Glossary of Terms

Absorption chilling – This is a water chilling process in which cooling of a solution is accomplished by the evaporation of a fluid such as water, which is then absorbed by a different solution such as lithium bromide, then evaporated under heat and pressure. The fluid is then condensed with the heat of condensation rejected through a cooling tower.

Acre-foot – One acre-foot is the volume of one acre 1 ft deep. 1 Acre-foot is equal to 1233.5 m^3 or 43 560 ft^3.

Aromatic compounds – A class of compounds containing carbon and hydrogen in a ring form. Example – Benzene (C_6H_6), toluene (C_7H_9) and xylene (C_8H_{11}).

Assymetric membranes – Pores that gradually decrease in size from the upstream side to the downstream side as opposed to symmetric membranes which have pores of the same size right across the membrane. Asymmetric membranes reduces fouling because the larger pores on the upstream side act as a prefilter while the absolute rated downstream side, or exclusion zone, acts as an absolute cut-off layer. This construction can considerably extend membrane life.

Backpressure turbine – A turbine that exhausts steam above atmospheric pressure. The exhaust steam usually is sent to other services.

Biodegradable organics are those that can be broken down by micro-organisms to form stable compounds such as carbon dioxide and water.

Bio – refractory organics are poorly biodegradable substances, prominent among which are aromatics and chlorinated hydrocarbons (benzene, chloroform, bromobenzene, nitrobenzene, styrene etc.).

Bleed rate (blowdown) – The rate at which water in a system must be bled off in order to maintain the Total Dissolved Solids (TDS) at an acceptable level so that scale does not build up in the cooling system.

BOD (biochemical oxygen demand) is the amount of oxygen in mg/L used by micro-organisms to consume biodegradable organics in wastewater under

aerobic conditions over a 5-day period at a temperature of 20° C. The 5-day test equates to 2/3 of the total BOD.

Boiler horsepower – A unit of rate of water evaporation equal to the evaporation per hour of 34.5 pounds of water at a temperature of 2120° F into steam at 2120° F. One boiler horsepower equals 33 475 Btu/hr.

British Thermal Unit (Btu) – The amount of heat required to raise the temperature of one pound of water by one degree Farenheit; equal to 252 calories or 4.18 J. It is roughly equal to the heat of one kitchen match.

Bulking activated sludge – The term used to describe sludge in the secondary clarifier with poor settling characteristics. This is often due to a high proportion of filamentous bacteria and a lack of health floc–forming bacteria.

Carbohydrates – A class of compounds containing carbon, hydrogen and oxygen. General formula is $(CH_2O)_n$. Examples are sugars and starch.

COD (chemical oxygen demand) measures the total *organic* content that can be oxidised by potassium dichromate in a sulphuric acid solution and is expressed as mg/L.

Cogeneration – The simultaneous production of electrical or mechanical work and thermal energy from a process, thus reducing the amount of heat or energy lost for the process. Also known as combined heat and power (CHP).

Coliform bacteria are non-pathogenic microbes found in faecal matter that indicate the presence of water pollution; are thereby a guide to the suitability of water for potable use.

Colony-forming unit (CFU) is a measure of viable bacterial numbers. Unlike in direct microscopic counts where all cells, dead and living, are counted, CFU measures viable cells. A sample is spread or poured on a surface of an agar plate, left to incubate and the number of colonies formed are counted. The CFU is not an exact measure of numbers of viable cells, as a colony-forming unit may contain any number of cells.

Colour – A measure of dissolved substances in water that give it a coloured appearance. The measurement is in Hazen units. It is a comparison to platinum and cobalt salts. The drinking water standard is 15 Hazen units.

Condensate – Condensed steam.

Condensate pump – A pump that pressurizes condensate allowing it to flow back to a collection tank, deaerator or boiler.

Condenser – A heat exchanger in which a refrigerant or steam cools and then condenses from vapour to liquid.

Conductivity measured in microS/cm (μS/cm) is used as a proxy for TDS.

Continuous blowdown – The process of removing water, on a continuous basis, from a boiler to remove high concentrations of dissolved solids,

chlorides and other products. Water is replaced by treated make-up water add to the condensate.

Dalton – The unit of measurement of molecular weight, named after the physicist and chemist John Dalton, founder of the atomic theory. The Dalton is used to denominate the molecular weight of very complex molecules and is defined as one-twelfth of the weight of the atom of the C12 isotope of carbon.

Deaerator – A device that uses steam to strip feedwater of oxygen, carbon dioxide and ammonia.

Dissolved oxygen – A measure of the oxygen dissolved in water. In aerobic wastewater treatment plants the oxygen levels can vary between 0.5 and 3.0 mg/L depending on the process. In cooling water and boiler water systems dissolved oxygen contributes to corrosion.

Drift Loss – This is the additional carry over of water that occurs from cooling when droplets of water escape from the cooling tower.

E-coli (Escherichia coli) is also one of the non-pathogenic coliform organisms used to indicate presence of pathogenic bacteria in water.

Effluent is the liquid, solid or gaseous product discharged or emerging form a process.

Evaporation rate – The rate at which water evaporates as part of the evaporative cooling process.

External Water Footprint – External Water Footprint is defined as the annual volume of water resources used in other countries to produce goods and services consumed by the inhabitants of the country concerned.

Floating matter is that which passes through a 2000 μ sieve and separates by floatation in one hour.

Food to mass ratio (F:M) – The ratio of the bacterial food, that is BOD load, and the mass of bacteria available to treat the BOD. An important control parameter for the activated sludge process. Also referred to as the sludge loading rate (SLR).

Flux – Flux is the quantity of material passing through a unit area of membrane per unit time. SI units are $m^3/m^2/s$ or simply m/s. Other non-SI units are $L/m^2/h$ (LMH) and m^3 per day. The US units are gal./ft^2/day (GFD).

Food Cover – Any transaction or sale, whether a cup of coffee or a multiple course meal.

Greenhouse gas emissions – Those gases, such as water vapour, carbon dioxide, ozone, which are believed to contribute to climate change.

Heat exchanger – A device used to transfer heat from one medium by either direct or indirect contact.

Heat Recovery Steam Generator – A type of wasteheat boiler that captures the thermal energy in cogeneration systems and produces steam.

Internal Rate of Return (IRR) – Internal Rate of Return is the discount or interest rate at which the net present value of an investment is equal to zero.

Internal water footprint – Internal water footprint is defined as the use of domestic water resources to produce goods and services consumed by the inhabitants of the country.

Kilowatt hour (kWh) – A unit of measure of electric supply or consumption of 1000 W over the period of one hour; equivalent to 3412 Btu.

Kilowatt refrigeration (kWr) – Kilowatt refrigeration as distinct from kW electrical.

Latent heat – The change in heat content that occurs with a change in phase without a corresponding change in temperature. Changes in heat content that affect a change in temperature are called sensible heat changes. The Latent heat of water is 2431 kJ/kg (1000 Btu/lb).

Life cycle cost (LCC) – Cost estimate of a piece of equipment over its entire life, including development costs, production costs, warranty costs, repair costs and disposal costs.

Make up – Water supplied to a cooling tower to replenish water lost through evaporation, bleed, drift and wastage.

Membrane – A thin barrier that allows some compounds or liquids to pass through, and impedes others. It is a semi-permeable skin of which pass through is determined by the size or special nature of the particles. Membranes are commonly used to separate particles and dissolved ions.

Mixed Liquor Suspended Solids (MLSS) – A measure of the solids content of an activated sludge reactor. Generally measured in mg/L.

Molecular Weight Cut-off (MWCO) – Molecular weight cut-off is the nominal molecule size rejected by a membrane. The units are expressed in Daltons.

MPN Index (most probable number) is used to report results of the coliform test for bacteria. It represents the number of coliform bacteria in the water.

Net Present Value – Net Present Value (NPV) is equal to the present value of a future returns, discounted at a marginal cost of capital, minus the present value of the cost of the investment.

Nitrification – The biological oxidation of ammoniacal nitrogen to nitrate. It is a two-stage process requiring two types of bacteria. *Nitrosomonas* sp. convert ammoniacal nitrogen to nitrite, then *Nitrobacter* sp. convert nitrite to nitrate.

Organic nitrogen is the nitrogen combined in organic molecules such as proteins, amines and amino acids.

ORP (oxidation–reduction potential) indicates the degree of completion of the chemical reaction by detecting the ratio of ions in reduced form to those in the oxidised form as variations in electrical potential form an ORP electrode assembly.

Overflow – The water which may accidentally flow over the basin of a cooling tower, or through the tower overflow pipe, due to a deficiency in the condenser water system.

Pathogenic bacteria are those micro-organisms capable of producing diseases in man, animals and plants such as *Legionella, Salmonella, Giardia, Listeria* and *Camphylobacter*.

Payback – The amount of time required for positive cash flows to equal the total investment costs. This is often used to describe how long it will take for the savings resulting from using water and/or energy efficient equipment to equal the premium paid to purchase the water (energy)-efficient equipment.

Payback period – Measures the length of time taken for the return on an investment exactly to equal the amount originally invested.

ppb – Parts per billion. Commonly considered equal to micrograms per litre (μg/L).

ppm – Parts per million. Commonly considered equal to milligrams per litre (mg/L).

ppt – Parts per trillion. Commonly considered equal to nanograms per litre (ng/L).

Refrigerant – The working fluid of the refrigeration system such as ammonia or other that absorbs heat from the evaporator (chiller) and then rejects it in the condenser.

Risk management – The process for identifying, assessing, monitoring and controlling the key factors that could affect the desired outcome of a maintenance procedure.

Sensible heat change – A change in heat content with a corresponding change in temperature.

Settleable solids are those in suspension that will pass through a 2000 μ sieve and settle in 1 hour under the influence of gravity.

Sludge age – Often referred to as the mean cell residence time. A measure of time the biomass is retained within the system. It is closely related to the F:M ratio and an important plant control parameter.

Steam ejector – A device that uses a relatively high pressure motive steam flow through a nozzle to create a low-pressure or suction effect.

Steam trap – An automatic control device that allows for the removal of condensate, air and carbon dioxide and other non-condensable gases, whilst keeping living steam in the system.

Suspended solids are those solids that can be removed by filtration.

Thermal conductivity – This is a positive constant k, that is a property of a substance and is used in the calculation of heat transfer rates for materials. It is the amount of heat that flows through a specified area and thickness of a material over a specified period of time when there is a temperature difference of one degree between the surfaces of the material.

Throttling – Regulating flow rate by closing a valve in the system.

Total dissolved solids (TDS) – A measure of the salinity of water, expressed in mg/L.

Total organic carbon (TOC) – A measure of the organic carbon content in an effluent. A useful indicator of the organic strength, particularly suited to on-line monitoring, expressed in mg/L.

Total solids equal the sum of suspended solids and dissolved solids.

Turbidity is the amount of suspended matter in wastewater obtained by measuring its light-scattering intensity and reported as NTU.

Turbine – A device that converts the enthalpy of steam into mechanical work. There are two types of turbines – condensing and backpressure turbines. Condensing turbines exhausts steam to sub-atmospheric conditions, where the steam is condensed. These are normally found in power plants. Backpressure turbines exhausts steam above atmospheric conditions. The exhaust steam is usually sent to a lower pressure system.

Variable Frequency Drive – A type of variable speed motor drive in which the motor is supplied with electrical power at frequencies other than standard 60 Hz through a converter.

Virtual Water – Virtual water is defined as the volume of water needed to produce a commodity or service.

Virus – Any large group of sub-microscopic infective agents capable of growth and multiplication only in living cells of a host. Examples are given in Chapter 2. Phages are used as a proxy for virus contamination.

Waste heat – Heat that is discharged from a mechanical process, wastewater or ventilation exhaust system that could be reclaimed for useful purposes.

Water footprint – The water foot print of a country is defined as the volume of water needed for the production of goods and services consumed by the

inhabitants of the country. National water footprint consists of internal water footprint and external water footprint.

Wet bulb temperature – The lowest temperature that can be obtained by evaporating water into the air at constant pressure. The average yearly wet bulb temperature for Sydney is 14.9° C.