5.2 Descriptions of techniques

5.2.1 General techniques

Technique	Description
Advanced control system	The use of a computer-based automatic system to control the combustion efficiency and support the prevention and/or reduction of emissions. This also includes the use of high-performance monitoring of operating parameters and of emissions.
Optimisation of the incineration process	Optimisation of the temperature, flow rates and points of injection of the primary and secondary combustion air to effectively oxidise the organic compounds while reducing the generation of NO_X. Optimisation of the design and operation of the combustion chamber (e.g. flue-gas temperature, flue-gas and waste residence time, oxygen level, waste agitation).
Waste blending and mixing	Wastes are blended and/or mixed prior to incineration, e.g. by: • bunker crane mixing; • a feed equalisation system; • blending of compatible liquid and pasty wastes (subject to prior compatibility testing as required); in order to ensure stable combustion conditions, to increase the burnout and the destruction efficiency, and/or to reduce pollutant emissions. In some cases, solid wastes are shredded prior to mixing.

5.2.2 Techniques to reduce emissions to air

Technique	Description
Bag filter	Bag or fabric filters are constructed from porous woven or felted fabric through which gases are passed to remove particles. The use of a bag filter requires the selection of a fabric suitable for the characteristics of the flue-gas and the maximum operating temperature.
Boiler sorbent injection	Direct injection of dedicated alkaline reagents into the boiler at a high temperature, in the boiler post-combustion area, to achieve partial abatement of the acid gases. The technique is highly effective for the removal of SO_2 and HF, and provides additional benefits in terms of flattening emission peaks.
Catalytic filter bags	Filter bags are either impregnated with a catalyst, or the catalyst is directly mixed with organic material in the production of the fibres used for the filter medium. Such filters can be used to reduce PCDD/F emissions as well as, in combination with a source of NH_3, to reduce NO_X emissions.
Direct desulphurisation	The addition of magnesium- or calcium-based adsorbents to the bed of a fluidised bed furnace. The surface of the sorbent particles reacts with the SO_2 in the fluidised bed boiler.
Dry sorbent injection	The injection and dispersion of a dry powder sorbent in the flue-gas stream. Alkaline sorbents (e.g. sodium carbonate, sodium bicarbonate, hydrated lime) are injected to react with acid gases (HCl, HF and SO_2). Activated carbon is injected or co-injected to adsorb in particular PCDD/F and mercury. The resulting solids are removed, most often with a bag filter.
Electrostatic precipitator	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. Electrostatic precipitators are capable of operating under a wide range of conditions. Abatement efficiency may depend on the number of fields, residence time (size), and upstream particle removal devices. They generally include between two and five fields.
Flue-gas recirculation	Recirculation of part of the flue-gas to the combustion chamber to replace part of the fresh combustion air, with the dual effect of cooling the temperature and limiting the O_2 content for nitrogen oxidation, thus limiting the NO_X generation. It implies the supply of flue-gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame.
Low-NO_X burners	The technique is based on the principles of reducing peak flame temperatures; low-NO_X burners are designed such as to delay but improve the combustion and increase the heat transfer (increased emissivity of the flame). The air/fuel mixing reduces the availability of oxygen and reduces the peak flame temperature, thus retarding the conversion of fuel-bound nitrogen to NO_X and the formation of thermal NO_X, while maintaining high combustion efficiency.
Selective catalytic reduction (SCR)	Selective reduction of nitrogen oxides with ammonia or urea in the presence of a catalyst. The technique is based on the reduction of NO_X to nitrogen in a catalytic bed by reaction with ammonia (in general, aqueous solution; the ammonia source can also be anhydrous ammonia or a urea solution) at an optimum operating temperature of around 300–450 °C. Several layers of catalyst may be applied. A higher NO_X reduction is achieved with the use of several layers of catalyst. 'In-duct or slip' SCR combines SNCR with downstream SCR which reduces ammonia slip from SNCR.
Selective non-catalytic reduction (SNCR)	Selective reduction of nitrogen oxides to nitrogen with ammonia or urea at high temperatures and without catalyst. The operating temperature window is maintained between 800 °C and 1000 °C for optimal reaction.
Semi-wet absorber	Also called semi-dry. An alkaline aqueous solution or suspension (e.g. lime milk) is added to the flue-gas stream to capture the acidic compounds from the flue-gas. The water evaporates and the reaction products are dry. The residue may be recirculated to improve reagent utilisation. This technique includes a range of different designs, including *flash-dry* processes which consist of injecting water (providing for fast gas cooling) and reagent at the filter inlet.
Wet scrubber	Use of a liquid, typically water or an aqueous solution/suspension, to capture pollutants from the flue-gas, in particular acidic compounds by absorption, as well as other soluble compounds and solids. Different types of scrubber designs are used, e.g. jet scrubbers, rotation scrubbers, Venturi scrubbers, spray scrubbers and packed tower scrubbers.

5.2.3 Techniques to reduce emissions to water

Technique	Description
Adsorption on activated carbon	The removal of soluble substances (solutes) from the waste water by transferring them to the surface of solid, highly porous particles (the adsorbent). Activated carbon is typically used for the adsorption of organic compounds and mercury.
Chemical precipitation	The conversion of dissolved pollutants into insoluble compounds by adding chemical precipitants. The precipitates are subsequently separated by sedimentation, flotation or filtration. If necessary, this may be followed by microfiltration or ultrafiltration. Typical chemicals used for metal precipitation are lime, dolomite, sodium hydroxide, sodium carbonate, sodium sulphide and organosulphides. Calcium salts (other than lime) are used to precipitate sulphate or fluoride.
Coagulation and flocculation	Coagulation and flocculation are used to separate suspended solids from waste water and are often carried out in successive steps. Coagulation is carried out by adding coagulants with charges opposite to those of the suspended solids. Flocculation is carried out by adding polymers, so that collisions of microfloc particles cause them to bond thereby producing larger flocs.
Equalisation	Balancing of flows and pollutant loads at the inlet of the final waste water treatment by using central tanks. Equalisation may also be decentralised or carried out using other management techniques.
Filtration	The separation of solids from waste water by passing it through a porous medium. It includes different types of techniques, e.g. sand filtration, microfiltration and ultrafiltration.
Flotation	The separation of solid or liquid particles from waste water by attaching them to fine gas bubbles, usually air. The buoyant particles accumulate at the water surface and are collected with skimmers.
Ion exchange	The removal of ionic pollutants from waste water and their replacement by more acceptable ions by transferring them to an ion exchange resin. The pollutants are temporarily retained and afterwards released into a regeneration or backwashing liquid.
Neutralisation	The adjustment of the pH of the waste water to neutral (approximately 7) by adding chemicals. Sodium hydroxide ($NaOH$) or calcium hydroxide ($Ca(OH)_2$) is generally used to increase the pH whereas sulphuric acid (H_2SO_4), hydrochloric acid (HCl) or carbon dioxide (CO_2) is used to decrease the pH. The precipitation of some substances may occur during neutralisation.
Oil-water separation	The removal of free oil from waste water by mechanical treatment using devices such as the American Petroleum Institute separator, a corrugated plate interceptor, or a parallel plate interceptor. Oil-water separation is normally followed by flotation, supported by coagulation/flocculation. In some cases, emulsion breaking may be needed prior to oil-water separation.
Oxidation	The conversion of pollutants by chemical oxidising agents to similar compounds that are less hazardous and/or easier to abate. In the case of waste water from the use of wet scrubbers, air may be used to oxidise sulphite (SO_3^{2-}) to sulphate (SO_4^{2-}).
Reverse osmosis	A membrane process in which a pressure difference applied between the compartments separated by the membrane causes water to flow from the more concentrated solution to the less concentrated one.
Sedimentation	The separation of suspended solids by gravitational settling.
Stripping	The removal of volatile pollutants (e.g. ammonia) from waste water by contact with a high flow of a gas current in order to transfer them to the gas phase. The pollutants are removed from the stripping gas in a downstream treatment and may potentially be reused.

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