

BOILER OPERATION AND MAINTENANCE IN SUGAR INDUSTRY

W.R.AHER

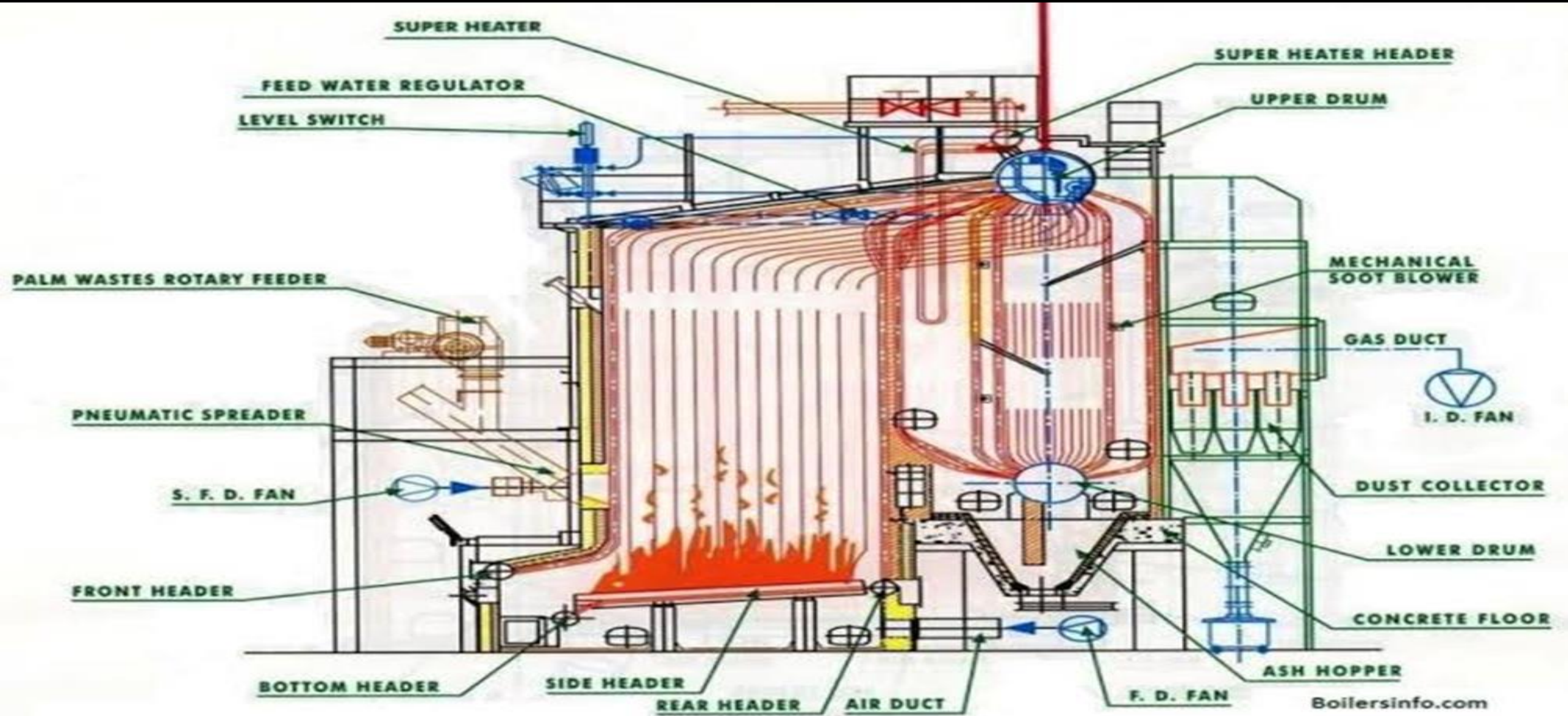
(B.E.MECH ,M I E,BOE)

- **Council Member of DSTA.–II Term**
- **Member of board of B.O.E. Examination Maharashtra**
- **Examiner of B.E.Mech project, Pune University**
- **Director P.V.V.P CO-OP BANK LTD. NASHIK**
- **Energy Manager**
- **Life member of STAI, DSTA & SISTA.**
- **Ex-council member of STAI New Delhi.-Two terms.**

INTRODUCTION

- ▶ Now a days Sugar & allied industries are installing high pressure boilers for their utilization to have efficient use of steam & fuels
- ▶ Special considerations in design, engineering, selection of boilers has to be made as these are influential factors in operation & trouble shooting.
- ▶ This also adds maintenance, spare management & additional precautions.
- ▶ Few boilers have been constructed for multi-fuel firing also.
- ▶ This paper deals with some of the important factors to be considered in efficient operation of boilers & trouble shooting .
- ▶ Normal, regular operational & maintenance points are discussed in this paper.

WATERTUBE BOILER-40T/HR, 45 KG/CM², 427°C TE



BOILER PRESSURE PART-MATERIAL SPECIFICATION

- ▶ BOILER DRUMS AND DISHENDS —BS1501 490B,Grade224
- ▶ BOILER HEADERS --SA106Gr B
- ▶ BOLER TUBES --BS 3059PART1 ERW
- ▶ SUPERHEATER TUBES --SA213 GradeT11 ALLOY STEEL
- ▶ ECONOMISER TUBES --BS 309PART ERW
- ▶ AIR HEATER TUBES --BS 1775 Grade11
- ▶ STRUCTURE /DUCTING --IS 2062
- ▶ NUT BOLTS -- 8.8(For pressure parts)
- ▶ INSULATION -- IS 8183 MINERAL WOOL
- ▶ REFRACTORY --IS 8 WITH45%AL2O3
- ▶ GRATE BARS -- GRY ALLOY CASTING
- ▶ HP VALVES --SA216WCB -ABOVE50 NB&SA105 BELOW40NB

STEAM DRUM

- ▶ High pressure boilers are designed with higher design pressures, higher steam temperature to get maximum power generation per kg of steam.
- ▶ Higher design pressure calls for higher quality steels, thicker drum plates for dish end covers larger thicknesses of headers shells & end covers, special grooves for tube expansions and in some cases seal welding , more sophistications in fabrication , IBR welding, higher quality norms in radiography ,stress relieving etc.
- ▶ **TUBES**=Tube thicknesses are also higher. Feed pump pressures call for multi -stages, valves also need special type of internals, neck weld flanges are employed and jointing material requires metallic jointing with serrations.
- ▶ **SUPER HEATERS COILS** call for higher alloy elements and strict temperature control range so accurate attemperation. Specially laid down quality assurance plans must be strictly adhered to. This is required to protect super heater, steam piping, life of Turbine blades.
- ▶ Steam piping and high pressure water piping needs stress analysis , proper supports and expansion provisions.

SUPERHEATER



FURNACES

- Furnaces are made up from water walls of membrane panels or mono walls made from tubes & fins so as to make seal Proof walls & to reduce excess air. Membrane walls are to be preferably machine welded for better quality.
- Efficient Firing equipments are required to reduce unburnt carbon loss & reduce excess air. Since furnace & grate is heart of boiler, selection of this equipment, design of moving parts. Material selection sizing, heat release rates etc are to be taken care.
- This will have large influence on efficient operation of boiler. Furnace volume, residence time, furnace exit temp, ash fusion temp, over fire air turbulence & excess air are very important factors In operations.
- Next important point is circulation calculations.
- Furnace geometry, arrangement of tubes, no& sizes of down comers, risers, heat absorbed by various walls, generation in each wall, no of separators are decided very critically.

DRUM INTERNALS AND STEAM PURITY.

- ▶ Drum Internals are other important parts to achieve highest possible steam purity. Selection of primary separators, secondary scrubbers, seal proof baffles, combination of demisters or chevrons ensure proper purity.
- ▶ Sizing of separators, scrubbers, feed pipes etc. has to be done with simplicity of maintenance. Accurate installation of these parts with maximum possible care is need of high Pressure boilers.
- ▶ Improper design, installation, poor maintenance can result in carry over , lower steam temp, erosion of turbine blades & SH failures. It will also affect power output& fuel consumption.
- ▶ In Order to get better steam purity, DM/RO plant is required. Any makeup water required by the boiler has to be through DM/RO plant.
- ▶ Condensate water quality also is always to be monitored & compared with recommended norms of feed water quality, Recommended quality of feed water & boiler water Is attached here with.

FUEL STORAGE & VARIATIONS

- ▶ In order to have fewer fluctuations in load & steam Pressures, practically it is advisable to have fuels to be stored for few minutes, because of lighter physical properties of bagasse. Like coal or lignite storage capacity is not possible for more than 12 hours,
- ▶ It is possible to have storage of 5 minutes. This will give extra breathing time but also helps to regulate excess air. Larger divergent chutes with extractor of larger diameters are used with horizontal screw conveyors.
- ▶ Any moving part added will surely add maintenance problems. That's the drawback with this system besides the cost of equipments.
- ▶ There are also variations in moisture content of bagasse which reduces calorific value, increases air requirements, reduces furnace temp & creates fluctuations in load. Reduction in moisture makes the furnace brighter.
- ▶ Hence little lower % of moisture is always advisable. There are means under development for reduction in moisture.

ECONOMIZER AIR HEATER.

- ▶ Optimum velocities of gas in economizer & air heater will give us max heat transfer with minimum draft losses & fan power. This will also protect the costlier parts from erosion & span of life is enhanced.
- ▶ There is also a need of minimum Temp of feed water to protect the coils from corrosion. Higher the feed water temp higher is the response of boilers & higher is plant efficiency.
- ▶ So pressurized deaerators have been often used, & more often is feed water heaters will take a bleed steam from turbine & heat the incoming water so that the difference between saturation temp & Inlet temp to drum is minimum.
- ▶ This needs a high standard circulation check but will result in better, quicker boiler response & fuel economy. Apart from Inlet feed water temp, it is also essential to check sufficient water flow through each coil.
- ▶ Optimum pressure drops in water circuit is to be ensured. Mal distribution of gases & water both are harmful.

ECONOMIZER



INSTRUMENTATION & CONTROLS

- ▶ More attention is to be paid to instrumentations & controls in HIGH pressure boilers. High pressure boilers naturally take you TO POWER BOILER CULTURE
- ▶ Sophisticated instruments & control with higher reliability has proved that efficiency of boilers can be continuously maintained, monitored by operation & maintenance engineers demonstrated consistently.
- ▶ Proper training is also a must so that they take interest & try to maintain the standard, can have better energy conservations. ID fan especially needs larger margins of sizing for variation in fuel characteristics.
- ▶ Similarly, last few legs of air heater tubes are suggested with carbon steel tubes in order to protect them from corrosion. This is especially true where metal temp of tubes at the entry of air side is low & is attacked by low temp corrosion due to moisture content in air.
- ▶ There are now designs with plate type air heaters wherein we can further go down on back end temp & improve thermal efficiency.

PARAMETERS AFFECTING EFFICIENT OPERATION

- ▶ PARAMETERS AFFECTING EFFICIENT BOILER OPERATION ARE MAINLY THE HEAT LOSSES .TOTAL HEAT LOSSES ARE ABOUT 20%-22%
- ▶ TYPES OF HEAT LOSSES ARE AS FOLLOWS,
- ▶ Loss due to dry flue gas.
- ▶ Loss due to hydrogen in fuel.
- ▶ Loss due to moisture in fuel.
- ▶ Loss due to moisture in air.
- ▶ Loss due to carbon monoxide.
- ▶ Loss due to surface radiation.
- ▶ Losses due to unburnt in fly ash and in bottom ash.

OPERATIONAL ASPECTS --1

- ▶ High pressure boilers are meant for power generations and even at lower loads of 60% steam temp should not fall. So steam temp control must be operative.
- ▶ Any variation in fuel quality & quantity can result into furnace temp variations and cause fluctuations in press and loads. Uniform loading on boilers and minimum variations can lead into better efficiency and better power output.
- ▶ If boiler is working with multi fuel arrangement then designers guidelines for limiting the use of particular fuel must be followed to get best possible result.
- ▶ Air to fuel ratio for all fuels must be studied and followed. Excess air control has major role in deciding efficiency of boiler.
- ▶ There is also need for training and understanding of silent features of boiler to get maximum output. Operating engineers must be BOE and trained .
- ▶ As pointed our earlier it is our duty of every boiler operating personnel to bring the power culture to this important field.
- ▶ It must be borne in mind that fuel or power is not free. They have a huge cost.

OPERATIONAL ASPECTS--2

- ▶ Water management, condensate management has direct impact on steam quality, power output, fuel consumption, steam temp, life of SH, turbine, piping etc. So these equipments must be studied and best use of them must be made to have maximum benefits.
- ▶ Furnace and grate are hearts of boiler. This is subjected to high temp and has moving parts ,prone to wear and tear.
- ▶ Frequent inspection and minute observations on performance and combustion pattern will certainly help in a long run.
- ▶ In order to have maximum absorption of heat all soot blowers in radiant and convection zones must be made operative.
- ▶ It must be made a habit so that always we get additional 1% efficiency due to effective cleaning due to soot blowing.
- ▶ Frequent removal of ash will not allow to clinker to build and in turn reduce un-burnt losses.

BOILER PARAMETERS FOR OPERATIONS

UNIT	PRESSURE/DRAFT	TEMPERATURE	FLOW
SUPER HEATER INLET/OUTLET	YES	YES	YES
FEED WATER PUMP &LINE	YES	YES	YES
FURNACE	YES	YES	
ECONOMISER INLET/OUTLET	YES	YES	YES
AIRPREHEATER AIRSIDE/FLUE GAS SIDE	YES	YES	YES
ID FAN INLET/OUTLET	YES	YES	YES
FD FAN INLET/OUTLET	YES	YES	YES
STEAM DRUM	YES	YES	YES

MAN POWER REQUIREMENT FOR BOILER OPERATION AND MAINTENANCE

- ▶ 1NO-ASSISTANT ENGINEER—BOE PASSED.
- ▶ 1NO-BOILER ATTENDENT—SSC, 1 ST CLASS BOILER COMPETANCY PASSED.
- ▶ 1NO-FIREMAN-- SSC,2ND CLASS BOILER COMPETANCY PASSED
- ▶ 1NO-WATERMAN—SSC,2ND CASS BOILER COMPETANCY PASSED.
- ▶ 1NO-FEED WATER PUMPMAN---SSC
- ▶ 1NO-CARRIER ATTENDENT-SSC
- ▶ 1NO-INSTRUMENT TECHNICIAN- ITI WITH INSTRUMENTATION AND AUTOMATION
- ▶ 4 NOS-UNSKILLED WORKERS.
- ▶ CONTRACT FOR FUEL FEEDING AND ASH DISPOSAL.
- ▶ THE ABOBE MANPOWER IS FOR ONE SHIFT ONLY

OFF SEASON MAINTENANCE

- ▶ All pressure parts and other heating surfaces must be cleaned thoroughly. UTS test should be carried out for all pressure parts. For which scaffolding arrangement is must prior to offseason.
- ▶ Replacement of corroded, wasted and low thickness pressure parts must be changed with due recommendation of GOVT. authorities.
- ▶ Chemical cleaning of pressure parts must be done. ID/FD/SA fans, feed water pumps & bagasse feeders are to be dynamically balanced & overhauled.
- ▶ Lapping & grinding of HP valves& Hyd test is to be done for every valve. Boiler HYD. test is to be carried out at 1.5 times WP. Brickwork is to be repaired in offseason.
- ▶ Insulation is to provided on all open heating surfaces .
- ▶ AUTOMATION-VFD drives and DCS boiler automation are to be provided to ID fan, feed water pump& bagasse feeders. Wet scrubber./dust collectors, DM water plant/RO is to be kept ready for operation.

PERIODICAL CLEANING

- ▶ Super heater, economizer and air heater chambers are to be checked for ash accumulation removal.
- ▶ Blow down leakages, vent leakages; steam drain leakages may be attended.
- ▶ Grate bars and furnace chambers are to be checked for ash accumulation removal.
- ▶ Electrical drives and control automation panels checking may be attended.
- ▶ Pressure parts and ducting are to be checked for erosion

WEEKLY MAINTENANCE

- ▶ VFD drives and boiler automation are to be checked to ID fan, feed water pump & bagasse feeders.
- ▶ Wet scrubber./dust collectors, DM water plant is to be kept ready for operation. Ash and soot should be removed from ash chambers and Furnace.
- ▶ Greasing is to be provided to all bearings of the rotating units. Gland packing is to be provided to leaky valves.
- ▶ Wet scrubbers, Ash drying beds are to be cleaned. Brickwork repair must be attended. Excess bagasse should be controlled by all possible means.
- ▶ Water cooling connections of bagasse spreaders are to be cleaned and greasing is to be done.
- ▶ Super heater, economizer and air heater chambers are to be checked for ash accumulation removal.
- ▶ Blow down leakages, vent leakages; steam drain leakages may be attended.

DAILY MAINTENANCE

- ▶ Furnace and combustion chambers are to be cleaned in every shift. pressure & temperatures are to be noted in every shift, for All water/steam /draft/flue gas points,
- ▶ Proper bagasse feeding and drum water level control are to be ensured.
- ▶ Fan & pump Bearing vibration, sound and temp is to be recorded for corrective action.
- ▶ Excess bagasse is to be controlled with operation of baling machines. Soot blowers and blow downs are to be operated twice in every shift.
- ▶ Continuous blow down is better option for boiler water quality.
- ▶ Ash drying beds, Wet scrubbers/ESP/dust collectors' ash should be discharged to ash yard in every shift.

FEED & BOILER WATER PARAMETERS FOR -45kg/cm²

Description	Unit	Feed water	Boiler Water
Total Hardness (max.)	ppm	Nil	Nil
pH Value at 25 OC		8.5-9.2	9.5-10.5
Oxygen (max.)	ppm	0.007	Nil
Iron (max.)	ppm	Nil	Nil
Copper (max.)	ppm	Nil	Nil
Silica (max.)	ppm	0.02	2.5
Total CO ₂ (max.)	ppm	Nil	Nil
Permanganate (max.)	ppm	Nil	Nil
Total Dissolved Solids (max.)	ppm	0.1	100
Total suspended Solids (max.)	ppm	Nil	5
Oil (max.)	ppm	Nil	Nil
Specific electric conductivity at 25 degree C	micro S/cum	0.2	200
Residual Hydrazine (max.)	ppm	0.02	Nil
Residual Phosphate (max.)	ppm	Nil	20

FEED WATER AND BOILER WATER PARAMETERS FOR 110 KG/CM² G HIGH PRESSURE BOILER

PARAMETER	FEED WATER	PARAMETER	BOILER DRUM WATER
PH	9.3.to9.5 at 25°C	PH	9.7 to 10.2
TDS	<0.4PPM	TDS	47PPM
SILICA AS SiO ₂	<0.015 PPM	SILICA AS SiO ₂	0.58PPM
Hydroxide Alkalinity(OH)	NIL	Hydroxide Alkalinity(OH)	9.4PPM
Max. Chlorides(CL)	NIL	Phosphate as(PO ₄)	7PPM
Oil& Organics	NIL	Max. Chlorides(CL)	4PPM
Copper Cu	0.005ppm	Max. Specific conductivity	100Micro S/cm
Dissolved Oxygen	0.007 ppm	Max. Suspended solids	1PPM
Iron Fe	0.01ppm		
Cat ion Conductivity	0.2ppm(Max.)Micro S/cm		
Hydrazine	0.02ppm(Max.)		

BASIC CHEMICALS FOR FEED WATER /BOILER WATER TREATMENT

- ▶ For **pH** :To increase the pH of water, **Caustic soda flakes** and **Tri Sodium Phosphate** are used in solution form.
- ▶ For **Hardness** : To minimize the hardness , **Sodium Hexa Meta Phosphate** is used.
- ▶ For **Phosphate** :To maintain the phosphate level , **Sodium Hexa Meta Phosphate** or **Sodium Phosphate** are used.
- ▶ For **Dissolved Oxygen**:To minimize the dissolved Oxygen level; **Hydrazine**, **Sodium Sulphite** are used. By increasing the **feed water temperature 100° to 110° C**, Dissolved Oxygen can be minimized.
- ▶ **Caustic Alkalinity** :To maintain the caustic alkalinity, **caustic soda** and **Tri sodium phosphate** are used in solution form.

▶ **ACTIVITIES TO SUPPORT TREATMENT OF BOILER WATER**

- ▶ Control of corrosion :a) Maintenance of pH of water in the desired range is required to control corrosion.
- ▶ b) Oxygen in feed water should be controlled with in 0.007 ppm, priming by good aeration, supplemented by Hydrazine dosing.c) D.M water storage tank should be properly sealed.d) Condensers and Heaters should be air tight.e) Proper wet lay up of units during shutdowns.
- ▶ **Blow Down:**The object of blowing down a boiler is **to maintain the concentration of dissolved and suspended solids** within the specified limits to avoid priming and carryover.
- ▶ **Continuous Blow Down:**This is installed in order to regulate and maintain the boiler water concentration at a constant level. The percentage of blow down should be controlled to a minimum necessary to achieve this.
- ▶ **Antiscaling agent-**The most common natural polymers include tannins and lignosulphonates, while the synthetic polymers available to you include polystyrene sulphonates and maleic acrylate copolymer

INDIAN BOILER ACT 1923/REVISED IN 1950/ LATEST REVISION 2020.

- ▶ –1. Act II means the Boilers Act, 1923 (5 (b) of 1923); –2. Boiler Operation Engineer II means a person granted with a certificate of proficiency as a Boiler Operation Engineer under these rules.
- ▶ 3. Supervision of operation of boiler.- The owner of a single boiler or two or more boilers connected in a battery or of many separate individual boilers situated within a radius of fifty meters having a total heating surface exceeding one thousand square meters in any of the cases shall not use the same or permit the same to be used unless the boiler or boilers are placed in direct charge of a competent person specified in rule 4 in addition to such number of boiler attendants as specified in these rules: Provided that the Chief Inspector may permit any boiler attendant to remain in-charge of a boiler for a maximum period of three months notwithstanding any thing contrary contained in these rules: Provided further that nothing in these rules shall debar a person holding a first class certificate of competency granted under the Boiler Attendants' Rules, 2011 from remaining in attendance and in charge of a boiler or boilers of any size and any such certificate shall for the purpose of these rules be deemed to have been granted under these rules. 4. Competent Person shall possess certificate and extent of qualification.-Any person, who does not possess a certificate of proficiency as a Boiler Operation Engineer under these rules, shall not be deemed to be a fit and proper person to hold the charge of any boiler or boilers exceeding the limits as laid down in rule 3.

▶ Continued---

- ▶ Limits of daily period of attendance, reliefs, and sphere of action.- (1) A person who is in-charge of a boiler shall be deemed to be in direct and immediate charge of the same when he is physically present within hundred meters of such boiler. (2) A person who is in-charge of a boiler for which a certificate of proficiency is required under these rules may be relieved of charge in any one day for not more than two periods, which when combined do not exceed two hours in duration by a person holding a first class certificate of competency as a Boiler attendant. (3) The holder of a first class certificate of competency as a boiler attendant may also with the consent in writing of the Chief Inspector or Director of Boilers, as the case may be, relieve a person holding a certificate of proficiency as boiler operation engineer for a period which may extend to ten consecutive days which, in special circumstances, the Chief Inspector or Director of Boilers may extend to any length of time not exceeding thirty days at a time.
- ▶ 8. When Boiler shall be deemed to be in use.- (1) A boiler shall be deemed to be in use for the purpose of these rules when there is fire in the furnace fire box or fire place for the purpose of heating the water in the boiler or under banked fire condition: Provided that a boiler shall not be deemed to be in use when the fire is removed and all steam and water connections are closed. (2) An economiser or waste heat boiler shall be deemed to be in use for the purpose of these rules when there is a flow of flue gases or other heating media past the economiser or waste heat boiler and an appreciable heat transfer takes place between the water and the heating gases or media.



THANK YOU

The background features abstract, overlapping geometric shapes in various shades of green, ranging from light lime to dark forest green. These shapes are primarily located on the right side of the frame, creating a dynamic, layered effect. The rest of the background is plain white.