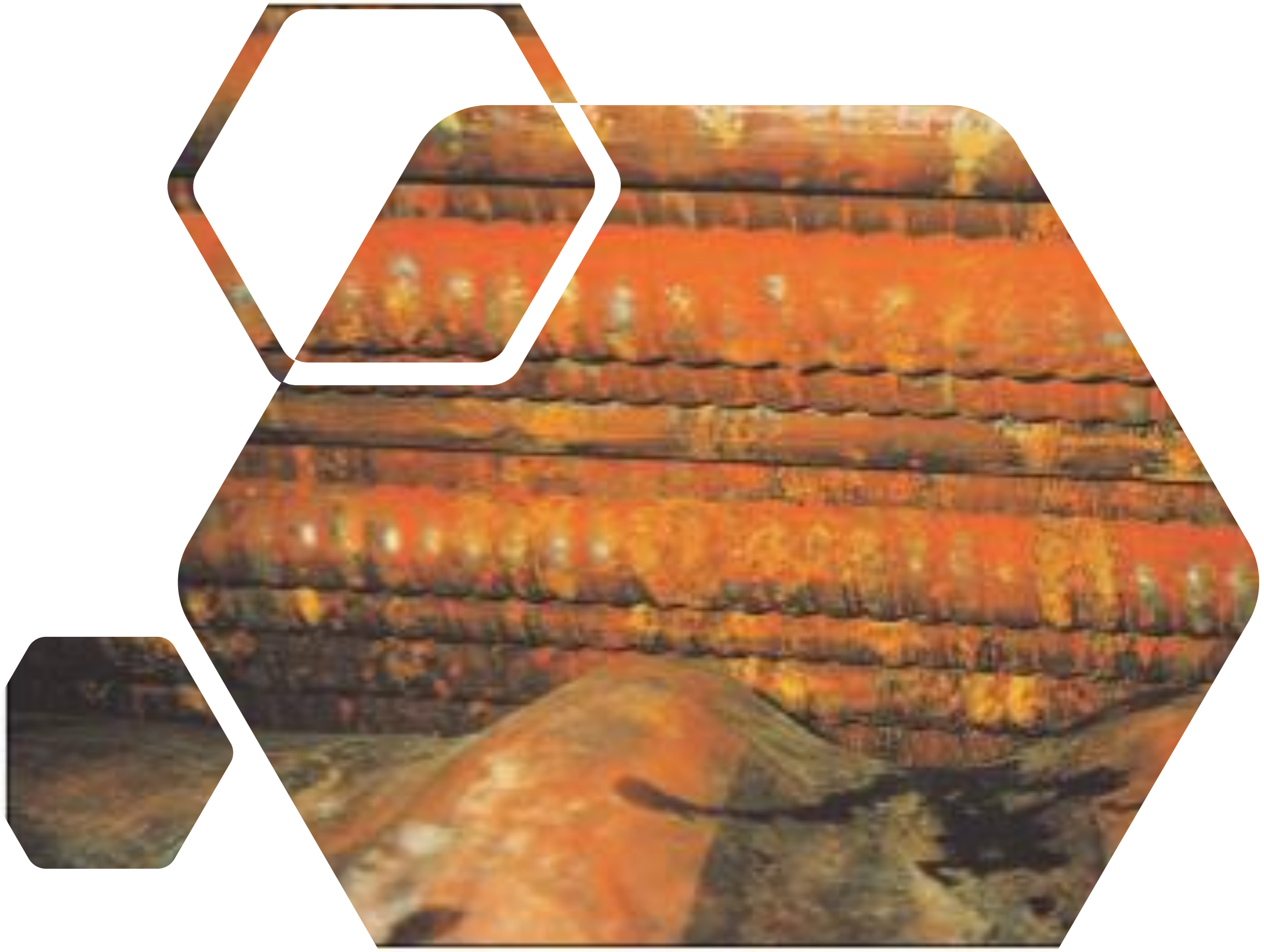
Causes of Corrosion

Boiler Area

- Insufficient oxygen removal in feed water
- High pH value and alkalinity
- Increase in suspended solids and deposits

Steam and Condensate Area

- Formation of carbon dioxide
- Low pH-values



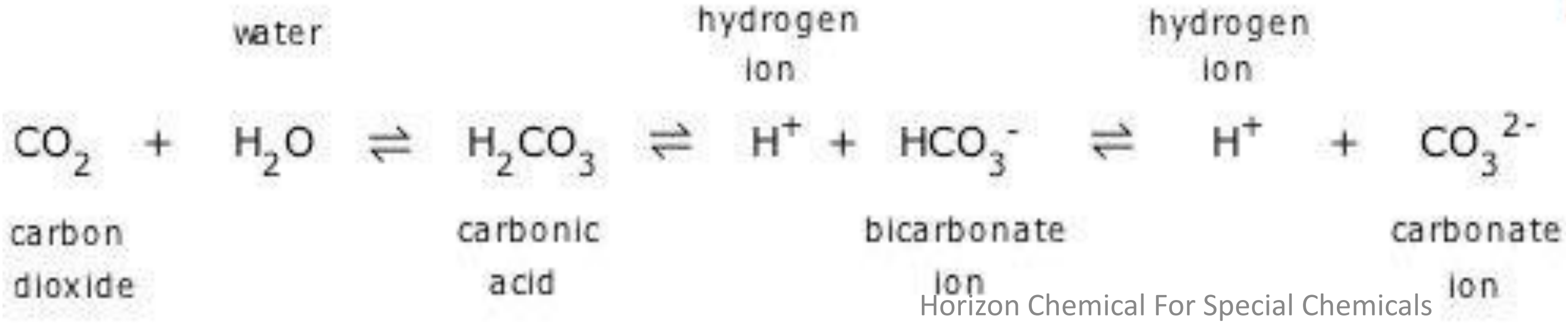
n of a fire and flue-tube boiler by

Steam And Condensate Corrosion

- Carbonic acid Behavior(corrosion)
- Bicarbonate degradation inside boiler

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O \quad \text{..................................} \quad (2.50)$$

$$Na_2CO_3 + H_2O \xrightarrow{\text{Heat}} 2NaOH + CO_2 \quad \text{..................................} \quad (2.51)$$



$$\underset{\text{carbon dioxide}}{CO_2} + \overset{\text{water}}{H_2O} \rightleftharpoons \underset{\text{carbonic acid}}{H_2CO_3} \rightleftharpoons \overset{\text{hydrogen ion}}{H^+} + \underset{\text{bicarbonate ion}}{HCO_3^-} \rightleftharpoons \overset{\text{hydrogen ion}}{H^+} + \underset{\text{carbonate ion}}{CO_3^{2-}}$$

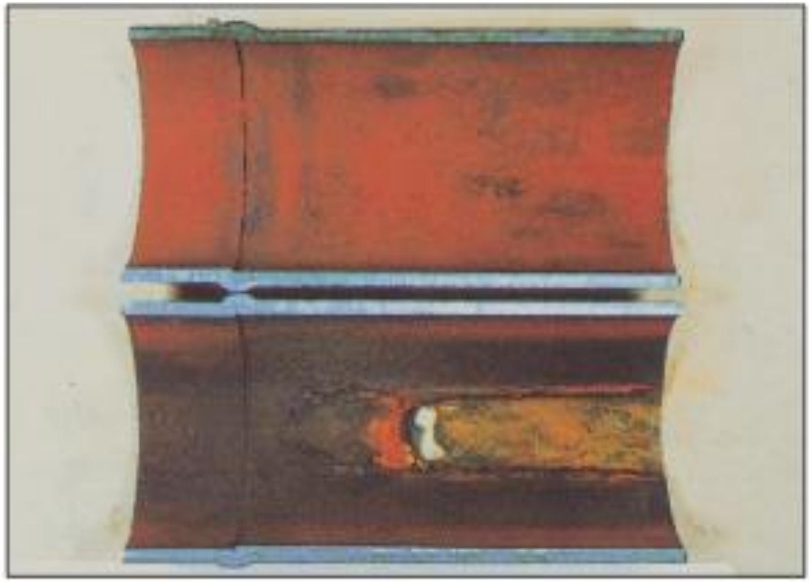


Photo 2.6 Corrosion of a steam condensate line

What causes corrosion in boilers?

- **Dissolved gases**

Oxygen, carbon dioxide, and ammonia creates corrosion in boilers as the degree of oxygen depends on concentration of dissolved oxygen, pH and temperature of water.

- **Dissolved or suspended solids**

It increases electrical conductivity of water, higher dissolved solids indicate greater conductivity and eventually causes corrosion

- **Acidity**

High velocity increases corrosion by transporting oxygen to the metal and carrying away the products of corrosion at a faster rate. When water velocity is low deposition of suspended solids can establish localized corrosion cells.

- **Temperature**

Concentration of oxygen along with increased temperature accelerates the reaction so that even a small quantity of dissolved oxygen causes severe corrosion.

Oxygen Attack

- Oxygen is highly corrosive when present in hot water. Even small concentrations can cause serious problems. Because pits can penetrate deep into the metal, oxygen corrosion can result in rapid failure of feedwater lines, economizers, boiler tubes, and condensate lines. Additionally, iron oxide generated by the corrosion can produce iron deposits in the boiler.
- Oxygen attack is an electrochemical process that can be described by the following reactions:

$$Fe \rightarrow Fe^{2+} + 2\,e^{-} \text{ (Anodic)}$$

$$2\,H_2O + O_2 + 4\,e^{-} \rightarrow 4\,OH^{-} \text{ (Cathodic)}$$

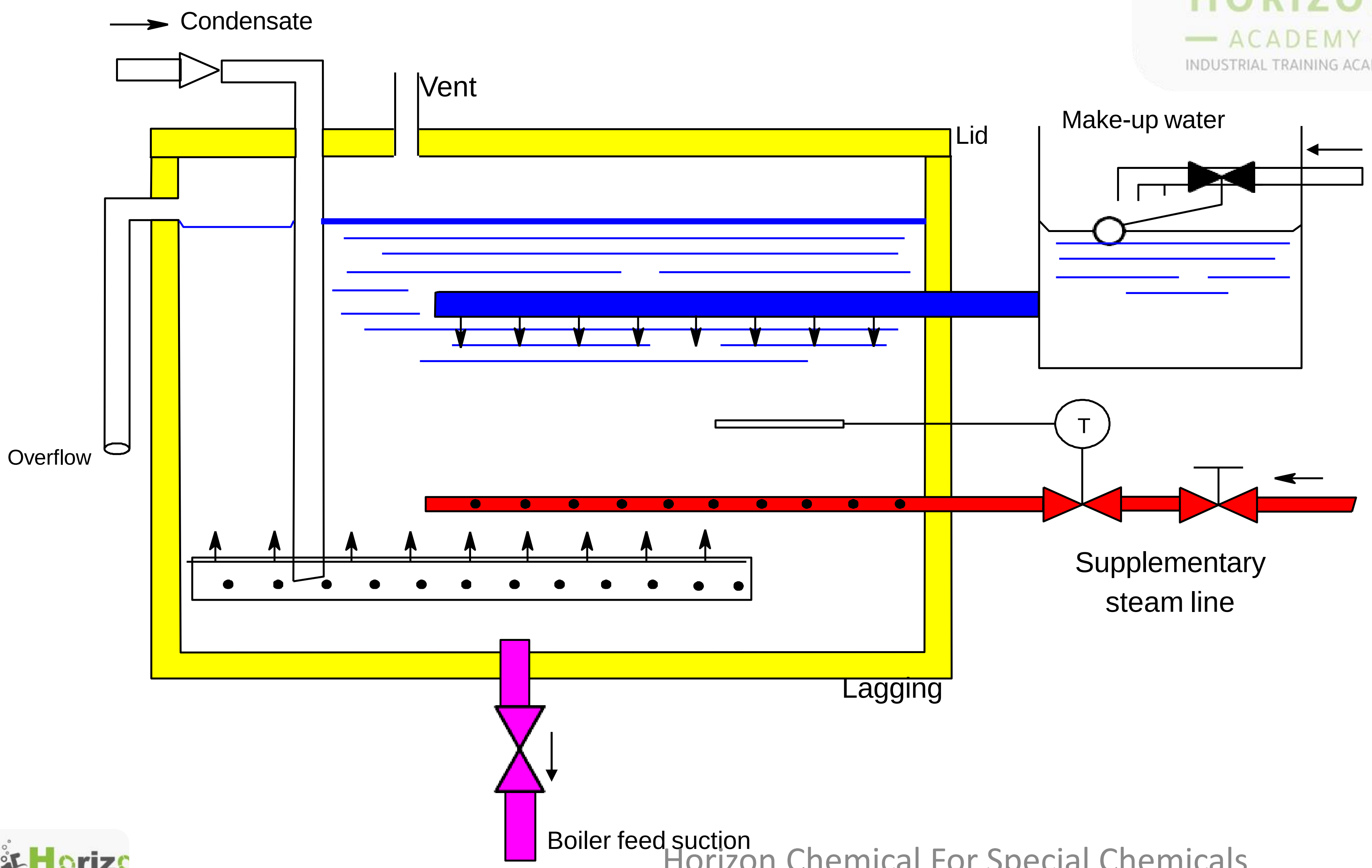
$$Fe^{2+} + 2\,OH^{-} \rightarrow Fe(OH)_2 \text{ (Chemical)}$$

The influence of temperature is important ,a temperature rise provides enough additional energy to accelerate reactions at the metal surfaces, resulting in rapid and severe corrosion.

At 60°F and atmospheric pressure, the solubility of oxygen in water is approximately 8 ppm. Efficient mechanical deaeration reduces dissolved oxygen to 7 ppb or less. For complete protection from oxygen corrosion, a chemical scavenger is required following mechanical deaeration.

Major sources of oxygen in an operating system include poor deaerator operation, in-leakage of air on the suction side of pumps, the breathing action of receiving tanks, and leakage of undeaerated water used for pump seals.

Feed water Temperature



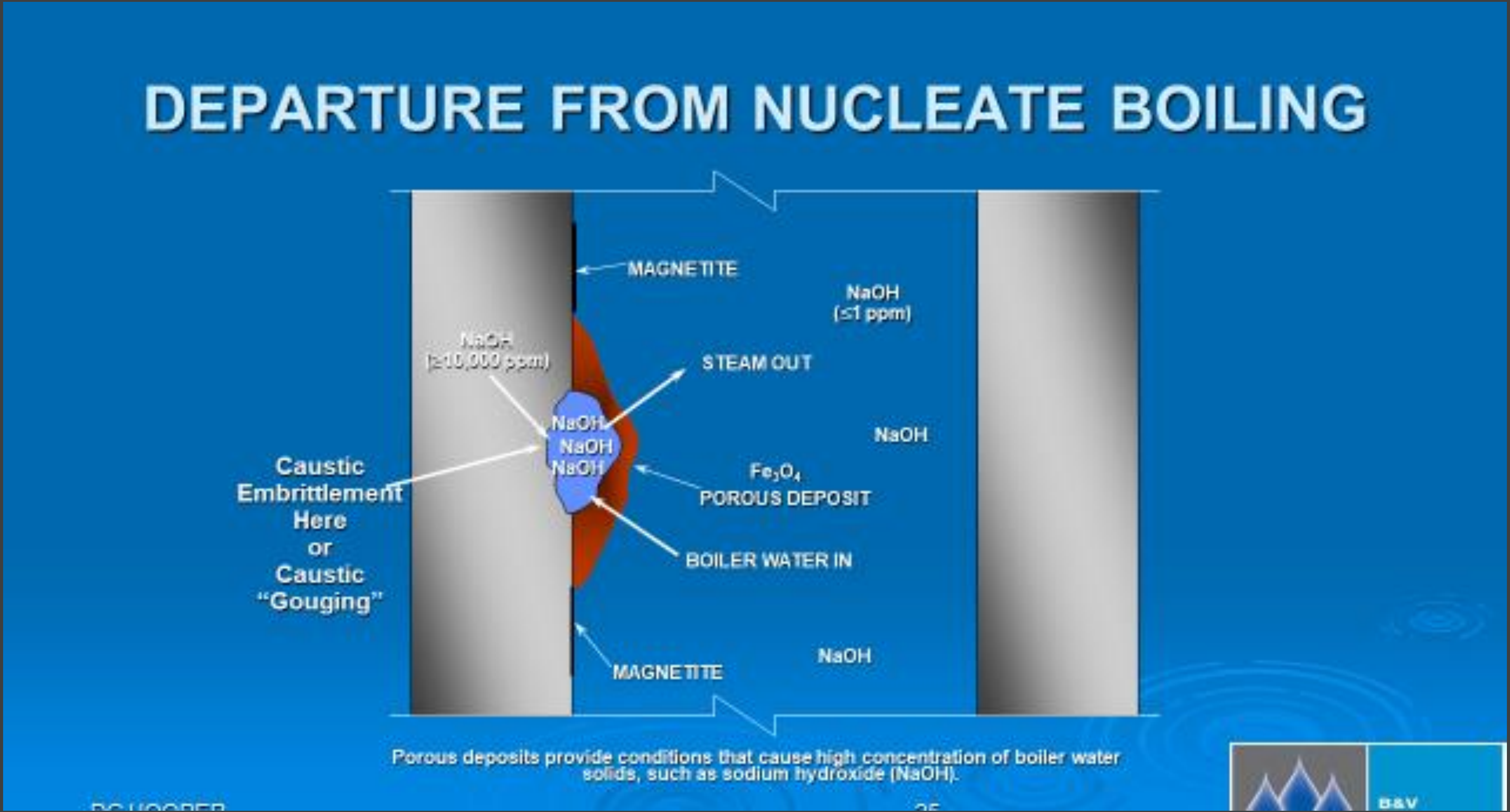
°C	°F	Oxygen for saturation ppm
0	32	14.16
5	41	12.37
10	50	10.92
15	59	9.76
20	68	8.84
25	77	8.11
30	86	7.83
35	95	7.04
40	104	6.59
50	122	5.57
60	140	4.76
70	158	3.89
80	176	2.89
90	194	1.63
100	212	0

- It is important that the water in the feed tank is kept at a high enough temperature to minimize the content of dissolved oxygen and other gases.
- Cost savings associated with reducing the dissolved oxygen in feedwater by heating.
- **Shouldn't add sodium sulphite $Na_2SO_3^{-2}$ at temperature less than 70 c̥**

2Na2SO3 (7.88 ppm) + O2 (1 ppm) → 2Na2SO4 For the residual, 1.6 ppm Na2SO3 will yield 1 ppm SO3.

The total calculation equation to remove residual oxygen and provide a boiler water residual is:

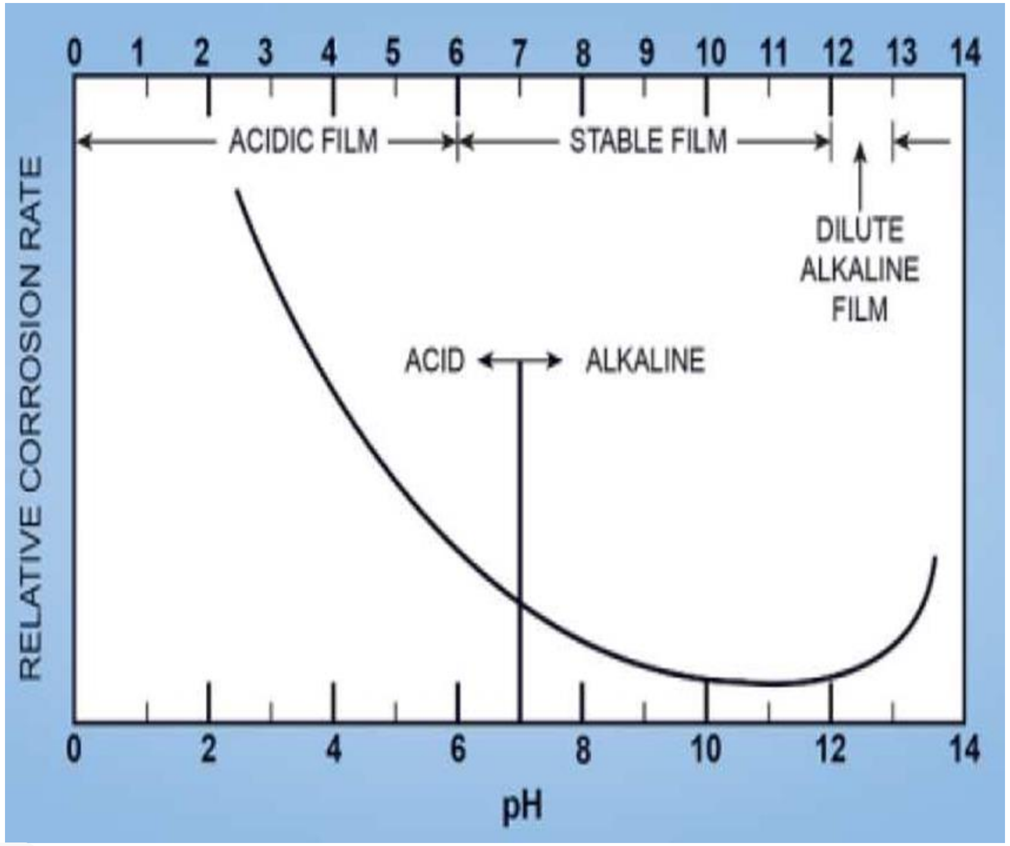
(Feedwater O2 x 7.88) + (1.6 x Boiler Water SO3 Residual) / Feedwater Cycles = Feedwater Dosage of 100% sodium sulfite in ppm.

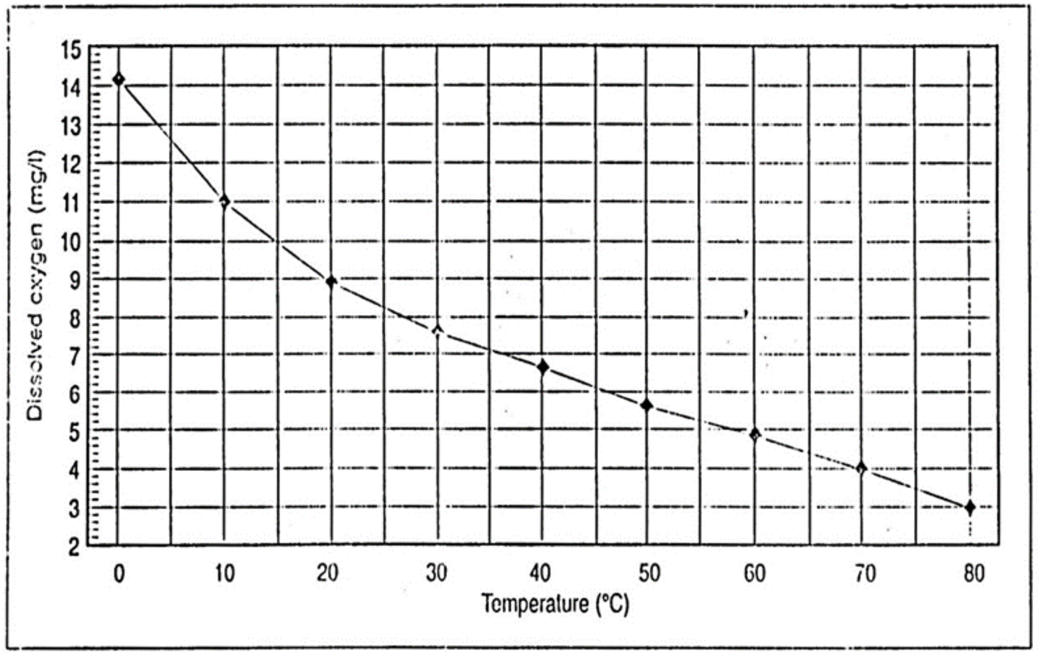


DEPARTURE FROM NUCLEATE BOILING

Porous deposits provide conditions that cause high concentration of boiler water solids, such as sodium hydroxide (NaOH).

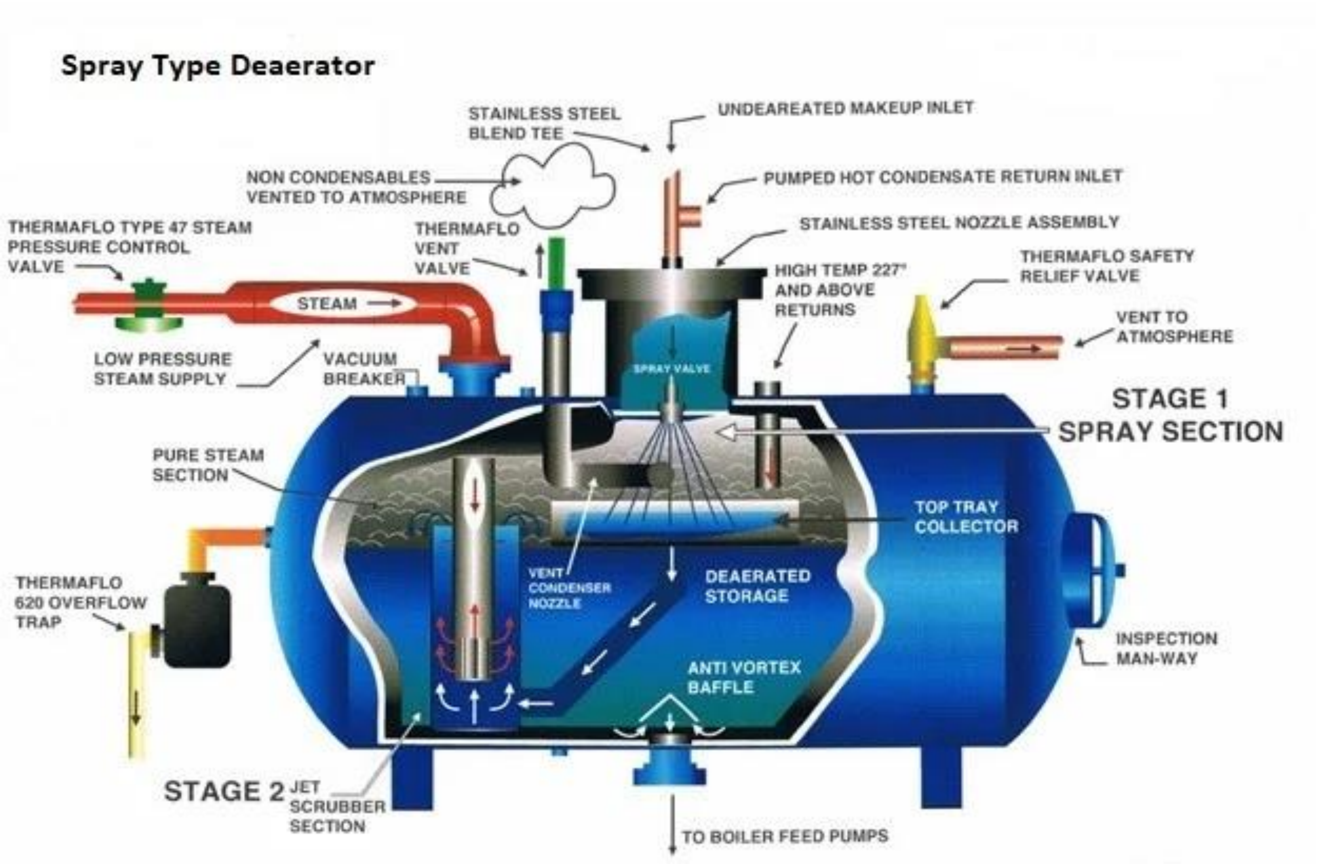
Factors Affecting Corrosion

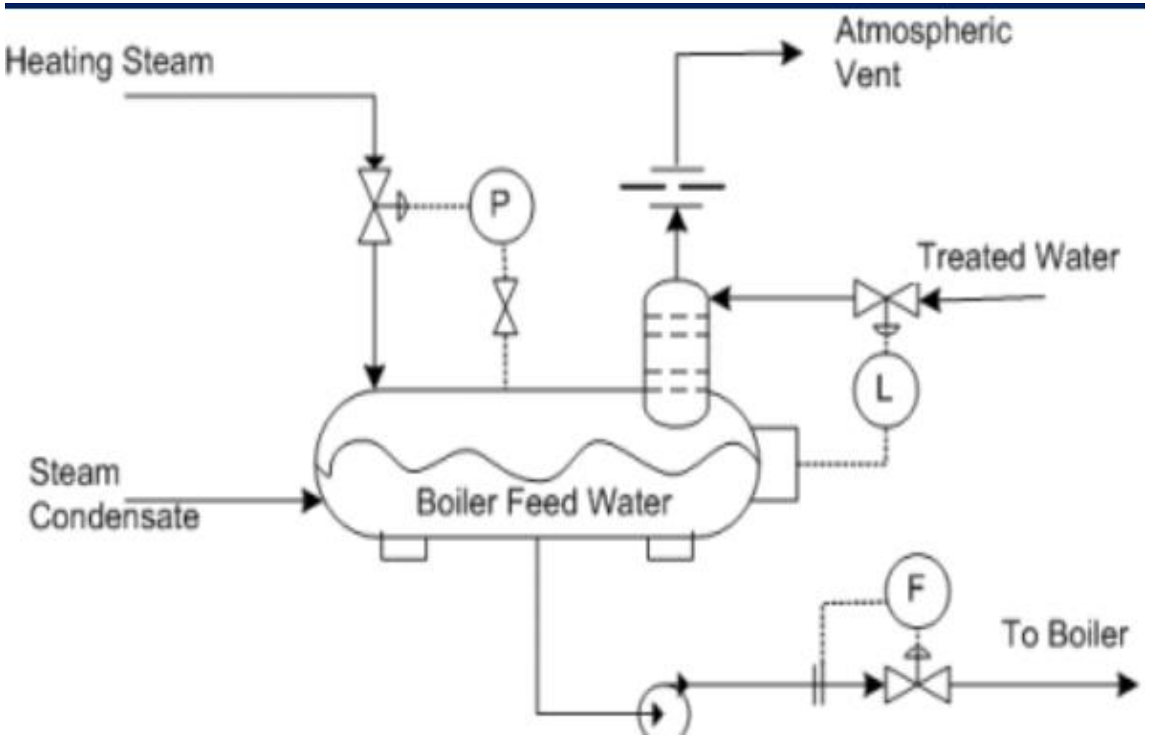




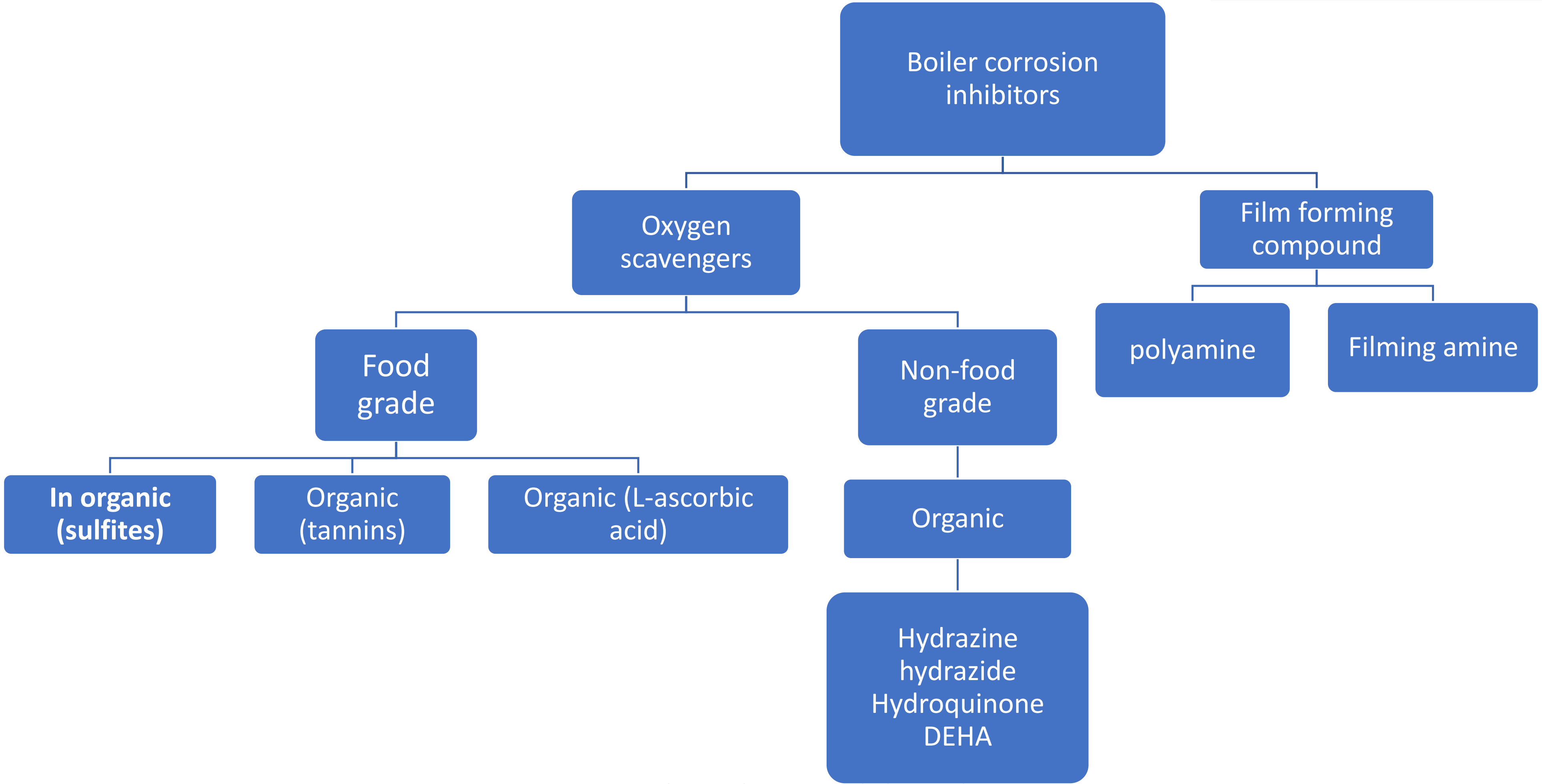
Change in solubility of oxygen in water with temperature

Corrosion (pretreatment –first defense line) Deaerator



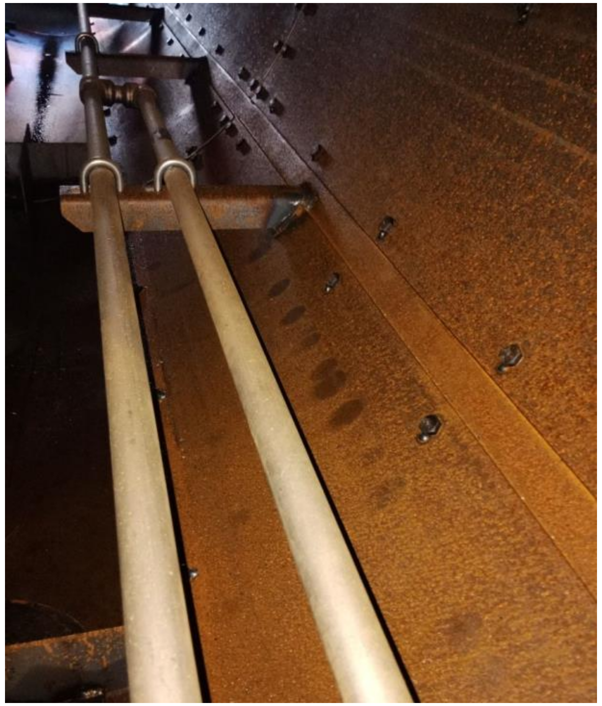


Boiler corrosion inhibitors (internal treatment –second defense line)



- Boiler corrosion inhibitors
  - Oxygen scavengers
    - Food grade
      - **In organic (sulfites)**
      - Organic (tannins)
      - Organic (L-ascorbic acid)
    - Non-food grade
      - Organic
        - Hydrazine
          hydrazide
          Hydroquinone
          DEHA
  - Film forming compound
    - polyamine
    - Filming amine

PASSIVATION



Chemistry Of Agents

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

$$12Fe_2O_3 + (N_2H_3)_2CO \rightarrow + 8Fe_3O_4 + 3H_2O + 2N_2 + CO_2$$

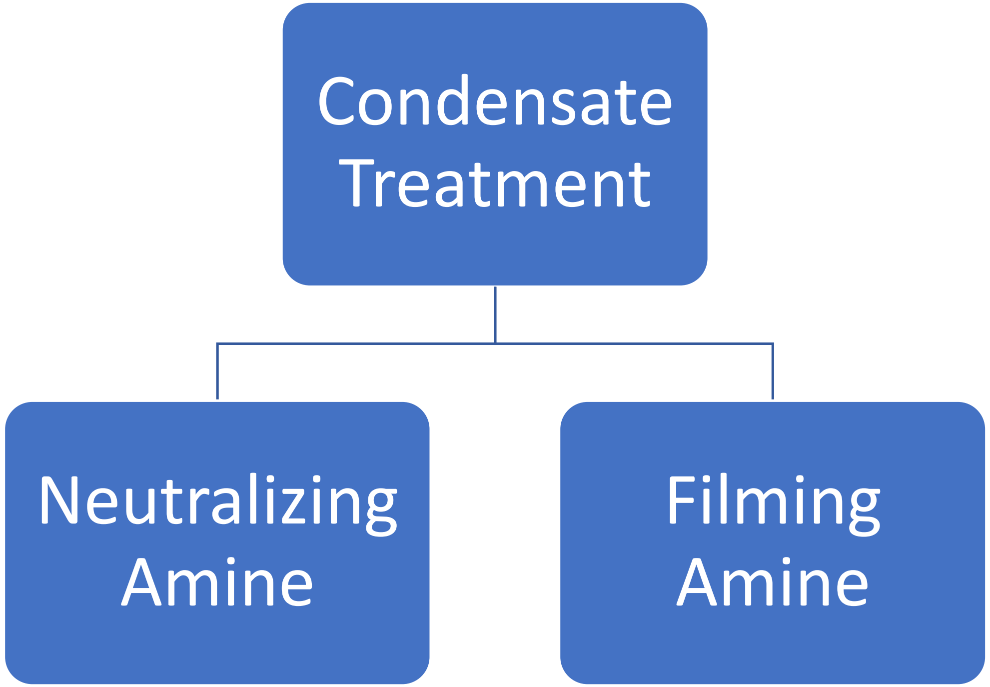
$$8Fe_3O_4 + 2O_2 \rightarrow 12Fe_2O_3$$

$$8CuO + (N_2H_3)_2CO \rightarrow + 4Cu_2O + 3H_2O + 2N_2 + CO_2$$

Condensate treatment

Why?

- Power saving
- Water saving
- Chemical saving
- Money saving
- Higher water quality


Condensate Treatment

Neutralizing Amine

Filming Amine

3.Fouling

Fouling is deposition of suspended solids or buildup of microbiological organisms within heat exchanger and cooling tower fills.

Fouling caused by :

- Scale deposits
- Metal oxide solubility
- Feed contamination
- Precipitation Treatment & no dispersant

4. Carryover

- Carryover accelerate By Two Factors:

1.Priming - this is the ejection of boiler water into the steam take-off and is generally due to one or more of the following:

-Operating the boiler with too high a water level.

-Operating the boiler below its design pressure; increases the volume and the velocity of the steam released from the water surface.

2. Foaming - this is the formation of foam in the space between the water surface and the steam off-take.

Priming

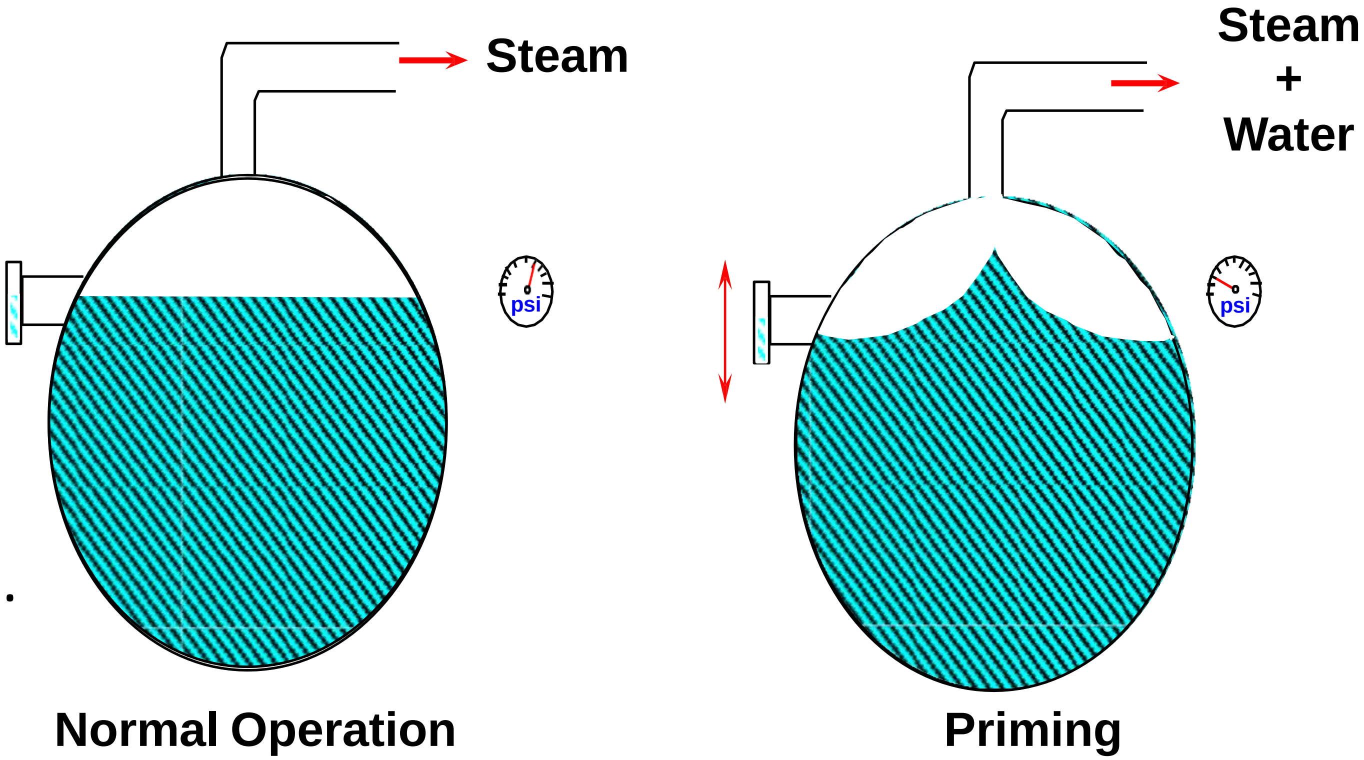
Priming Caused by :

- Rapid drop in boiler pressure
- Rapid increase in Steam load

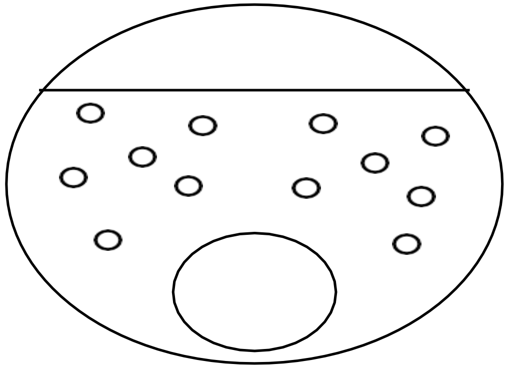
Both lead to :

- Increase in specific volume of steam.
- Increase in steam velocity.

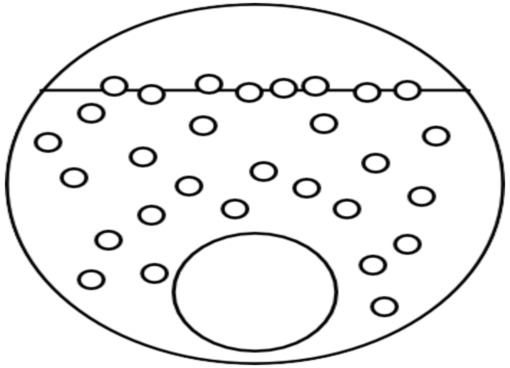
Boiler Water in ' Sucked out' of the boiler.



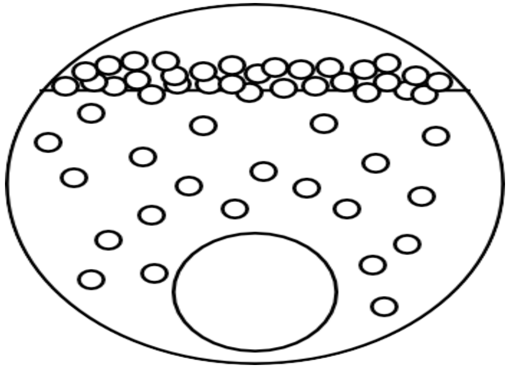
Foaming



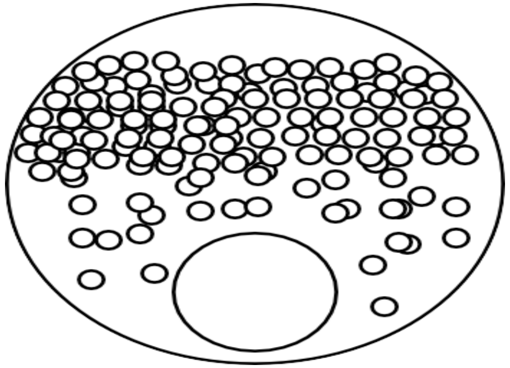
Normal Operation



Slight Foaming



Severe Foaming



DANGER!

Foaming caused by :

- High TDS/Alkalinity
- High Suspended Solids
- Contaminated feedwater - organics, etc.

Priming/foaming can lead to:

- Contaminated Steam/Condensate
- Extremely high boiler TDS levels
- Uncovered tubes
- In extreme cases tube failure/explosions

Carry over treatment

1- Adjust water chemistry controlling

TDS

Alkalinity

Silica below 0.02 mg SiO_2/l for preventing the silica deposition on turbine blades.

Eliminate organic contaminations

2- Antifoam dosing

3- operate boiler at standard operation conditions (water level -..etc.)

Boiler Blowdown

Boiler Type	Maximum TDS (ppm)*
Low pressure Water tube boiler	2000–3000 ppm
High Pressure Water tube boiler with superheater	3,000–3,500 ppm

- When water is boiled and steam is generated, any dissolved solids contained in the water remain in the boiler. if more solids are put in with the feed water, they will concentrate, these solids encourage foaming and cause carryover of water into the steam. the deposits also lead to scale formation inside the boiler, resulting in localized overheating and finally causing boiler tube failure **so to control the level of concentration of the solids** a certain volume of water is blown off and is automatically or manually replaced by feed water – thus maintaining the optimum level of total dissolved solids (TDS) in the boiler water

Conductivity as Indicator of Boiler Water Quality

- conductivity measurement is used for monitoring the overall TDS present in the boiler. A rise in conductivity indicates a rise in the “contamination” of the boiler water.

- TDS= Conductivity ms\cm *.6= ppm
- ms:millisiemens

Blowdown calculations

- The quantity of blowdown required to control boiler water solids concentration is calculated by using the following formula:

$$\boldsymbol{Blow\ down}\ (\%) = \frac{\boldsymbol{Feed\ water\ TDS} \times \%\ \boldsymbol{Make\ up\ water}}{\boldsymbol{Maximum\ Permissible\ TDS\ in\ Boiler\ water}}$$

- If maximum permissible limit of TDS as in a package boiler is 3000 ppm, percentage make up water is 10% and TDS in feed water is 300 ppm, then the percentage blow down is given as: =(300 x 10)/ 3000 = 1%

Benefits of Blowdown

- Good boiler blow down control can reduce treatment and operational costs that include:

– Lower pretreatment costs

– Less make-up water consumption

– Reduced maintenance downtime

– Increased boiler life

– Lower consumption of treatment chemicals

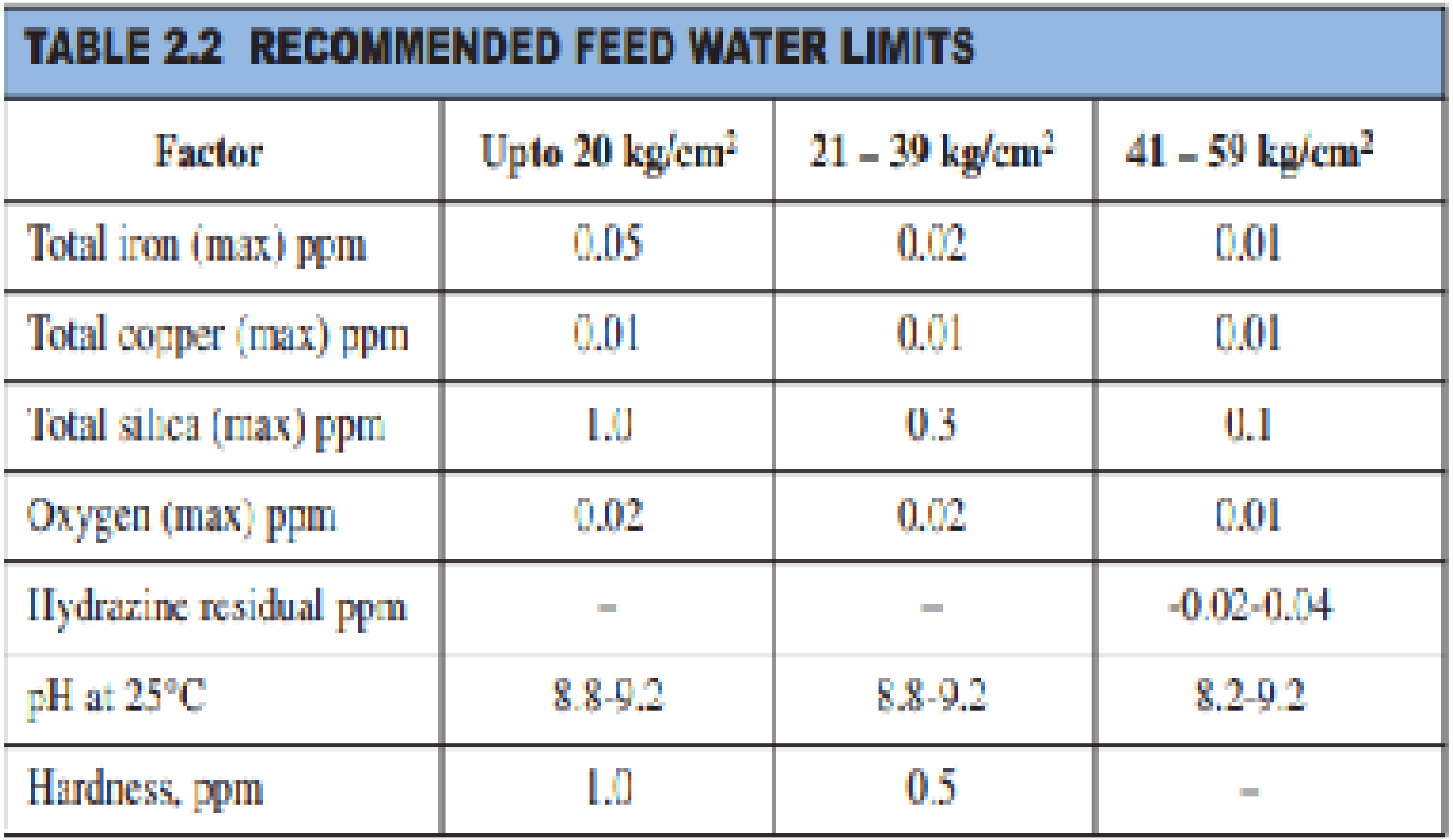


TABLE 2.2 RECOMMENDED FEED WATER LIMITS

Factor	Upto 20 kg/cm^2	21 – 39 kg/cm^2	41 – 59 kg/cm^2
Total iron (max) ppm	0.05	0.02	0.01
Total copper (max) ppm	0.01	0.01	0.01
Total silica (max) ppm	1.0	0.3	0.1
Oxygen (max) ppm	0.02	0.02	0.01
Hydrazine residual ppm	–	–	-0.02-0.04
pH at 25°C	8.8-9.2	8.8-9.2	8.2-9.2
Hardness, ppm	1.0	0.5	–

HORIZON
ACADEMY
INDUSTRIAL TRAINING ACADEMY

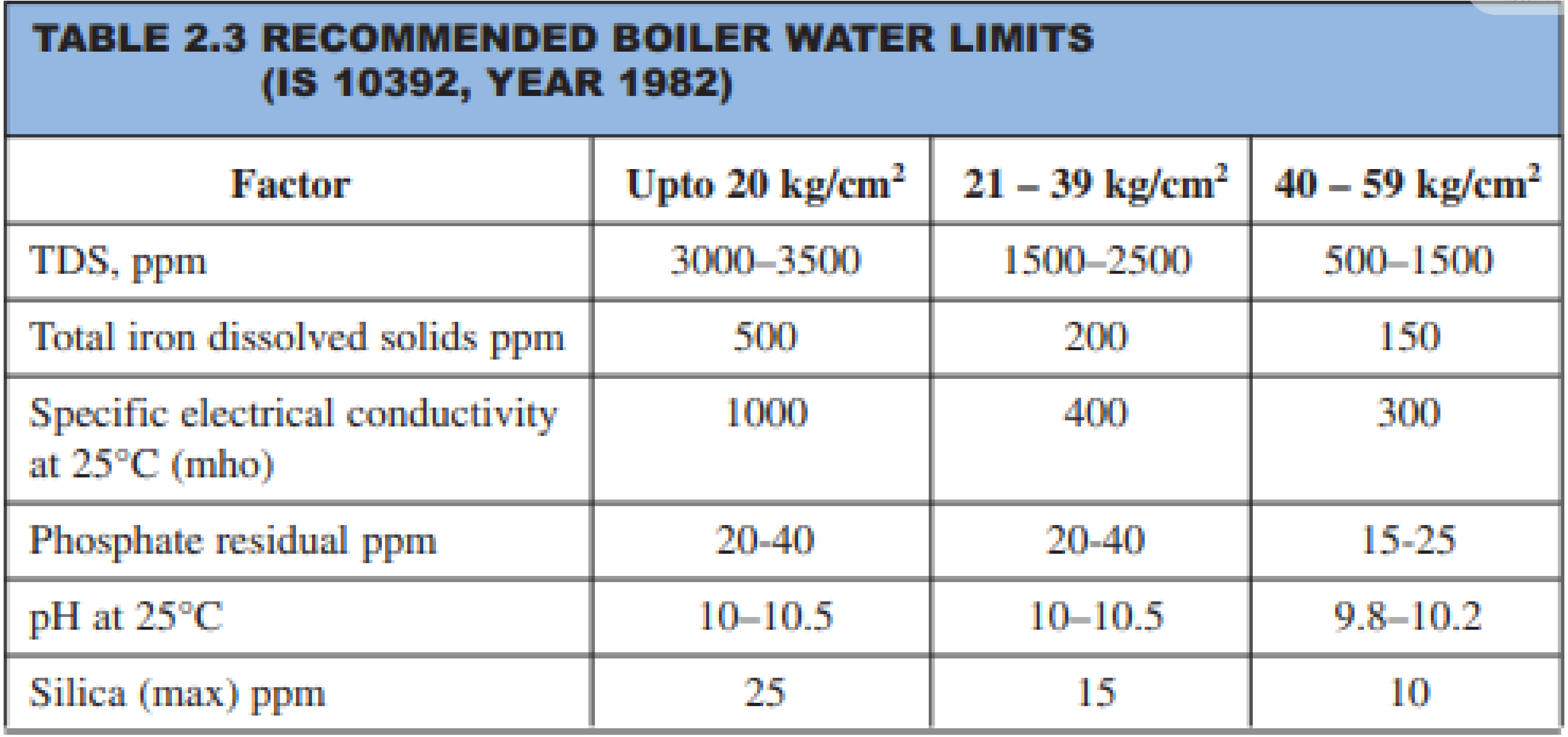
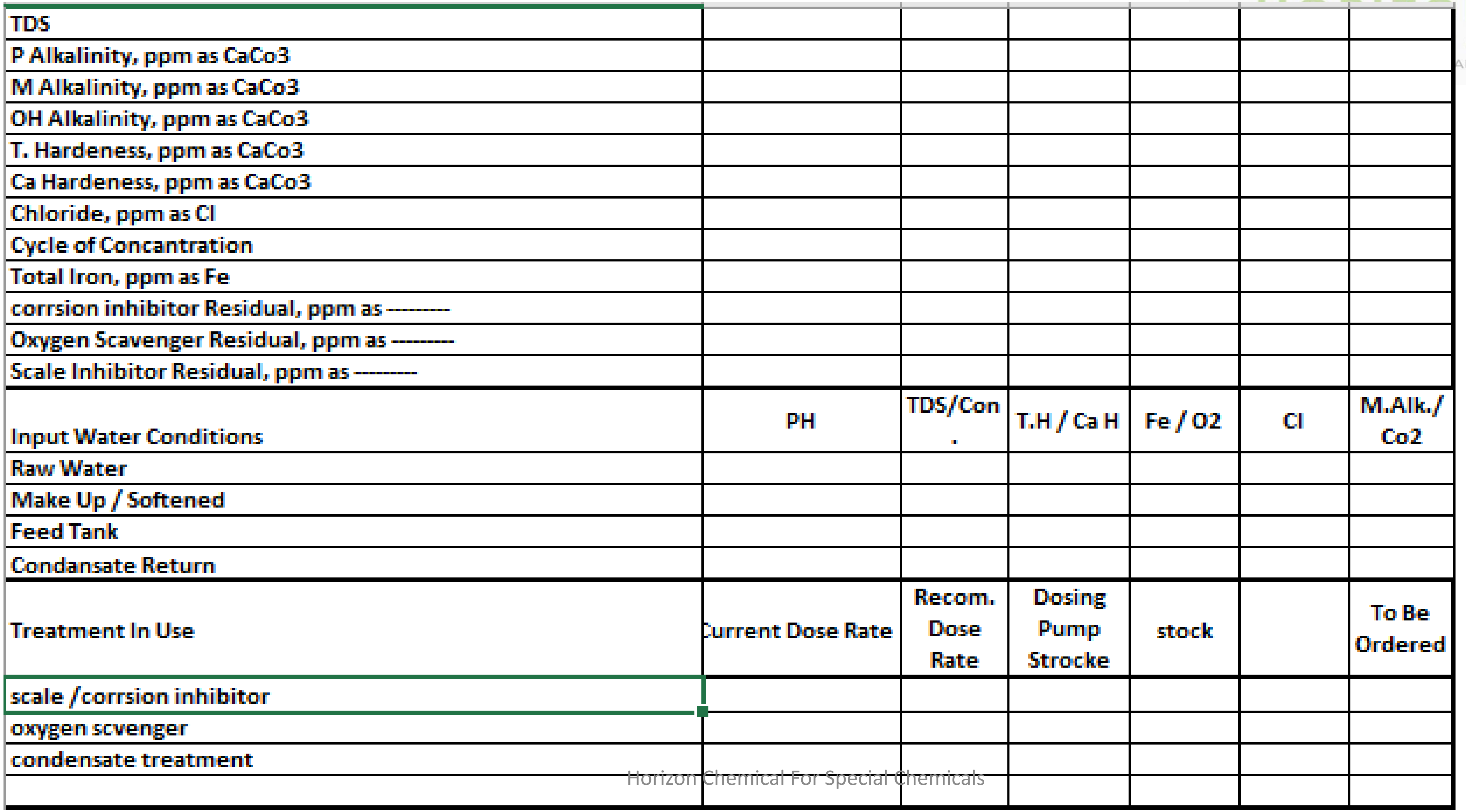


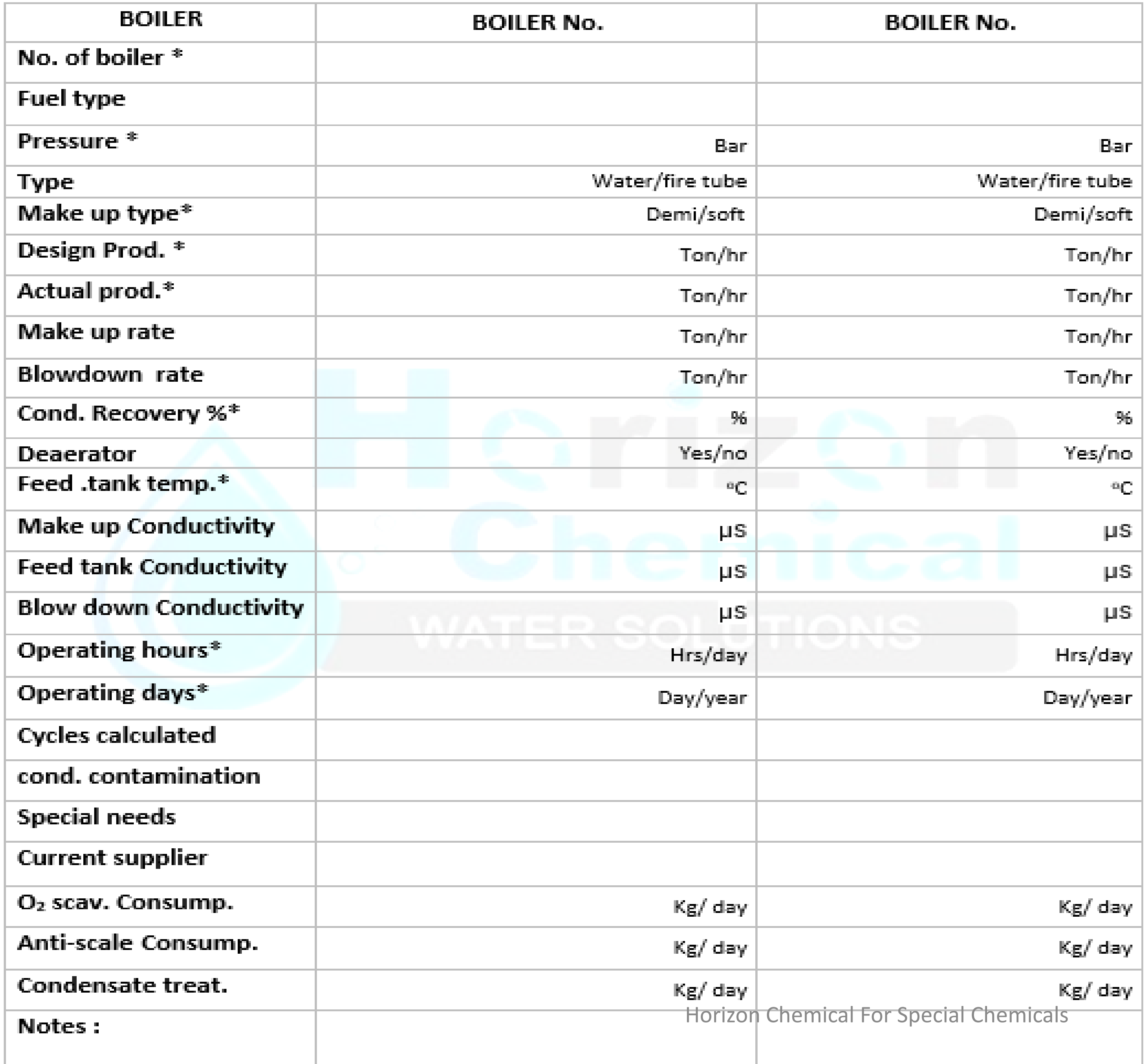
TABLE 2.3 RECOMMENDED BOILER WATER LIMITS (IS 10392, YEAR 1982)

Factor	Upto 20 kg/cm^2	21 – 39 kg/cm^2	40 – 59 kg/cm^2
TDS, ppm	3000–3500	1500–2500	500–1500
Total iron dissolved solids ppm	500	200	150
Specific electrical conductivity at 25°C (mho)	1000	400	300
Phosphate residual ppm	20-40	20-40	15-25
pH at 25°C	10–10.5	10–10.5	9.8–10.2
Silica (max) ppm	25	15	10

Parameters



TDS						
P Alkalinity, ppm as CaCo3						
M Alkalinity, ppm as CaCo3						
OH Alkalinity, ppm as CaCo3						
T. Hardeness, ppm as CaCo3						
Ca Hardeness, ppm as CaCo3						
Chloride, ppm as Cl						
Cycle of Concantration						
Total Iron, ppm as Fe						
corrsion inhibitor Residual, ppm as ---------						
Oxygen Scavenger Residual, ppm as ---------						
Scale Inhibitor Residual, ppm as ---------						
Input Water Conditions	PH	TDS/Con.	T.H / Ca H	Fe / O2	Cl	M.Alk./ Co2
Raw Water						
Make Up / Softened						
Feed Tank						
Condansate Return						
Treatment In Use	Current Dose Rate	Recom. Dose Rate	Dosing Pump Strocke	stock		To Be Ordered
scale /corrsion inhibitor						
oxygen scvenger						
condensate treatment						

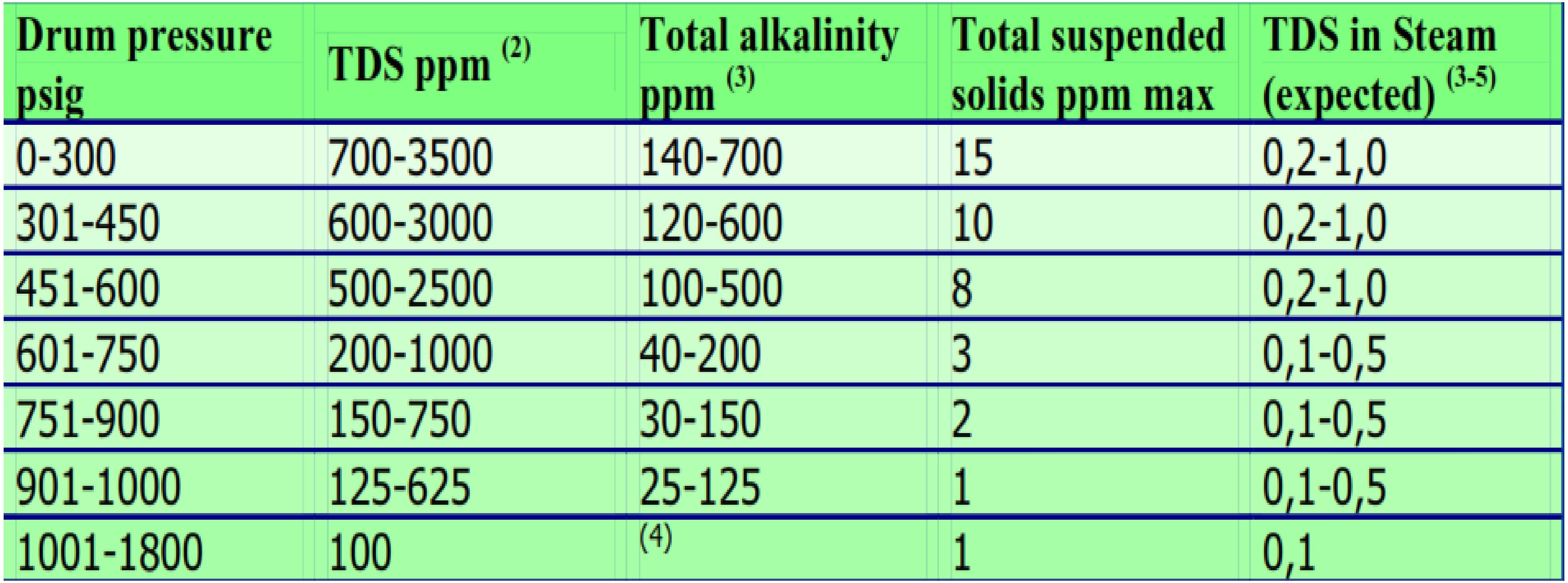


BOILER	BOILER No.	BOILER No.
No. of boiler *		
Fuel type		
Pressure *	Bar	Bar
Type	Water/fire tube	Water/fire tube
Make up type*	Demi/soft	Demi/soft
Design Prod. *	Ton/hr	Ton/hr
Actual prod.*	Ton/hr	Ton/hr
Make up rate	Ton/hr	Ton/hr
Blowdown rate	Ton/hr	Ton/hr
Cond. Recovery %*	%	%
Deaerator	Yes/no	Yes/no
Feed .tank temp.*	°C	°C
Make up Conductivity	µS	µS
Feed tank Conductivity	µS	µS
Blow down Conductivity	µS	µS
Operating hours*	Hrs/day	Hrs/day
Operating days*	Day/year	Day/year
Cycles calculated		
cond. contamination		
Special needs		
Current supplier		
O_2 scav. Consump.	Kg/ day	Kg/ day
Anti-scale Consump.	Kg/ day	Kg/ day
Condensate treat.	Kg/ day	Kg/ day
Notes :		

Horizon
Chemical
WATER SOLUTIONS

Recommended FW limits	Unit	Feed water	Boiler Water
Hardness		Nil	
pH at 25oC		8.8–9.2	9.1–9.6
Oxygen – maximum	ppm	0.007	
Total iron– maximum	ppm	0.01	
Total silica – maximum	ppm	0.02	
Conductivity at 25oC	Micor s/cm	0.3	30
Hydrazine residual	ppm	0.01–0.02	
Total solids – maximum	ppb		15
chlorides	ppm		
Copper – maximum	ppm	0.005	
Permanganate consumption	ppm	Nil	

Boiler Feed Water Limits



Drum pressure psig	TDS ppm (2)	Total alkalinity ppm (3)	Total suspended solids ppm max	TDS in Steam (expected) (3-5)
0-300	700-3500	140-700	15	0,2-1,0
301-450	600-3000	120-600	10	0,2-1,0
451-600	500-2500	100-500	8	0,2-1,0
601-750	200-1000	40-200	3	0,1-0,5
751-900	150-750	30-150	2	0,1-0,5
901-1000	125-625	25-125	1	0,1-0,5
1001-1800	100	(4)	1	0,1

Analysis

- TDS
- pH
- Alkalinity
- Hardness
- chloride Sulfite
- phosphate or organophosphate

Measurements

1. PH

Scale (0-14)

2. TDS (total dissolved solids)

Unit :” ppm ” (part per million)

3. Conductivity :concentration of ions in the water

Unit : “us/cm” or “ms/cm”(Milli or Micro siemens per centimeter)

4. Turbidity : is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy

Unit : nephelometric turbidity units (NTU) and Formazin Nephelometric Unit (FNU)

PH measurement device

TDS measurement device

Conductivity measurement device

Turbidity measurement device

Testes

Determine the total hardness

- Hardness in water is due to the presence of dissolved salts of calcium and magnesium.
- Hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent
- Two type of hardness is present in water first is temporary hardness and second is permanent hardness. Temporary hardness is due to the presence of bicarbonates of calcium and magnesium ions. It can be easily removed by boiling. Permanent hardness is due to the presence of chlorides and sulphates of calcium and magnesium ions. This type of hardness cannot be removed by boiling.

Reagent

1. EDTA 0.02N
2. Erio–T indicator
3. Ammonia buffer

Procedure:

1. The burette is filled with standard EDTA solution to the zero level.
2. Take 50ml sample water in flask.
3. Add 1ml Ammonia buffer.
4. Add 5 to 6 drop of Erio– T indicator. The solution turns into wine red colour.
5. Note the initial reading.
6. Titrate the content against EDTA solution. At the end point colour change from wine red to blue colour.
7. Note the final reading and record it. Repeat the process till we get concordant value.
8. Take 50ml sample in another flask and boiled it. (Add distilled water to get final volume of water.

Calculation

- Total hardness of water mg/L ($CaCO_3$ Scale) = ml of EDTA used (unboiled) $*10^3$ /ml of sample
- Permanent hardness of water mg/L ($CaCO_3$ Scale) = ml of EDTA used (boiled) $*10^3$ /ml of sample
- Temporary hardness of water mg/L ($CaCO_3$ Scale) = Total hardness of water - Permanent hardness of water

- Total hardness as $CaCO_3$ In ppm$=\frac{\mathrm{V1}*N*50*1000}{V}$=ppm

When :

- V1=volume of end point , N=normality of EDTA=molarity *valence =.02*4
- V=volume of sample,
- 50 is equivalent weight of $CaCO_3$ $=\frac{\text{molecular } weight}{total\ no\ of\ positivve\ charge\ on\ cation\ ca{+}{+}} = \frac{40+12+(16*3)}{2}$

Determine the Alkalinity

- The alkalinity of the water is a measure of its capacity to neutralize acids.

Reagents:

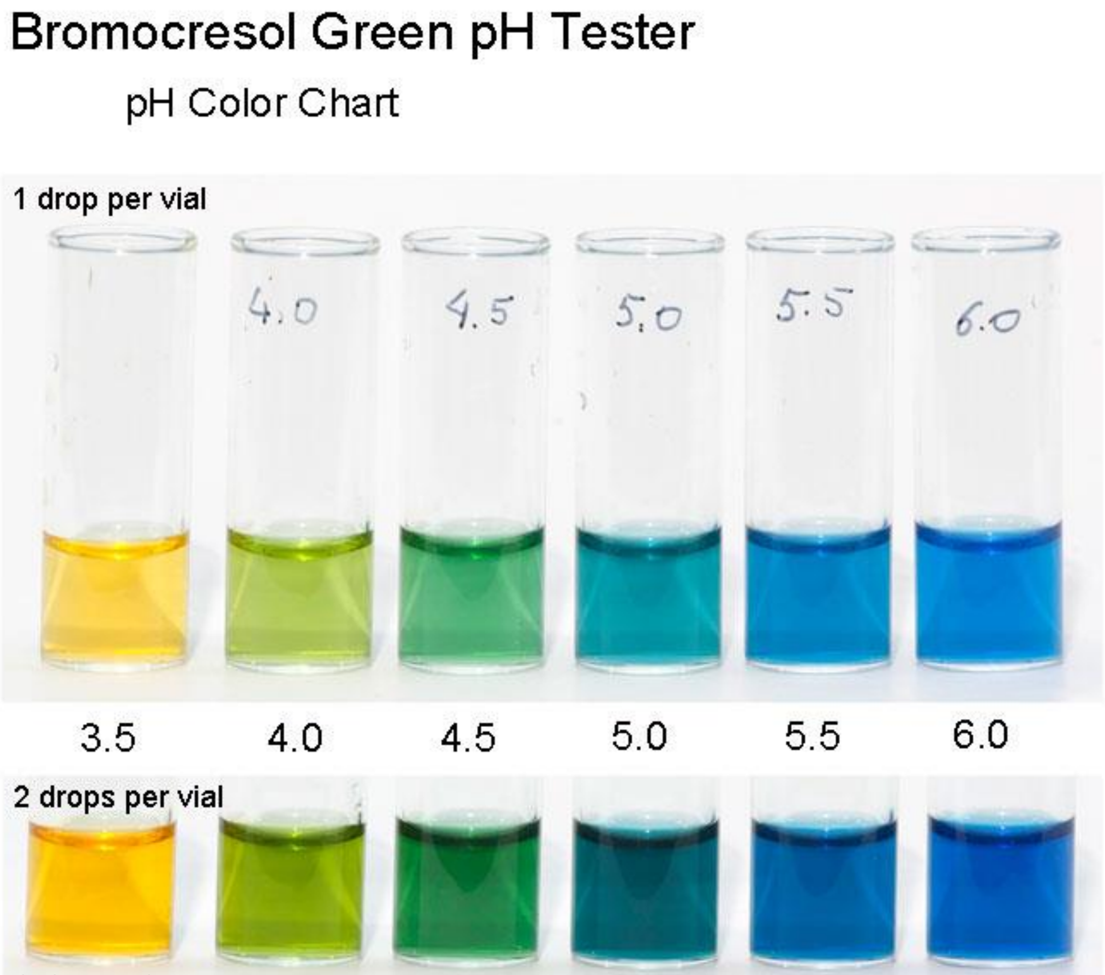
H_2SO_4 solution 0.01 N

Phenolpthalein indicator

Methyl Orang indicator OR Bromocrosol green

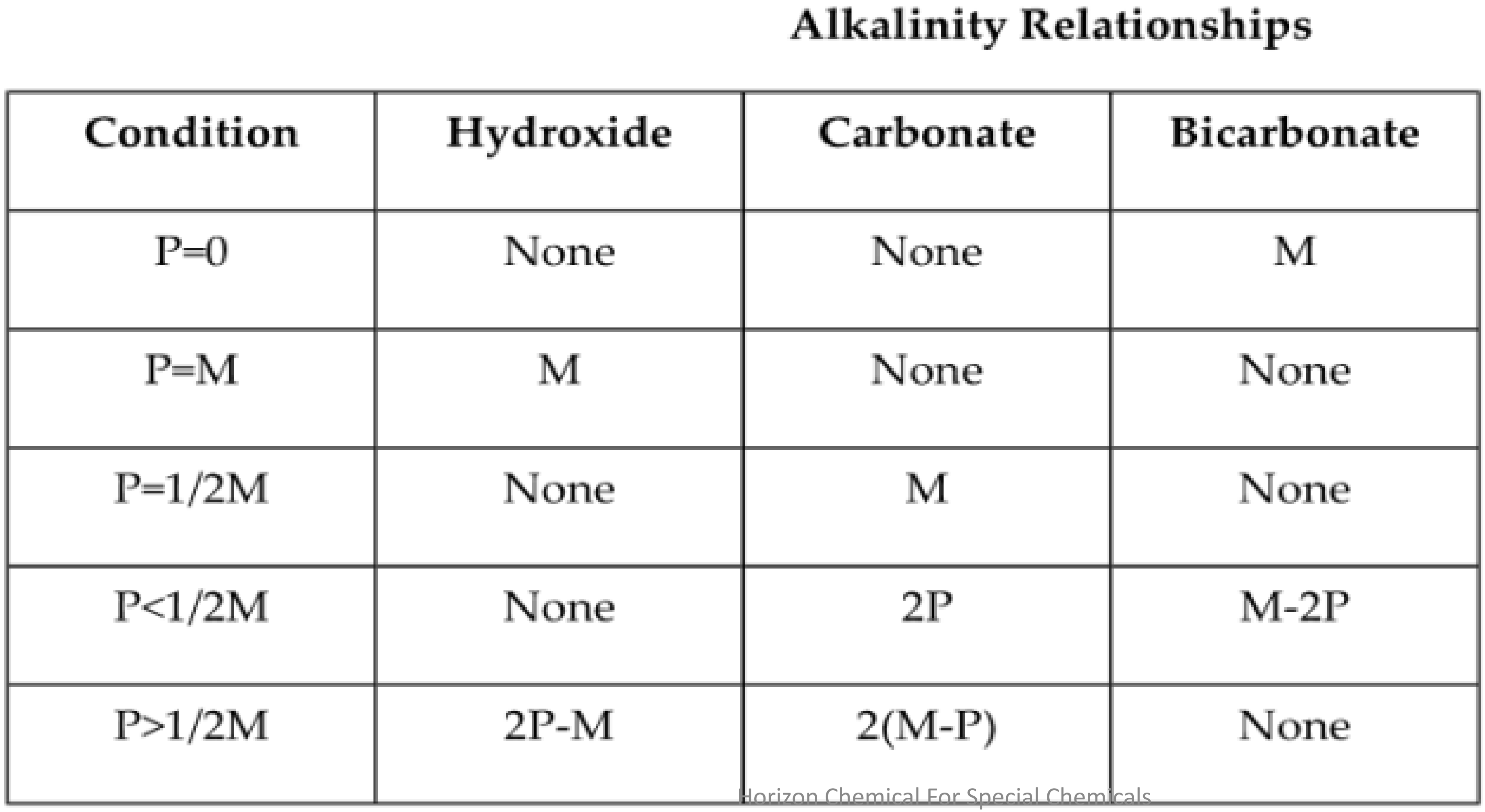
Procedure:

1. Fill the burette to H_2SO_4 0.01 N solution.
2. Take a 50 ml water sample in flask. Add few drop of Phenolphthalein indicator.
3. Titrate against H_2SO_4 till the pink colour disappear.
4. Note the end point reading and get volume of used H_2SO_4 in ml
5. Add 1-3 drop of Bromocrosol green in same sample flask.
6. Titrate it, till the appearance of green colour.
7. Note down the final reading and find the volume of used H_2SO_4 .



Calculation

$$\text{M-P-Alkalinity} = \frac{(N*V)H2SO4*50000}{Vml}$$



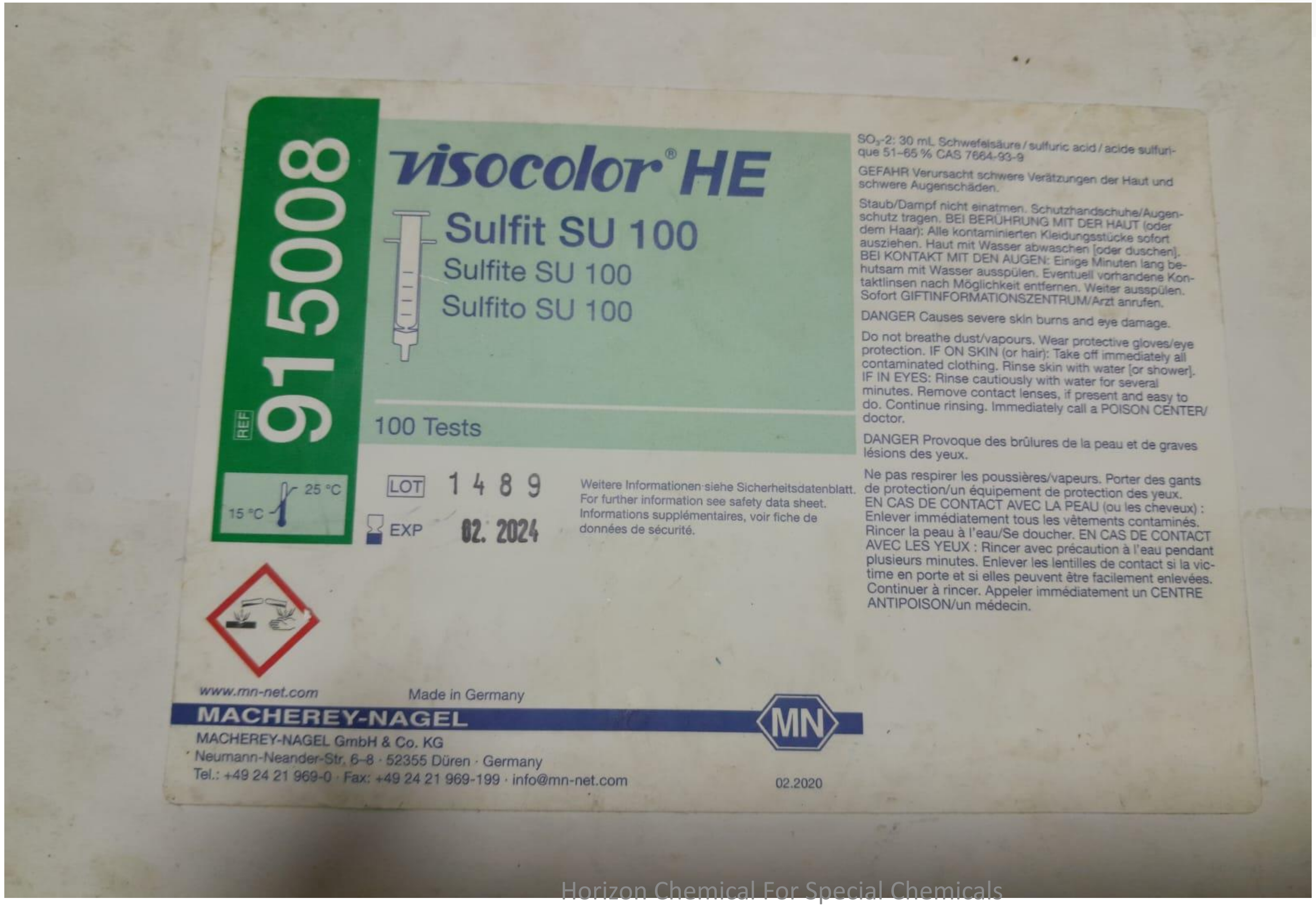
Alkalinity Relationships

Condition	Hydroxide	Carbonate	Bicarbonate
P=0	None	None	M
P=M	M	None	None
P=1/2M	None	M	None
P<1/2M	None	2P	M-2P
P>1/2M	2P-M	2(M-P)	None

Note:

Sulphate	Sulphite	Sulphide
1. The chemical or molecular formula for **sulphate is** SO_4^{2-}.	2. The molecular or chemical formula of **sulphite is** SO_3^{2-}	3. The chemical or molecular formula of **sulphide is** S^{2-}.

Sulfite Test Kit



REF 915008

visocolor® HE

Sulfit SU 100
Sulfite SU 100
Sulfito SU 100

100 Tests

15 °C – 25 °C

LOT 1 4 8 9
EXP 02. 2024

Weitere Informationen siehe Sicherheitsdatenblatt.
For further information see safety data sheet.
Informations supplémentaires, voir fiche de données de sécurité.

SO_3-2: 30 mL Schwefelsäure / sulfuric acid / acide sulfurique 51–65 % CAS 7664-93-9

GEFAHR Verursacht schwere Verätzungen der Haut und schwere Augenschäden.

Staub/Dampf nicht einatmen. Schutzhandschuhe/Augenschutz tragen. BEI BERÜHRUNG MIT DER HAUT (oder dem Haar): Alle kontaminierten Kleidungsstücke sofort ausziehen. Haut mit Wasser abwaschen [oder duschen]. BEI KONTAKT MIT DEN AUGEN: Einige Minuten lang behutsam mit Wasser ausspülen. Eventuell vorhandene Kontaktlinsen nach Möglichkeit entfernen. Weiter ausspülen. Sofort GIFTINFORMATIONSZENTRUM/Arzt anrufen.

DANGER Causes severe skin burns and eye damage.

Do not breathe dust/vapours. Wear protective gloves/eye protection. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower]. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/doctor.

DANGER Provoque des brûlures de la peau et de graves lésions des yeux.

Ne pas respirer les poussières/vapeurs. Porter des gants de protection/un équipement de protection des yeux. EN CAS DE CONTACT AVEC LA PEAU (ou les cheveux) : Enlever immédiatement tous les vêtements contaminés. Rincer la peau à l'eau/Se doucher. EN CAS DE CONTACT AVEC LES YEUX : Rincer avec précaution à l'eau pendant plusieurs minutes. Enlever les lentilles de contact si la victime en porte et si elles peuvent être facilement enlevées. Continuer à rincer. Appeler immédiatement un CENTRE ANTIPOISON/un médecin.

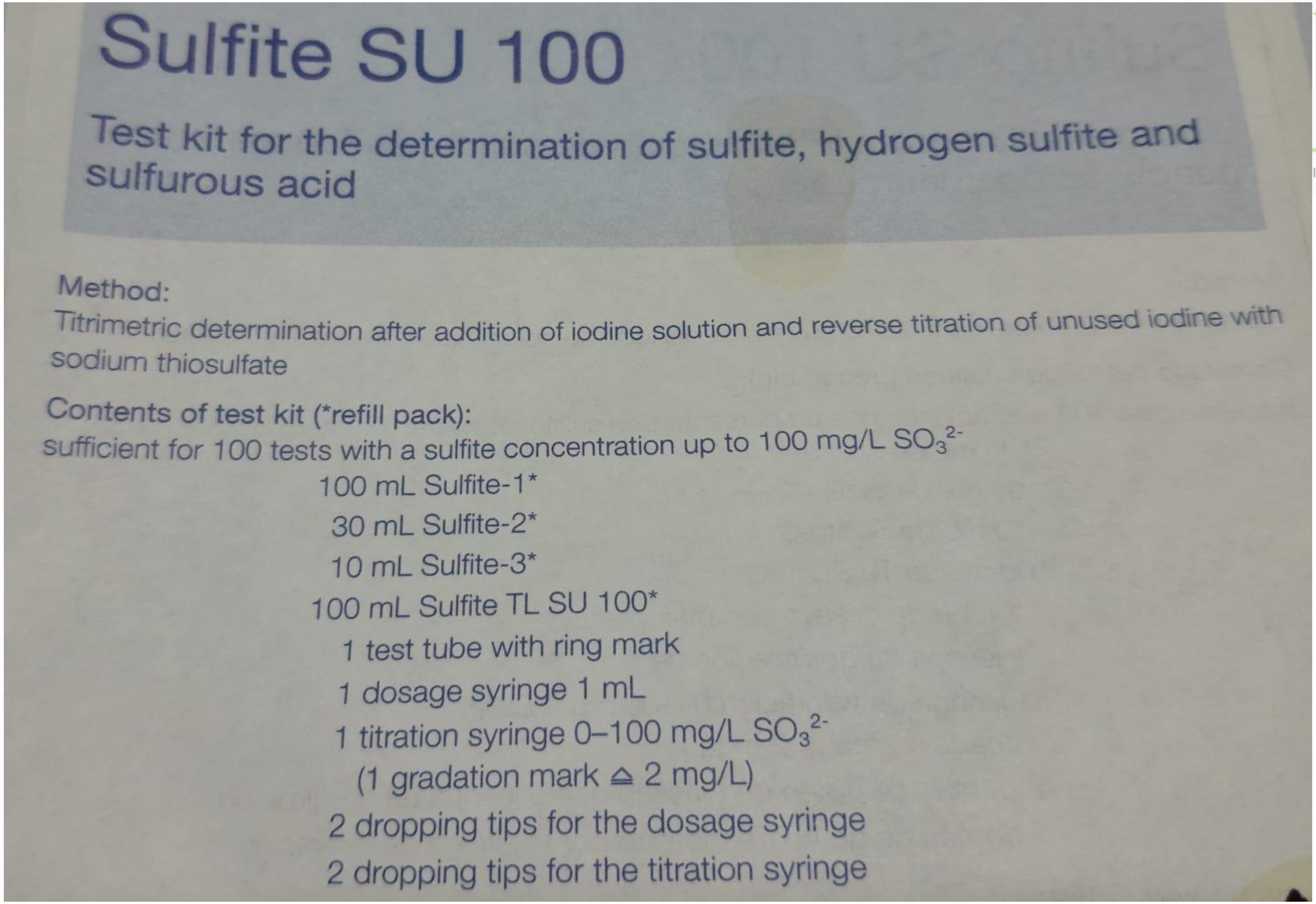
www.mn-net.com
Made in Germany

MACHEREY-NAGEL
MN

MACHEREY-NAGEL GmbH & Co. KG
Neumann-Neander-Str. 6–8 · 52355 Düren · Germany
Tel.: +49 24 21 969-0 · Fax: +49 24 21 969-199 · info@mn-net.com

02.2020


visocolor HE
Sulfit SU 100
Sulfite SU 100
Sulfito SU 100
SO$_3$-1
1 mL
100 mL
EXP 02. 2024
MACHEREY-NAGEL GmbH & Co. KG
Tel.: +49 24 21 969-0 · www.mn-net.com
02.2020
SO$_3$-2
2
30 mL
SO$_3$-3
1
TL SU 100
100 mL
5 mL



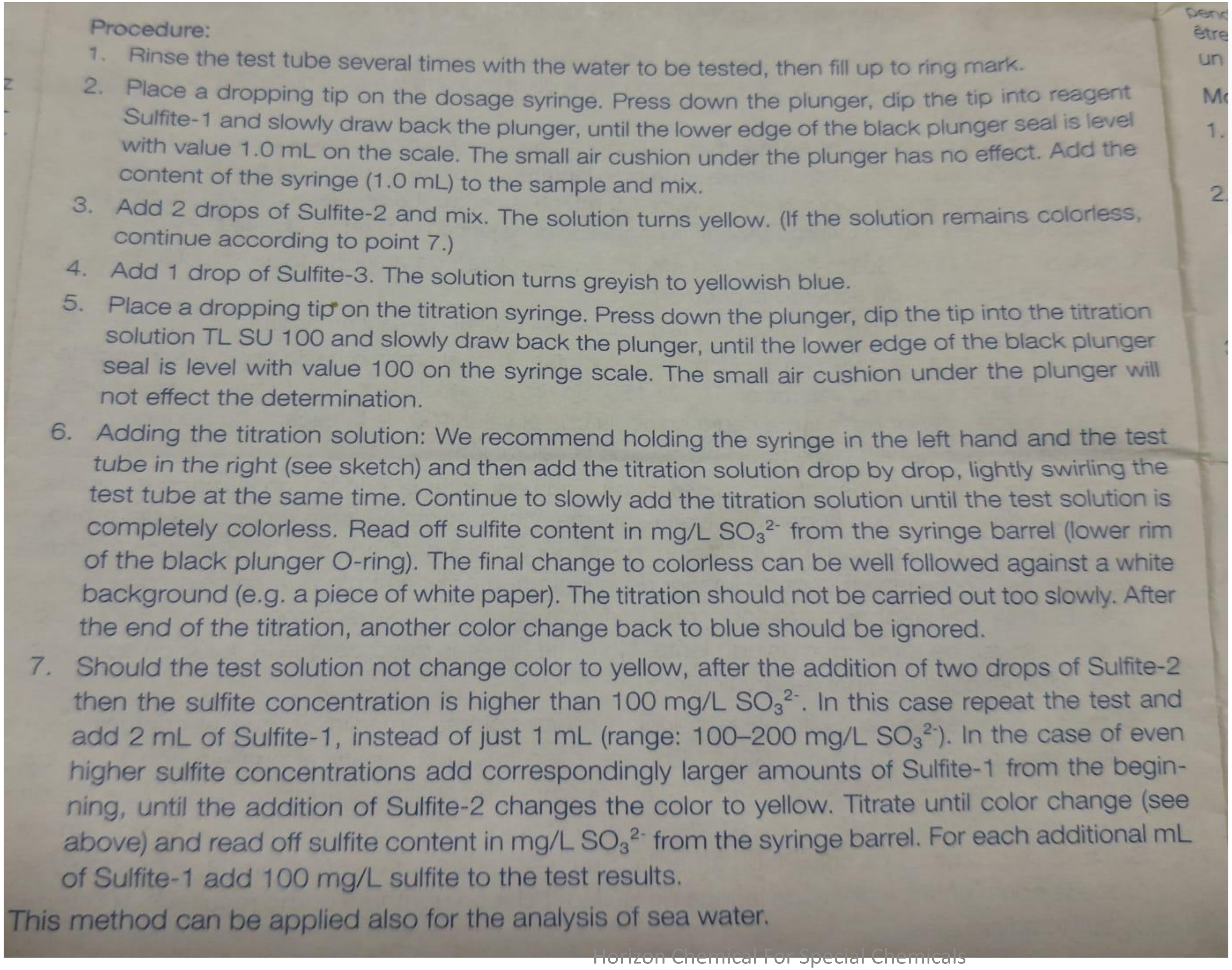
Sulfite SU 100

Test kit for the determination of sulfite, hydrogen sulfite and sulfurous acid

Method:
Titrimetric determination after addition of iodine solution and reverse titration of unused iodine with sodium thiosulfate

Contents of test kit (*refill pack):
sufficient for 100 tests with a sulfite concentration up to 100 mg/L SO_3^{2-}

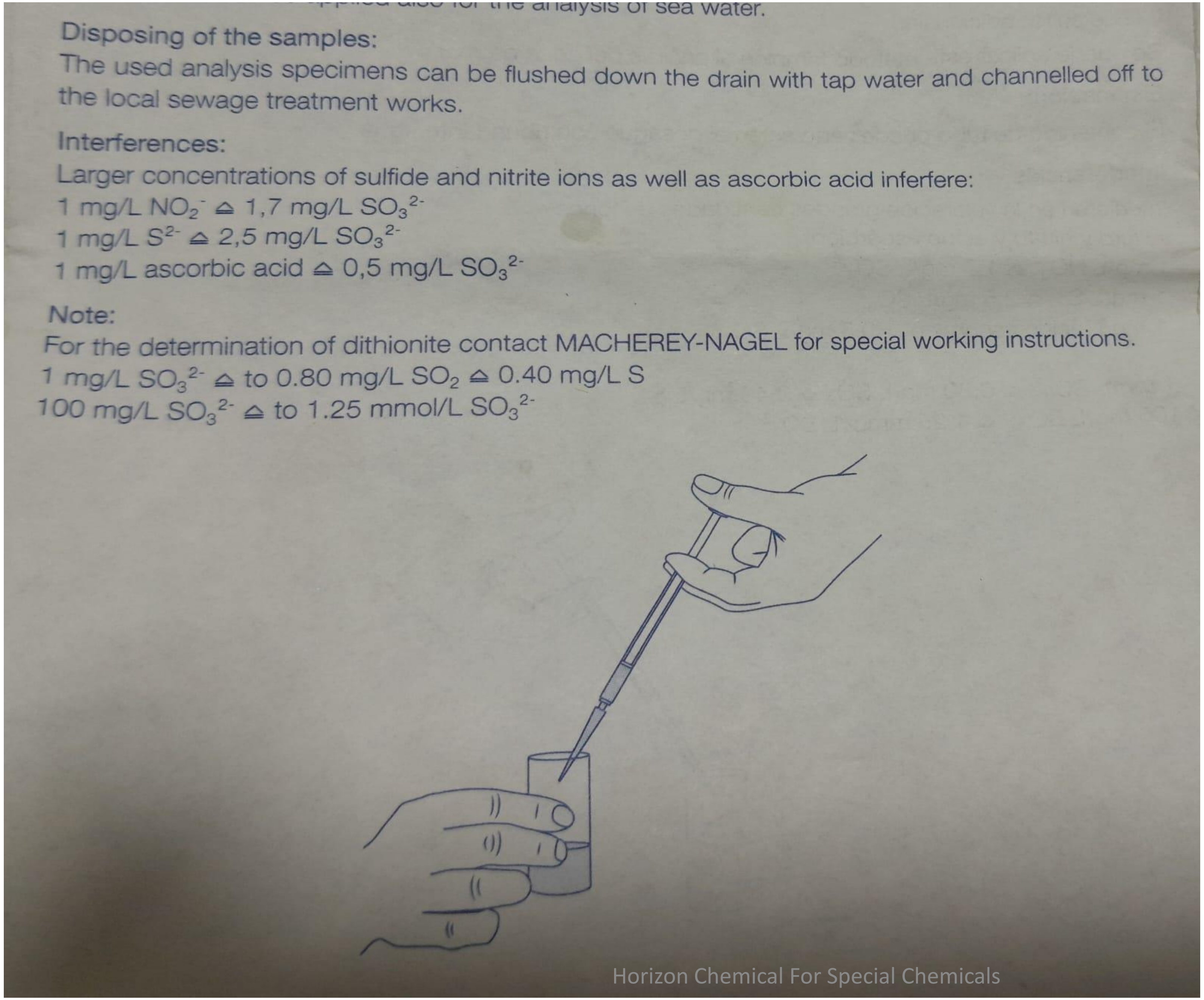
100 mL Sulfite-1*
30 mL Sulfite-2*
10 mL Sulfite-3*
100 mL Sulfite TL SU 100*
1 test tube with ring mark
1 dosage syringe 1 mL
1 titration syringe 0–100 mg/L SO_3^{2-}
(1 gradation mark ≙ 2 mg/L)
2 dropping tips for the dosage syringe
2 dropping tips for the titration syringe



Procedure:

1. Rinse the test tube several times with the water to be tested, then fill up to ring mark.
2. Place a dropping tip on the dosage syringe. Press down the plunger, dip the tip into reagent Sulfite-1 and slowly draw back the plunger, until the lower edge of the black plunger seal is level with value 1.0 mL on the scale. The small air cushion under the plunger has no effect. Add the content of the syringe (1.0 mL) to the sample and mix.
3. Add 2 drops of Sulfite-2 and mix. The solution turns yellow. (If the solution remains colorless, continue according to point 7.)
4. Add 1 drop of Sulfite-3. The solution turns greyish to yellowish blue.
5. Place a dropping tip on the titration syringe. Press down the plunger, dip the tip into the titration solution TL SU 100 and slowly draw back the plunger, until the lower edge of the black plunger seal is level with value 100 on the syringe scale. The small air cushion under the plunger will not effect the determination.
6. Adding the titration solution: We recommend holding the syringe in the left hand and the test tube in the right (see sketch) and then add the titration solution drop by drop, lightly swirling the test tube at the same time. Continue to slowly add the titration solution until the test solution is completely colorless. Read off sulfite content in mg/L SO_3^{2-} from the syringe barrel (lower rim of the black plunger O-ring). The final change to colorless can be well followed against a white background (e.g. a piece of white paper). The titration should not be carried out too slowly. After the end of the titration, another color change back to blue should be ignored.
7. Should the test solution not change color to yellow, after the addition of two drops of Sulfite-2 then the sulfite concentration is higher than 100 mg/L SO_3^{2-}. In this case repeat the test and add 2 mL of Sulfite-1, instead of just 1 mL (range: 100–200 mg/L SO_3^{2-}). In the case of even higher sulfite concentrations add correspondingly larger amounts of Sulfite-1 from the beginning, until the addition of Sulfite-2 changes the color to yellow. Titrate until color change (see above) and read off sulfite content in mg/L SO_3^{2-} from the syringe barrel. For each additional mL of Sulfite-1 add 100 mg/L sulfite to the test results.

This method can be applied also for the analysis of sea water.



pplied also for the analysis of sea water.

Disposing of the samples:

The used analysis specimens can be flushed down the drain with tap water and channelled off to the local sewage treatment works.

Interferences:

Larger concentrations of sulfide and nitrite ions as well as ascorbic acid inferfere:

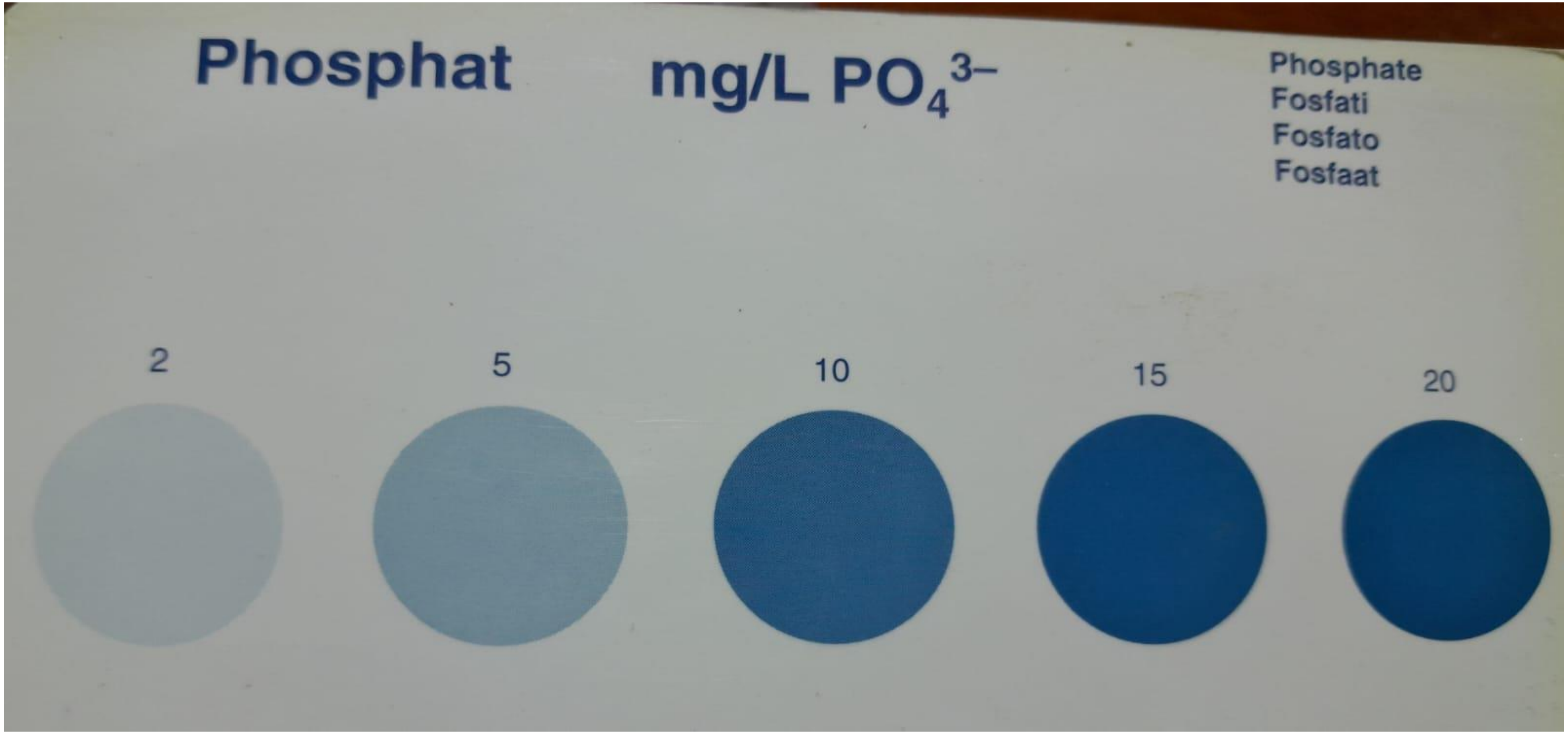
1 mg/L NO_2^- $\triangleq$ 1,7 mg/L SO_3^{2-}
1 mg/L S^{2-} $\triangleq$ 2,5 mg/L SO_3^{2-}
1 mg/L ascorbic acid $\triangleq$ 0,5 mg/L SO_3^{2-}

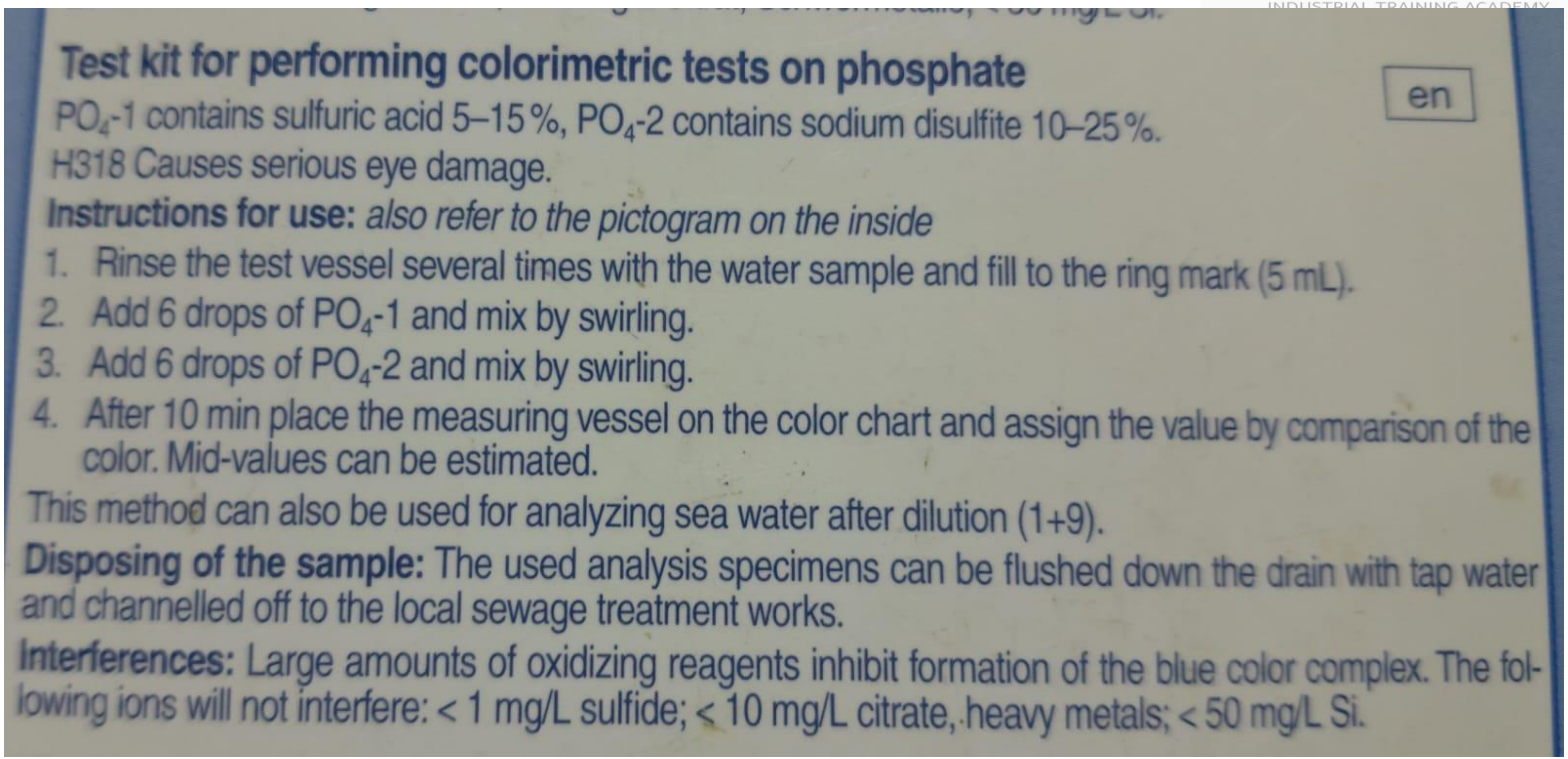
Note:

For the determination of dithionite contact MACHEREY-NAGEL for special working instructions.

1 mg/L SO_3^{2-} $\triangleq$ to 0.80 mg/L SO_2 $\triangleq$ 0.40 mg/L S
100 mg/L SO_3^{2-} $\triangleq$ to 1.25 mmol/L SO_3^{2-}

Phosphate Test Kit


Phosphat
mg/L PO_4^{3-}
Phosphate
Fosfati
Fosfato
Fosfaat
2
5
10
15
20



Test kit for performing colorimetric tests on phosphate

en

PO_4-1 contains sulfuric acid 5–15 %, PO_4-2 contains sodium disulfite 10–25 %.

H318 Causes serious eye damage.

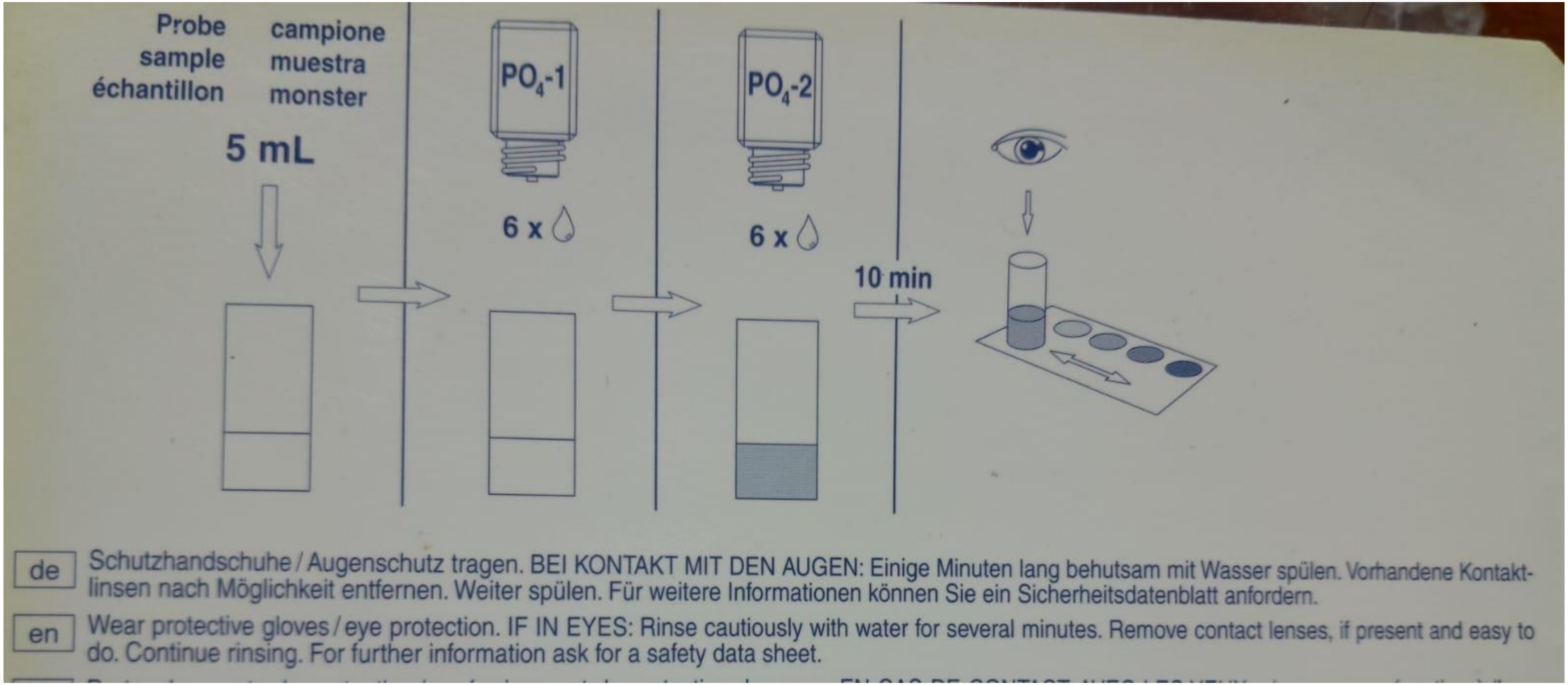
Instructions for use: *also refer to the pictogram on the inside*

1. Rinse the test vessel several times with the water sample and fill to the ring mark (5 mL).
2. Add 6 drops of PO_4-1 and mix by swirling.
3. Add 6 drops of PO_4-2 and mix by swirling.
4. After 10 min place the measuring vessel on the color chart and assign the value by comparison of the color. Mid-values can be estimated.

This method can also be used for analyzing sea water after dilution (1+9).

Disposing of the sample: The used analysis specimens can be flushed down the drain with tap water and channelled off to the local sewage treatment works.

Interferences: Large amounts of oxidizing reagents inhibit formation of the blue color complex. The following ions will not interfere: < 1 mg/L sulfide; < 10 mg/L citrate, heavy metals; < 50 mg/L Si.



de Schutzhandschuhe / Augenschutz tragen. BEI KONTAKT MIT DEN AUGEN: Einige Minuten lang behutsam mit Wasser spülen. Vorhandene Kontaktlinsen nach Möglichkeit entfernen. Weiter spülen. Für weitere Informationen können Sie ein Sicherheitsdatenblatt anfordern.

en Wear protective gloves / eye protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. For further information ask for a safety data sheet.

Thank you