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GLOSSARY OF TERMS RELATING TO BOILER WATER

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GLOSSARY OF TERMS RELATING TO BOILER WATER

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Indian Standard

GLOSSARY OF TERMS RELATING TO BOILER WATER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 November 1985, after the draft finalized by Boiler Water Sectional Committee had been approved by the Chemical Division Council.

0.2 This standard has been formulated with a view to eliminate ambiguity and confusion arising from different interpretation of terms relating to treatment of water for low, medium and high pressure boilers and chemical conditioning of boiler feed water and boiler water.

0.3 Should any difference exist between the definitions in this standard and those in individual standards, the latter shall prevail.

0.4 This standard is intended chiefly to cover the technical definitions of terms, and it may not necessarily include all the legal interpretations nor achieve academic precision. Although many terms defined in the standard are of general applicability, these have been defined with specific reference to boiler water.

0.5 In the preparation of this standard, considerable assistance has been derived from 'Glossary of water treatment terms' and 'Glossary of power station terms' published by Education and Training Department, the Central Electricity Generating Board, UK.

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1. SCOPE

1.1 This standard defines the terms commonly used in the field of treatment of water for low, medium and high pressure boilers and chemical conditioning of boiler feed water and boiler water.

2. TERMS AND DEFINITIONS

ABS — Alkyl Benzene Sulphonate-common class of detergents. It also denotes acrylonitrile butadiene styrene which is used for chemical pipe work and other purposes.

A

Acid — A compound which dissociates in aqueous solution to furnish hydrogen ions.

Acid Cleaning — A method of cleaning pipe work, boilers, condensers, etc. Acid is used with proper inhibitor (to prevent corrosion of bare metal) to remove mill scale or other deposits.

Activated Carbon — An amorphous form of carbon having porous internal structure and characterised by high adsorptivity for many gases, vapours, colloids, organics and higher molecular weight compounds.

Activated Silica — A form of colloidal solution (silica sol) prepared immediately before use by partial neutralisation of sodium silicate. It is a good coagulant aid.

Active Groups or Sites — Ions and radicals affixed to the matrix of an ion exchanger, each associated with a counter ion of opposite charge and replaceable in the exchange process. Anodic sites developed on a metal surface leading to corrosion are also referred to active sites.

Adsorption — Taking up of gases, liquids or dissolved substances on the surface of solids without chemical reaction.

Air Mix — Process of passing large quantities of air through mixed bed columns, causing the resin to turn over and mix intimately.

Air Scour — Air agitation done before backwashing in filter beds and ion exchanger beds to improve backwash efficiency. This produces more shear and agitation of bed, breaking up the accumulated dirt.

Algae — Chlorophyll bearing primitive plants, uni or muti-celled capable of synthesizing their foodstuffs by photosynthesis and occurring as contaminants in water.

Alkali — Substances which dissociate and release hydroxyl ions into the solution.

Alkali Boil Out — A method of cleaning boiler system. Alkaline solution is fed to the system and heated to desired pressure and temperature to remove oil, grease and other debris from inside surface by loosening, emulsifying and dispersing.

Alkaline Rinsing — Rinsing of anion resin bed after alkali injection with either the service water for the particular anion bed or with anion bed outlet water stored previously during the service run of the anion bed.

Alkalinity — The quantitative capacity of aqueous media to react with hydrogen ions. It indicates amount of bicarbonates, hydroxides and carbonates in water.

Anion — A negatively charged ion.

Anion Exchange — Exchanging the anions present in water with the help of an anion exchange resin.

Anion Exchange Resins — An ion exchange resin capable of reversible exchange of negative charged ions.

Anode — The positive electrode of an electrolytic cell, to which negatively charged ions travel when an electric current is passed through the cell.

Anodic Protection — Method of reducing corrosion of a material capable of forming a passive film on it by applying a suitable potential after making the material anodic to the reference electrode. Aluminium, magnesium, titanium, austinitic steel using electrolytic chloride solution or sulphuric acid give very heavy stable films of oxides on their surfaces with only small current density, providing excellent resistance to corrosion. Such anodic coatings are hard and have good electrical insulating properties.

Anthracite — Class of coal having 86—98 percent fixed carbon and used as filter media for water under a bed of different sizes.

Antiscalants — Chemicals used to prevent deposits on metallic surfaces in contact with water (mainly polyphosphates, organic polymers, etc).

Attrition — Size reduction or disintegration of particles in a packed bed due to hydraulic stress, frictional wear and osmotic shock.

B

Back Wash — Process by which beds of filter or ion exchanger beds are lifted and loosened by up-flow with the bed free to rise into the rising space. It reclassifies the bed and is used to wash out dirt and resin fines.

Base Exchange — A cation exchange softening process in which the hardness forming calcium and mangesium ions are exchanged for sodium.

Base Loaded Boiler — A steam generator operating continuously at a constant steaming rate.

Bead — Modern ion exchangers are made in the form of tiny spheres which are called beads.

Bed — Settled filtering or ion exchange material in compact form in a suitable vessel, through which water passes from one end to the other.

Bed Depth — The height of the material in a packed column.

Bed Expansion — Loosening and expansion of the particles in packed bed columns due to backwashing, causing increased space between resin

particles. It can be controlled by regulating backwash flow. It is expressed as a percent of the original bed height taking into consideration the ionic form while computing the bed height.

Bed Volume — Gross volume of the ion exchange bed or filter bed.

Bicarbonate Alkalinity — The presence in a solution of hydroxyl (OH^-) ion resulting from the hydrolysis of bicarbonates. When these salts react with water a strong base and a weak acid are produced, and the solution is alkaline.

Biochemical Oxygen Demand (BOD) — The quantity of oxygen required for the oxidation of biodegradable organic matter by microbiological action in the presence of oxygen. It is a measure of the strength of organic matter in terms of its ability to deplete oxygen in water. Generally, the standard test consists of measuring the oxygen depletion at 20°C for 5 days.

Biological Deposits — Water formed deposits of organisms or the products of their life processes, usually found in the form of slimes, barnacles, or mussels and gelatinous or filamentous in nature.

Blow Down — Lowering the concentration of contaminants or dissolved salts from boiler water, cooling tower water, etc, by draining some of the water to waste for a predetermined period, an equal quantity of fresh water being taken up for make up.

Boiler Boxing Up — Shut down of boiler by extinguishing fire, reducing pressure, closing down all inlet and outlet valves, drains and vents, so that it can be lighted up again after some period when required for use. Idle boilers are also boxed up for preservation purpose to avoid air entry to corrode internal surface of the system.

Boiler Drum — A part of boiler in the form of vessel providing a reserve of water for circulation and a space in which steam and water are separated.

Boiler in Banking Condition — Boiler under fired condition, but without any use of processed steam. This is being done to avoid the loss of initial heat in heating up the brick work and other materials of construction and avoid delay in bring up the boiler without setting up stresses by unequal expansion.

Boiler in Floating Condition — Boiler remaining lighted up but steam only partially utilised to support the short fall from the other boiler running in parallel.

Boiler Water — Water present in a boiler when steaming is, or has been taking place.

Boiling Out — *See* alkali Boilout.

Brackish Water — Water having salinity more than that of potable water (usually 1 000 ppm) but less saline than sea water (usually 30 000 ppm).

Break Point Chlorination — The appearance of free chlorine, after satisfying the chlorine demand of water.

Break Through — The first appearance in the solution, flowing from an ion exchange unit, of unadsorbed and desorbed ions is an indication that regeneration of the resin is necessary.

Brine — concentrated aqueous solution of chloride.

Brine Wash — A process to restore the effectiveness of anion resins which have been fouled by organic matter. It is usually done by soaking the resins with two bed volume mixture of 10 percent sodium chloride and 2 percent sodium hydroxide for few hours (usually more than 12 hours) and draining. Heating may be required, depending on type of resin.

C

Carry Over — Passing of undesirable soluble or insoluble particles from one treatment process to the other or from one phase to the other. For example in clarifier some flocs which do not settle are carried over to the clarifier water storage tank and similarly some soluble salts of boiler water are carried over to the steam phase.

Cartridge Filter — A filtering unit having pressure shells containing a number of cotton, nylon or polypropylene cartridges mounted on stainless steel perforated cores. Each cartridge is made of continuously wrapped, single cotton, nylon or polypropylene thread, like a bobbin, and is so thick that even fine particles cannot pass through. It is usually used for trapping the resin leak through the demineralised water and trapping rust and other corrosion products from boiler feed water.

Cascading —The inter-connection of the feed heater drains so that the flash steam from one heater can be used as heating steam in another heater at lower pressure. This term is also used for an arrangement for flow of water into different stages in such a manner as to facilitate exposing a large surface by making them droplets and come in contact with air, so as to remove gaseous impurities from water or to oxidise some impurities, such as iron.

Cathode — The negative electrode of an electrolytic cell, to which positively charged ions migrate when a current is passed through the cell.

Cathodic Protection — Most important approach to corrosion control, where an auxiliary anode (either electrolytic or galvanic) acts as a substitute for the anode on the metal surface to be protected. In either case the electrical energy supplied by the auxiliary anodes forms a fence that prevents flow of current in the local cells on the protected surface. With

current flow stopped, mettallic ions cannot escape from the area to be protected and corrosion is virtually nil. Under these conditions a metal can be maintained in a corrosive environment for an indefinite time.

Cation Exchange — An ion exchange resin, capable of the reversible exchange of positively changed ions.

Cation Exchange Resins — Resins which exchange cationic portion of ionisable salts present in water with Na^+ or H^+ ions.

Caustic Cracking — Cracking in steel under severe stress in the presence of high concentration of caustic soda.

Caustic Embrittlement — Hardening of mild steel surface, resulting in less of strength and impairment of other physical properties and causing intercrystalline cracking, due to presence of corrosive medium (caustic soda) on the metallic surface under tensile stress. This phenomina commonly occurs in boilers and boiler tubes.

Caustic Gauging — Thinning of steel surface caused by caustic attack, when caustic soda solution concentrates below deposits at high heat input areas. This is due to the result of the caustic dissolving the protective film of magnetic oxide. This is also known as ductile gauging.

Cavitation — The formation, as a result of local pressure drop of vapour bubbles and their subsequent collapse in a moving body of liquid, for example contained within the impeller of a feed pump. The sudden collapse of the vapour bubbles resulting from cavitation frequently damages the metal surfaces adjacent to the cavitation zone.

Channeling — Cleavage and furrowing of the bed due to faulty operational procedures in which the solution being treated follows the path of least resistance and runs through these furrows and fails to contact active groups in other parts of the bed. This happens usually in packed beds which have non-uniform pressure drop or no surface velocity.

Chelant — An organic compound which forms a coordination complex (cyclic compound) with a metallic ion.

Chemical Oxygen Demand (COD) — The amount of oxygen, expressed in mg/litre consumed under specified conditions in the oxidation of the oxidisable organic and inorganic matter contained in water, by an oxidizing chemleal corrected for the influence of chlorides.

Chemical Stability — Resistance to chemical action which ion exchange resins should possess to withstand contact with aggressive solutions.

Chlorination — The application of chlorine to water generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

Chlorine Demand — The difference between the amount of chlorine added to water and the amount of free chlorine remaining at the end of a specified contact period. The demand for any given water varies with time of contact and temperature.

Chlorine Residual — The total amount of colorine (combined and free available chlorine) remaining in water at the end of a specified contact period following chlorination.

Circulating Water — Water passed through the condenser and other auxiliary cooling tubes to condense the turbine exhaust steam or to reduce the temperature of vapour and fluids.

Clarifiers — Tanks where turbid water treated with chemicals is allowed to pass through with a certain retention time during which the particles causing turbidity settle out in the form of a sludge, which is latter removed by a suitable arrangement.

Clariflocculators — A system combining flocculation and clarification in separate compartments within the system with an arrangement for discharging accumulated sludges.

Coagulant — A material which removes suspended as well as colloidal matter present in water by reducing surface electrical charge so as to enable them to coagulate in the form of precipitates comprising floc particles more or less gelatinous in character. Normally a salt of iron or aluminium is introduced into water in conditions in which iron or aluminium hydroxide will precipitate and join with colloidal particles, which cause turbidity in water, to form flocs.

Coagulant Aid — Organic macro-ions whose charge helps small floc particles to adhere together to form large flocs to settle easily.

Coagulation :

a) The process of converting colloidal or finely divided suspended matter into particles of such sizes as can be settled reasonably rapidly by the addition of an appropriate chemical coagulant, by biological processes or by other means.

b) The process of adding a coagulant and other necessary reacting chemicals.

Cocurrent Regeneration — Regeneration process in which the regenerant flows in the same direction as the inlet service water to the exchanger bed.

Collector — An assembly located inside a filter or an ion-exchanger vessel for uniform collection of an outgoing liquid (such as treated water spent regenerant, rinse effluent, etc) from the vessel, with a controlled size of openings to prevent any carryover of filter media or ion-exchange resin into the outgoing liquid stream.

Colloids — Finally divided solids (particle size varying from 10^{-7} to 10^{-9}m) which will not settle but may be removed by coagulation or biochemical action.

Colloidal Silica — Silica in the insoluble or colloidal form (present in the form of clay, polymeric silicic acid and magnesium silicates). It cannot be measured by the standard ammonium molybdate reagent method and if not arrested in the boiler feed make-up water plant, it is converted to soluble and reactive silica under alkaline and high temperature-pressure boiler water conditions. Silica concentration in the boiler water will therefore be higher than expected resulting in significant carry over of silica in steam. (*see* Non-reactive silica).

Condensate:

a) Condensed steam from steam using equipment; it normally forms the greater part of the boiler feed water.

b) Water obtained by evaporation and subsequent condensation of steam; usually water of high purity, unmixed with any other water.

Condensate Polishing — Filteration and/or demineralization by ion exchange of contaminated condensate to remove insoluble and ionic impurities.

Condenser Leakage — Ingress of condenser cooling water into condensate through condenser tube leakages.

Condenser Tube Fouling — The deposition of foreign matter on condenser tube surface on (cooling) water side due to impurities in water.

Conditioning of Feed Water and Boiler Water — Addition of small quantities of chemicals to the final feed water (like hydrazine and ammonium hydroxide) or into the boiler drum (like sodium phosphate) to attain desired conditions in the water/steam circuit of preboiler system and boiler.

Conductivity — The unit of measurement of conductivity in international unit is now Microsiemens/cm. It gives a measure of ionic impurities in water.

Conductivity Comparator — Instrument which measures the conductivity of two samples taken simultaneously by two probes set at different heights and compares them on a bridge circuit. Device for uniform collection of treated water or regenerant across the resin belt.

Congruent Control — A method to eliminate free caustic alkalinity in boiler water to avoid caustic cracking by maintaining sodium to phosphate molar ratio in boiler water at or just below 2·6 : 1.

Cooling Tower — A tower for cooling of circulating cooling water by evaporation by spraying it from the top of the tower. Heat lost by evaporation of water cools down the circulating water. The working principle is evaporative cooling by natural draught or forced draught or induced draught.

Coordinated Phosphate *p*H Control — A method to eliminate free caustic alkalinity in boiler water to avoid caustic cracking by maintaining sodium to phosphate molar ratio at 3 : 1.

Corrosion — Tendency of a metal to attain its natural state by reacting with its environment through chemical or electrochemical means.

Corrosion Fatigue — The occurrence of transgranular cracks in structural material such as steam pipes, boiler drums, receivers and other parts, because of repeated thermal or mechanical stress in the presence of a corrosive environment.

Corrosion Products — A result of chemical or electrochemical reaction between a metal and its environment usually water and electrolytes present in it. These are usually insoluble salts of the metal found near the corroded area or transported elsewhere in the cycle. Rust (Iron oxides and hydroxide) are common corrosion products.

Counter Current Regeneration — Regeneration process in which the regenerant flows in the direction opposite to the service flow in the exchanger bed.

Critical Pressure — The pressure at which phases in a fluid do not separate. Critical pressure for water (as fluid) is 217·9 Kg/cm^2.

Cross Linking — The degree of bonding of the long chain molecules present in the ion exchange resin matrix (called Monomers) to form an insoluble tridimensional resin matrix. This controls the size and volume of the pores which take up water and prevents the resins from swelling and becoming soft. This is usually accomplished by Divinyl Benzene (DVB).

Crud — Transported solid product of corrosion of the surfaces in the steam water cycle of boilers. This may include other suspended and colloidal impurities. It occurs as surface deposit on system surfaces and as sediment in areas of low velocity. It consists mostly of metal oxides and normally appears as brown to black powder.

Cycle:

a) A complete course of ion-exchange operation starting with back wash and regeneration and service ending with exhaustion of the exchanger bed.

b) The flow path of boiler feed water completing one full circuit, that is, feed water, steam in boiler, condensate and back again as feed water.

D

Deaerator — Equipment for removing the dissolved gases (especially oxygen) from boiler water, normally involving injection of steam at saturation temperature in vacuum or under pressure.

Dealkalination — Process by which alkalinity is reduced. Normally used for total dissolved solid reduction when alkalinity is very high and water is to be used for low pressure boilers or in circulating water system.

Degasser — Equipment for removing a particular gas (usually carbon dioxide in water demineralisation process) from water usually without heating. Water is allowed to fall through a tower packed to make water droplets and air is blown from opposite direction. Water leaves such tower saturated with dissolved oxygen and nitrogen. Vacuum degasser needs vacuum pumps to extract carbondioxide in which some dissolved oxygen is also removed.

Decarburization — Leaching of carbon from ferritic phase of carbon steel.

Delignification — Chemical deterioration of wood, particularly encountered in cooling tower structures, when the lignin component of the wood is removed leaving the resulting residue to be rich only in cellulose with surface becoming bleached and fibrillated. High sodium carbonate, oxidising agents and alkaline materials present in circulating cooling water generally cause this problem.

Dezincification — Type of attack occurring with zinc alloys where zinc corrodes preferentially, leaving a porous residue of copper and corrosion products. The alloy so corroded often retains its original shape and may appear undamaged except for surface tarnish, but its tensile strength and ductility are reduced. Environmental factors that favour dezincification are (a) high temperature (b) stagnant solutions and (c) porous inorganic scale formation. Dezincified brass pipes may retain sufficient strength to resist internal water pressure until an attempt is made to uncouple the pipe or a water hammer occurs causing the pipe to split open.

Dialysis — A process using natural diffusion of ions and solutes through suitable membrane. In electrodialysis ions are moved under the influence of an applied electromotive force.

Dispersant — A chemical which increases the suspension of insoluble particles.

Displacement — A process taking place in ion exchange units, when water is expelled by regenerant or *vice-versa*, from the rising space and from the void volume.

Distributor — A device to distribute the inlet water/regenerant evenly across the resin bed. The distributor will have single/two/multiple arms depending upon the diameter of the unit.

Downcomer — A bunch of boiler tubes helping recirculation of boiler drum water through which boiler water comes down and then goes again to boiler drum through different tubes called "Riser".

Down Flow — Conventional direction of solution to be processed in ion-exchange column operation, that is, inlet at the top and outlet at the bottom of the column. The operation is usually undertaken to keep the resin bed in compact from during regeneration.

Drum Internals — Arrangement done by some equipment fixed on upper part of the boiler drum to facilitate easy separation of water and steam phase in the drum efficiently.

Dry Preservation — Method of protecting boiler surface from corrosion during idle period. Usually the boiler is drained under hot condition and nitrogen is passed under pressure to remove any moisture and oxygen. The boiler is capped with nitrogen for some time and then left out to remain idle. Alternatively, activated silca or quicklime are placed inside boiler drum for dry preservation.

E

Economiser — Part of the boiler used for transferring heat from the flue gases to the feed water.

Effective Size — Sieve apperture (in mm) which retains 90 percent of the sample of filtering material of resin.

Effluent — The waste water which emerges from an ion-exchange column during regeneration or from other equipment such as boiler blowdown and cooling tower blowdown or from an industry. This is also used to mean treated water coming out of an ion-exchange coloum during service.

Ejector — Apparatus for extracting air and other incondensable gases from a closed system or for sucking slurry. A throat and nozzle arrangement through which motive (power) fluid flows under pressure creating vacuum which can be used for evacuating or sucking of gases, liquid or slurries.

Electrolyte — A chemical compound which dissociates or ionises in water to produce positive and negative ions which will conduct an electric current.

Elution — The stripping of adsorbed ions from anion exchange material by the use of solutions containing other ions in relatively high concentration. It is rather carefully controlled regeneration, probably to recover some valuable or otherwise important ions which have been adsorbed by the resins.

Equivalent Mineral Acidity — Sum of chloride, sulphate, nitrate and other anions of mineral acid origin actually present in it.

Equivalent Per Million (epm) — Unit of equivalent concentration calculated as parts per million divided by the equivalent weight. For water analysis it is equivalent to meq/litre (milliequivalent per litre).

Erosion — Material loss associated with high velocity of water, steam, fine particles, etc, and consists of two sub-classes, impingement and cavitation.

Evaporaiive Capacity — The normal maximum quantity of steam produced by a boiler expressed in kg/h.

Evaporator — Auxiliary equipment for evaporating raw or softened water producing distillate, free from impurities, for use as make up water as it is through mixed bed exchanger.

Exchange Capacity — The term used to quantitatively denote the capacity of an ion exchange material to remove ions from aqueous solutions.

Exchange Zone — Band of resin in an ion exchange column in which exchange is actually taking place.

Exfoliation — Special type of oxidative corrosion, resulting in spalling off metallic surfaces.

Exhaustion — Term used to denote that the exchanger will not perform any more useful work. It does not mean that all the capacity in an column has been used.

External Regeneration — Method for regenerating the cation and anion exchange resins outside the surface unit and again putting it back in the surface unit.

External Treatment — Treatment of raw water done externally before it enters the boiler circuit, which has been found more effective and essential for high pressure boilers.

F

Feed Water Heater — A heat exchanger for preheating feed water before it passes to the boiler, mainly by means of steam bled from the turbine or by means of boiler blowdown waters.

Filming Amines — An amine (nitrogenous material) added to boiler feed water so as to obtain an uniform micro-film in the condensate system in order to protect the system from corrosion.

Filteration — The process of passing a liquid through a filtering medium (which may consist of granular material, such as sand, magnetite, or diatomeceous earth, finely woven cloth, unglazed porcelain, or specially prepared paper of synthetic media) for the removal of suspended or colloidal matter usually of type that cannot be removed by sedimentation.

Fines — Small uneven particles of ions exchange materials/filter media which cause excess pressure drop.

Flash Mixer (Flash Mixing Tank) — In precipitation process, it is a small tank with stirring gear in which chemicals are thoroughly mixed with the water, before it is allowed to go to the settling tanks or clariflocculator.

Flash Steam — Steam produced from pressurised hot water when the pressure is suddenly reduced.

Floc — Small gelatinous masses, formed in a liquid by the addition of coagulants or through biochemical processes by aggregation of microscopic and ultramicroscopic particles.

Flocculation — A process, mechanical or chemical or both, by which small particles of solids in a liquid are aggregated into larger masses, thus making it easier for the removal of solids by sedimentation.

Flux — The quantity of water flowing through a membrane per unit area of cross-section for a given membrane in a reverse osmosis process.

Fouling — Result of allowing material harmful to the performance of an exchanger to remain on it, for example, organic matter fouls the anion and cation exchanger resins by retaining into the resin matrix causing poor effluent quality and reduction in exchange capacity. In heat exchanger, on cooling water side, fouling may occur due to slimes, marine growth and corrosion products.

Foaming — It is a phenomenon which occurs in boilers under certain conditions like presence of oil or excessive suspended matter or excessive caustic alkalinity in boiler water, when bubbles of boiler water fill up the steam disengaging space and are carried over alongwith steam resulting in impure steam production.

Free Board — The space provided above the resin bed in an ion exchange column or filter column, for expansion of the bed during back washing.

Free Mineral Acidity — The quantitative capacity of aqueous media to react with hydroxyl ions to *p*H 4·3. In the decationized water it is equal to the sum of free anions, such as Cl^-, SO_4^{--}, NO_3^- and other mineral acids. At the outlet of cation exchanger the free mineral acidity is equivalent to equivalent mineral acidity (EMA) minus (—) sodium slip.

FRP — Fibre glass reinforced plastic material used in acid pipe, acid tank works, etc.

G

Galvanic Corrosion — Corrosion of metallic surface due to formation of galvanic cell because of the presence of two dissimilar metals side by side

in an electrolyte. The damage incurred by coupling two metals depends on how far apart they are in the galvanic series of metals, the potential difference between the two electrodes and conductivity of the corrosive environment. Weld junctions are ideal locations for this type of corrosion to occur since the metals for a perfect union.

Gauge Pressure — The net pressure above atmospheric pressure.

Gel Resins — Ion exchange resins in which the resin absorbs water which swells it and so creates channels, through which ions can travel. These pores disappear if the resin is dried.

Grading — *See* Effective Size.

Gram Mill Equivalents — The equivalent weight in milligrams.

Graphatization — Cast iron experiencing selective loss of iron, leaving the metal with a weak structure of graphite and iron-oxides, caused by low *p*H, high dissolved solids and acid contaminants. Carbon particles left behind due to graphitization are eaten away by hydrogen, giving out methane, resulting in a porous metal surface.

Gravels — These are coarser than coarse sand used as an even support for the filtering media (fine sand) and also to assist in liquid distribution. Filling of gravels into filter vessel and ion exchange vessel is also called as subfill or underfill.

H

Hardness — Bicarbonates of calcium and magnesium give carbonate hardness (temporary hardness) while sulphates, nitrates and chlorides impart non-carbonate hardness (permanent hardness).

Head Loss — The reduction in liquid pressure associated with resistance in the passage of a solution through a bed of filter or exchange materials. More head loss indicates a dirty bed or presence of too much of fines.

Heat Exchanger — An equipment designed to transfer heat across a separating surface.

Hideout — Phenomenon of temporary undetectability of a contaminant or additive in water. In boiler water, due to low solubility of trisodium phosphate at temperatures particularly above 250°C, phosphate ions concentrations are decreased while boiler is steaming at high loads only to reappear when load is decreased. This phenomenon is termed as 'chemical hides out' of phosphates. In addition, there is also possibility of physical hide out of phosphates beneath the corrosion product (crude) deposits, transported into the boiler tubes from the feed train. Both chemical and physical hideout of phosphates usually result in their concentration directly on boiler tubes surface and in turn in the increased corrosion rates (general wastage).

Hold Down — An operation undertaken during regenerating an ion-exchange resin bed by counter current fashion in order to prevent the floating of resin. Air, water or regenerant chemical pressure is used to keep the resin bed in compact form.

Humic Acid and Fulvic Acid — Generic terms for a vast number of organic compounds which are the products of decay of vegetable matter such as peat. They make water acidic and frothy and impart colour varying from light yellow to dark brown. Some of them foul ion exchange resins.

Hydraulic Classification — Rearrangement of particles in packed column by means of water flow. During backwashing process the particles are placed in mobile condition during which larger particles settle at bottom while smaller particles rise at top. Fines are however removed from bed to drain.

Hydraulic Test — Mechanical test conducted before commissioning pressure vessels, piping and assemblies to see whether these can stand the pressure 1·5 to 2 times of the working pressure. It is usually done by filling water and raising the pressure gradually.

Hydrogen Embrittlement — A type of corrosion occurring in the high pressure boilers on load. This usually occurs beneath relatively dense deposits on the boiler tube, when a low *p*H boiler water environment is produced as a result of condenser leakage or some other type of system contamination. Hydrogen produced in the corrosion reaction, diffuses through the underlying metal, producing decarbonization (by reacting with carbon producing methane) and intergranular microfissuring of the structure. Brittle fracture occurs along the partially separated boundries, resulting in the explosive in-service failure of a boiler tube from which a considerable area of the wall gets ejected because of loss of ductility and strength.

I

Impingement — Water, particularly having high concentration of suspended matter gases, etc is abrasive and physically tears metal away in the form of horse shoe shaped pits. A form of localised corrosion.

Indicator —

a) A device which receives a signal from a sensing element consequent upon a change and translates this signal into a movement on a scale or a chart.

b) Substance which gives a visible change, usually of colour, at a desired point in a chemical reaction.

c) A device which indicates the state of an operation, for example, an on/off light indicator.

Inert Resin — Resin which does not take any part in the exchange reaction of the resin bed in the exchanger. Used as (after density matching) separator in mixed bed exchanger to facilitate better separation of cation and anion exchange resin or used on top layer of any exchanger bed having counter current regeneration operation. It is also used in powder form as coating on cartridge filters.

Inhibitor — Chemical substance which prevents or retards specific chemical reactions, for example, one of the inhibitors 'Rhodine' is added to hydrochloric acid to prevent reaction of the acid with the bare metal during acid cleaning of boilers, in which only rust or mill scale of iron reacts.

Injection — Stage in which regenerating chemicals are added to the exchanger bed either through injection or pump.

Interface — The level at which the cation and anion resin components of a mixed bed separate, after classification by backwash and settling.

Internal Treatment — Process of dosing of chemicals into a boiler circuit to control the quality of water in the boiler and steam.

Ion — An atom or radical in solution carrying an integral electrical charge either positive (cation) or negative (anion).

Ion Exchange — A reversible process by which ions are interchanged between a solid capable of exchanging ions and a liquid with no substantial structural changes of the solid, for example, a cation resin takes up cations from the water (solution) reversibly and gives up hydrogen ions in the solution.

Ionization — The dissociation of molecules into charged particles. In natural water, the dissolved salts present in it are supposed to be fully ionized.

J

Jackson Candle Turbidity — An empirical measure of turbidity in special apparatus, based on the measurement of the depth of a column of water sample that is just sufficient to extinguish the image of a burning standard candle observed vertically through the sample.

Jet Condenser — A condenser where cooling and steam condensation is achieved by mixing the steam with a spray of water.

L

Langelier's Index — An expression to indicate the hydrogen ion concentration that a water should have to be in equilibrium with its content of calcium carbonate. It is a technique of predicting whether water will tend

to dissolve (corrosive tendency) or precipitate (Scale formation tendency) calcium carbonate. To calculate langelier index *p*H value of water saturated with $CaCO_3$ (without increasing Alkalinity), called *p*Hs is subtracted from *p*H value of water as observed. If the result is positive, scale forming tendency is expected and if negative, corrosive tendency.

Leaching — Separation of one or more components of any mixture or metallic alloy when exposed to the action of a solvent or water in which the component to be removed is soluble. In a corrosive environment, certain elements in an alloy are removed leaving behind the other components. This type of corrosive like dizincification or graphitic corrosion is identified as selective leaching.

Leakage — The phenomenon in which some of the influent ions are not adsorbed or exchanged and appear in the effluent, when a solution is passed through an under-regenerated exchange resin bed or because of malfunctioning of bed.

Lime Softening/Lime Soda Softening — Precipitation processes for removing most of the temporary and total hardness respectively. At around the boiling point (when some silica removal can also be obtained), the process is often called hot process. In lime softening only lime is mixed with water and allowed to settle but in lime-soda softening both lime and soda ash are added.

M

Macro-reticular Macroporous — A term used to describe resins that have a rigid polymer porous network in which there exists a pore structure even after drying. The pores are larger than atomic distances and are not likely to become clogged by macro-ions. These resins are mechanically stronger and more resistant to osmotic shock.

Magnetite — A passivated oxide state of ion (Fe_3O_4) the layer of which makes the metal beneath it corrosin-free and hence called protective layer.

Make-up Water — Purified water (distilled, demineralised or chemically treated) for replacing losses from a steam and water system.

Master and Regulating Valve — An arrangement of valves used for draining a system. The master valve can be opened fully, and draining is controlled by regulating valve.

Matrix — A frame work. In ion exchange resins commonly used in demineralisation plant, the matrix is frequently of cross linked polystyrene, which is itself quite inert but has active groups put on it in course of resin manufacture.

Membrane — A thin sheet with suitable micropores used in a separation process. In electrodialysis, the membrane is effectively an ion exchange resin in sheet form. In reverse osmosis, the membrane is semi permeable, often made of cellulose acetate.

Micromhos — A unit of specific electrical conductivity, microsiemens/cm.

Mill Scale — A thin layer consisting chiefly of Fe_3O_4 formed on iron or steel surface during manufacture when the material is hot in an atmosphere containing oxygen.

Mixed Bed — A unit in which cation and anion exchange processes proceed simultaneously and comprises of a physical mixture of anion exchange material and cation exchange material. The bed is usually employed for treating water having low ionic load as in condensate polishing or polishing the small impurities left through deionisation plant comprising of cation and anion exchanger bed.

Mud Balling — Clumping of clayey or sticky impurities on a filter or ion exchange bed in the form of a large ball heavier than the rest of the bed and sinking in it. It is difficult to break up by backwashing. It is formed when back wash duration is prolonged.

Multimedia Filters — A process in which water is passed first through coarse filter media of lower density (anthracite) and then progressively through finer and of higher density (sand). The bottom layer further may be of even finer and heavier garnet; all these layers being properly supported in the filtering vessel. This type of arrangement facilitates more flow rate and more length of filter run.

N

Naked Mixed Bed — The use of a mixed bed both as filter and polisher as in condensate polishing. The crud of the condensate is accumulated in this manner 'in depth' rather than on top of the bed and hence regeneration operations are done in separate vessels by transferring and cleaning.

Natural Circulation — The natural path of water circulation in a boiler induced by changes in density of the water due to heating. Thus heated water and steam rise in the furnace tubes to the drum, from which cooler feed water falls through external tubes to the bottom of the furnace tubes. Also known as thermal circulation.

Nephelometric Turbidity — An empirical measure of turbidity based on a measurement of the light scattering characteristics (Tyndall effect) of the particulate matter in the water.

Neutralising Amine — A volatile chemical injected into boiler feed water to neutralize the carbondioxide in boiler feed water and condensate; for examples : morpholine, cyclohexylamine, etc.

Neutral Effluent — Neutralization of effluents before disposal, for example, in demineralization plants spent acid and alkali during cation/anion regeneration are mixed together and neutralized by further addition of acid/lime, if necessary before discharging to plant drains.

Non-Reactive Silica — *See* colloidal silica.

Non-Regenerable — Ion exchange units in laboratories where the scale of operations does not justify the trouble of regenerating, or in condensate polishing where highly regenerated powdered resins are used as precoat on cartridge. These are thrown away when exhausted.

Nozzle — A piping branch on a tank. This term is also used for 'strainer nozzle' which is a small element, usually of plastic and provided with fine slots, used to retain sand or resin while permitting water to pass. Nozzle plates are false bottoms in tanks which are fitted with evenly distributed nozzles on which a sand or ion exchange bed rests. Basically a small tapered piece of pipe to increase the velocity of the fluid.

O

Off-Load Corrosion — The corrosion encountered during idle period of the boiler system due to the reaction of metallic tubes with water or moisture in combination with dissolved oxygen and chemicals or dissolved salts associated with water in the system. Corrosion products are mainly ferric hydroxide and ferric oxide. Rusting and pitting are the common phenomenon.

Once-Through Boiler — A boiler in which the feed water is converted into a steam without any water circulation.

On-Load Corrosion — Corrosion of the boiler system metal surfaces in contact with water or steam while the boiler is on-load. It is due to increased concentration of acidic or alkaline solution in certain section of the boiler system and aggravated by dissolved oxygen, carbon dioxide, ammonia, etc. Corrosion products are mainly Fe_3O_4 and Fe_2O_3, cuproamines, etc. Caustic embrittlement, hydrogen embrittlement and stress corrosion are the common phenomenon.

Orifice Plate — A thin metal annulus mounted on a carrier plate between flanges in a pipe line. It restricts the flow of steam or water causing a pressure drop which is used to measure the flow rate of the fluid.

Organic Trap — A unit containing a special type of resin (called scavenger resin) or activated carbon, which removes organic fouling matter. Sometimes activated carbon particles or sawdust is mixed in clariflocculator and scrapped while floating from the upper surface, trapping the organic matter.

Osmotic Shock — Ion exchange resins change to different volumes when solutions of different ionic concentration are passed over them, an ion exchange resin is switched successively from its expanded ionic form to its contracted form, an internal stress to resin bead known as 'Osmotic shock' is caused due to which the resin beads may deteriorate or crack or even burst.

Outage — The duration for which a unit is shut down because of grid and unit faults or for service, maintenance, etc.

Oxygen Scavenging — An internal treatment of boiler feed water in which reducing agents such as sodium sulphite or hydrazine are dosed into the water in order to consume up any oxygen present in it.

P

Packaged Boiler — A boiler fully assembled (alongwith ancillaries) at works so that it is ready for use.

Passivation — A process of completely polarising the corrosion reactions. When the boiler surface is chemically cleaned and the bare metal clean surface is available, it is oxidized with water again having ferric hydroxide coating on it. This at a particular temperature with suitably hydrazine dosed water is converted to Fe_3O_4 layer, which serves as protective layer for the rest of the metal surfaces for further corrosion. This process, after chemical cleaning, is called passivation.

Peaking Boiler — A boiler operated only to meet the peak demand for electricity and steam.

Permanent Hardness — Hardness present in water due to the presence of chlorides, nitrates and sulphates of calcium and magnesium, which is not removed by precipitation by boiling.

Permanganate Number — An acid method using potassium permanganate at specified temperature and for specified time for determination of organic matter (oxidizability). Expressed as mg/litre oxygen consumed. Time and temperature at which test is performed is to be stated.

*p*H — A numerical scale designated to show the degree of acidity or alkalinity of a solution. The *p*H value of an aqueous solution is the logarithm of the reciprocal of the hydrogen ion concentration (expressed in g/litre) of the solution. *p*H value of neutral water is 7·0. Below 7 water is called acidic and above 7 alkaline.

Physical Stability — Resistance of materials like ion exchange resins to changes that might be caused by attrition, high temperatures and other physical condition.

Piston Flow — Flow condition when liquid flowing through a column has the same velocity at every point of its cross-section so that the liquid front marks like a piston. The bigger the column diameter, the more difficult this is to achieve.

Pitting — A type of localised attack commonly found in water bearing equipment at points of metallurgical defects or at cuts, stretches or the crevices on the metal surface particularly at higher temperature zones. This is caused by the formation of highly active local anodic sites resulting from unequal ionic concentration or oxygen differentiate. The depth of the pit is in direct proportion to the ratio of the large cathodic area to the small active anodic site.

Polishing — An advanced stage of treatment used where a specially high quality of water is necessary.

Polyelectrolytes — Organic macromolecules (polymers) having ionized groups and capable of coagulating or floculating or dispersing suspended solids in water coagulant aids are usually polyelectrolytes.

Polystyrene — An inert plastic which forms the matrix of most ion exchangers (called monomers) formed by polymerisation of styrene by free radicals with peroxide initiator. The molecular weight depends on degree of polymerisation. Formula ($C_6H_5CH\ CH_2$)n.

Porosity — The degree of permeability in ion exchange resins to liquids and large organic molecules. Gel resins have less porosity than the macroporous resins.

Postcommissioning Cleaning — Cleaning done after the boiler has been in service for a certain period of time.

Post Precipitation — When the coagulants are not mixed properly or heavily dosed or retention of water in clariflocculator is less, there is likelyhood that the alum flocs are precipitated either in clear water storage tank or on ion exchanger bed. This is called post precipitation and is undesirable for operation of demineralisation plant.

Precipitation — Occurs when a chemical reaction in water throws a solid product of the reaction out of solution.

Precoat Filter — When coarse aperture of any cartridge is coated with any filter medium on an extended surface, it can retain even fine particles during filtration. This is called precoat filter and filter medium is used as candles, leaves, plates or even powdered exhausted resin. The medium is applied evenly before the start of a run and washed to drain or thrown away when it is clogged.

Precommissioning Cleaning — Chemical cleaning of new boilers, its parts before commissioning to remove deposits found in the boiler system.

Preservation of Boiler — When the boiler is taken out of service and kept idle there is likelyhood of corrosion of the internal surfaces of the food, boiler and steam system and hence boiler system has to undergo some form of treatment before steaming which is called preservation. Filling the boiler with suitably hydrazine dosed water with *p*H 10 is the common practice for wet preservation of boiler.

Priming and Carry Over — The entrainment of water droplets or foam in the steam leaving a boiler drum or evaporator, due to which dissolved salts of boiler water find place in steam for unworthy operation. Carryover of some salt to the steam is also affected due to volatility of some compound like silica at high pressure and temperature, provided silica is found in excess in the boiler water.

Probes — Device for taking samples of water for continuous monitoring for specific items, or for sensing monitoring parameters.

Protection — A means of safeguarding or disconnecting apparatus in the event of a fault.

Purge — Discharging of water from a closed system to bring down the concentration level of water, for example, from recirculating cooling water systems, some water is discharged to take up equal amount of fresh water.

Pyrogens — Organic impurities which make water unfit for many pharmaceutical uses. Sterile water is not necessarily pyrogen free.

Q

Quaternary Ammonium — A specific basic group $[-N(CH_3)_4^+]$ on which depends the exchange activity of certain anion exchange resins.

R

Raschig Rings — Packing material for degassifying tower, generally in the form of small rings so as to present the maximum contact area between water and injected air, when the tower is filled with sufficient number of such rings usually made of ceramic or plastic. Other shapes such as pall rings are also used.

Raw Water — Untreated water generally from source.

Reactive Silica — Soluble form of silica present in water detected by ammonium molybdate reaction in chemical test.

Regenerant — The solution used to restore the activity of an ion exchanger. Acids are employed to restore a cation exchanger to its hydrogen form and brine solution to its sodium form. Similarly anion exchanger is regenerated with an alkaline solution, for example, sodium hydroxide.

Regeneration — Restoration of the activity of an ion exchanger by replacing the ions adsorbed from the treated solution by ions that were adsorbed initially in the resin. The term is also used for that part of the operating cycle of an ion-exchange process in which a specific chemical solution is passed through the ion-exchange bed to prepare it for service run.

Regeneration Level — Amount of regenerant used, generally expressed as kg/m^3 of resin.

Regeneration Ratio — Ratio of chemicals used over the equivalent ion exchange capacity obtained. Also known as regeneration efficiency.

Rejection — Proportion of the salt content which a reverse Osmosis membrane will retain while allowing water to pass. Membranes show quite different rejections for different salts.

Resin — An organic macromolecule made for exchanging ions from water, containing active groups embedded in their matrix of polystyrene base, usually sulphonic, carboxylic, phenol or substituted amino groups.

Resin Trap — A device containing strainers to catch useful resin which has accidently come out of the vessel due to some reasons. Fines are however allowed to pass to drain.

Reverse Osmosis — A process for converting brackish water to potable strength. Water is forced through a semipermeable membrane which rejects the dissolved salts.

Rinse — The operation which follows regeneration for flushing out of excess regenerant. When rinse starts the exchange bed is full of regenerant, and this is still reacting with the resin. For maximum efficiency therefore the process is often started with a 'Slow Rinse' until most of the regenerant has been displaced and then a 'fast rinse' is given in order to save outage time.

Rinse Rate — The vertical water velocity in that part of a clarifier tank from which the flock is to settle out.

Rising Space — Space allowed above packed beds for backwashing. Its volume is normally between 0·5 to 1·5 times the bed volumes.

Ryznar Stability Index — An empirical method for predicting scaling and corrosive tendencies of water based on a study of operating results with water of various saturation indices. Stability Index $= 2\,pH_s - pH$; where pH_s = Langelier's saturation pH.

NOTE — The following chart illustrates how to use this index :

Ryznar Stability Index	*Tendency of Water*
4·0 — 5·0	Heavy scale
5·0 — 6·0	Light scale
6·0 — 7·0	Little scale or corrosion
7·0 — 7·5	Corrosion significant
7·5 — 9·0	Heavy corrosion
9·0 and above	Corrosion intolerable.

S

Salinometer — A hydrometer used to determine the concentration of dissolved salts in boiler water.

Salt Splitting — The conversion of neutral salts to their corresponding acids by cation exchange resins or to corresponding alkali by anion exchange resins.

Saturated Steam — Steam at temperature equal to the saturation temperature corresponding to its pressure and which contains no liquid phase.

Saturated Temperature — Boiling point of water at a given pressure.

Scale — A deposit formed from solution directly in place upon a confining surface.

NOTE — Scale is a deposit that will usually retain its physical shape when mechanical means are used to remove it from the surface on which it is deposited. Scale, which may or may not adhere to the underlying surface, is usually crystalline and dense, frequently laminated, and occasionally columnar in structure.

Scale, Boiler — An incrustation varying from a porous, friable crust to a dense, very hard coating deposited on boiler heating surfaces due to precipitation of minerals from the water used.

Scrapping — A process for removing the unwanted material from the upper portion of layers or bed. When used in relation to ion-exchange beds it implies the removal of the top few inches of the resin bed after a careful backwash, which is usually the last step from removal of all the fines.

Screen — A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flowing water, and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate, and the openings may be of any shape although they are generally circular or rectangular. The device may also be used to segregate granular material, into various sizes.

Seeding — Suitable particulate matter added from outside source as 'seed' to hasten the process of settling.

NOTE — Good floc formation in clarifloceulator often occurs more easily when water contains suspended particles on which precipitate formed by coagulant can settle.

Selectivity — The preference of adsorption of the resin for one ion to other, for example, trivalent ion will be exchanged first by the resin in comparison to divalent ion and the latter first in comparison to monovalent ion. Chelating resins can however be made to have special selectivities for particular ions.

Semi-Permeable — Term used to describe membranes with minute pores through which water can only diffuse very slowly and through which salts pass with difficulty or not at all.

Service Water — The net useful output of a plant, allowance having been made for treated or semitreated water, which may be used in bringing up the plant.

Shock — A sudden change of environment leading to dimensional changes of ion exchange resins. Change of temperature (thermal shock) and change of concentration of a solution (Osmotic shock) have this effect and cause physical break down of resin particles.

Shock Chlorination — Slug feed of chlorine applied for a short interval of time to raw water particularly to the recirculating cooling system, to provide maximum benefit for the 'kill' effect on microbiological growth in the water.

Silica vs Pressure Graph — Graph which shows different concentrations of silica, in boiler water at different boiler pressure, to be maintained.

NOTE — Silica at high pressure and temperature when present in alkaline condition, volatilises in steam through a definite distribution ratio between water and steam phase. Since silica forms a very hard and adherent scale on turbine difficult to remove and which brings down the efficiency of machine, it is recommended to limit the concentration of silica in boiler water so as to limit the silica concentration in steam as 0·02 mg/litre as silica.

Slime — Slippery organic growth on hot surfaces in cooling water systems due to certain types of bacteria like sulphate and iron bacteria present in cooling water.

Slip — *See* Leakage.

Sludge — A water-formed sedimentary deposit including that of suspended solids carried by the water and the settled flocs formed by coagulants.

Sludge Blanket — A horizontal layer of solids hydrodynamically suspended within an enclosed body of water.

Sludge Conditioners — Chemicals (natural or synthetic) added to boiler water that condition sludge to be of free flowing type which can be removed through blow down.

Sludge Recirculation — Pumping some old sludge back into the process, to act as a seeding material.

Softening — Any process which reduces or removes the hardness, that is mainly calcium and magnesium content, from the water.

Split Stream — When water flow is divided into two parts to undergo two different processes and finally treated for the third process after combining

the effluents from the former two processes, it is called split stream. For example water flow is split to pass through strongly acidic cation exchanger bed and a base exchanger bed simultaneously before being united to pass through the anion exchanger bed or through a degaser.

Spray Eliminators — Inclined battens or packing in a cooling tower to prevent spray being carried to atmosphere by the drought through the tower.

Stator Cooling Water — Water used for cooling the stator part of an alternator (or motor). Good quality water is used to avoid short circuiting due to salts present in it or the corrosion products of the system of water corroding the metallic portion of the system in contact.

Steam Trap — A device fitted at the lowest point of a steam pipe work system, to provide automatic drainage of water.

Stratified Bed — The use of strongly and weakly acidic or basic ion exchangers in a single vessel; the weak component lying in a separate layer immediately on top of the strong component.

Stress Corrosion — A combined effect of stress and corrosion which causes brittle failure of a metal at the point of stresses. Chlorides, hydroxides and sulphides are contributors to stress corrosion. Austentic steel surfaces are more prone to this type of corrosion.

Super Critical Boiler — A boiler which is operated at a pressure higher than the critical pressure of fluid. (For water critical pressure is 217·9 kg/cm^2).

Superheater — Heat added to steam to raise its temperature above the saturation temperature is called super heat and the part of the boiler used for adding superheat to saturated steam is called superheater.

Surface Condenser — A condenser where cooling water flows through tubes but does not mix with the steam condensing on the outer surfaces of the tubes.

Suspended Matter — All particles bigger than colloids, which are being carried in water.

Sweating (Condenser) — Minute seepage of cooling water in the form of small droplets through the tubes of condenser due to inside and outside pressure difference across the tubes; difficult to detect as condenser leak.

Swelling — The expansion of an ion-exchange bed which occurs when the reactive groups on the resin are converted into certain forms.

T

Thoroughfare — If the same regenerant is required for two different ion exchanger vessels for regeneration, but at different concentrations, for example, for strongly acidic/basic and weakly acidic/basic ion exchangers, the regenerant solution for the two units is passed in series; the first getting higher concentrated dose and the next lower, the operation is called thoroughfare regeneration.

Tower — An equipment for contacting liquid and gas in large contact area packed with ceramic or plastic rings or saddles in sufficient amount. Water flows downward and there is upward injection of air, so that water is broken into droplets and gases having less solubility in water, like carbon-dioxide, escape through the tower.

Turbidity — Reduction of transparancy of water due to the presence of particulate matter in it. The property of scattering light can be used to measure the amount of particulate matter present.

Type I and Type II Resins — Two types of strongly basic exchangers (Anion exchange resins). Type I has quarternary ammonium functional group and Type II has modified quarternary ammonium functional group, (one of the methyl group replaced with an ethanol group). Type I has somewhat less exchange capacity but more stability than Type II.

U

Upflow — The operation of an ion exchange unit or in a filler in which solutions are let in at the bottom and collected at the top of the container. In mixed bed while regenerating anion exchange resin, a slight upflow of water is also kept so that the caustic soda solution does not come in contact with cation resin and passes easily through the middle distributor header.

V

Venturi Tube — A tube which narrows to a throat and then gradually increases to the original diameter of the pipework. It is used to measure the flow of gas or liquid.

Void — The space between the resionous particles in an ion exchange bed.

Void Volume — Volume between resin particles, which is between 40 and 50 percent of the gross bed volume.

Volatile Treatment — Treatment of boiler feed water and boiler water, to prevent free hydroxide (caustic alkalinity) without use of any solid chemicals which may remain in the system as dissolved salts. Neutralizing amines, particularly morpholine and cyclohexylamine are used to provide

volatile alkalinity in boiler water. The reduced volatility of these amines compared with that of ammonia is advantageous in giving corrosion protection where condensation occurs, for example, in turbine exhaust region and the steam side of the food heaters. As such points the amines dissolve in the condensing steam more completely than does ammonia and consequently the condensate has a higher *p*H value and is less corrosive.

W

Waste Water —

a) Water that is actually wasted or not needed by party wasting the water, or that which, after it has served the purpose for which it was utilized, has been premitted to run to waste or escape; or which, from unavoidable causes, escapes from ditches, canals, or other conduits or from reservoirs of the lawful owners of such structures.

b) Water which contains contaminating waste products.

c) The total amount of water wasted, including that used in diluting regeneration chemicals and processes such as rinsing and backwashing.

Water Box — The dished end of a tubular heat-exchanger for entry and exit of cooling water.

Water Hold Down — *See* also Hold Down. When the operation of hold down is done with water pressure, it is called water hold down.

Water Regain — The amount of water present in the resin matrix expressed as percentage of the dry mass of the resin. Decrosslinking of gel type of resins generally increases water regain.

Water Walls — Walls of water tubes surrounding the combustion chamber. To save the wastage of heat, boiler combustion chambers are now so designed that water tubes themselves take place of the firebrick walls used in early type of boilers.

Wet Preservation — Process to store boiler system during its idle period to avoid corrosion on its metallic surfaces and protect magnetite layer intact. Usually done by a solution of hydrazine and attaining a *p*H of 10 with ammonia dose. For long term storage, however, a higher dose of hydrazine, usually 200 mg/l is given.

Z

Zeolite — Naturally occurring hydrous silicates exhibiting limited base exchange but able to remove hardness from water.

Zero Solids Treatment — All volatile treatment of boiler feed water in conjunction with the provision of full flow condensate polishing.

Zeta Potential — The potential across the diffuse layer of ions surrounding charged colloidal particle is called electrokinetic or zeta potential and is largely responsible for colloidal stability. When this potential is discharged by addition of polyvalent ions of opposite charge in the water, coagulation takes place and colloidal particles settle down. Zeta potential also has a role in deposition, release and transport of corrosion products.

Zwitter Ions — Dipole ions carrying opposite charges at opposite ends of the same molecule. These polarities change with the change of *p*H. At a definite *p*H called iso-electric point, they exhibit neutral or non-ionic character. In water they originate from decomposition of vegetative protein. Because of their dual nature their removal by coagulation or by deionization is difficult.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg. m/s
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2