RAW WATER PRE-TREATMENT: INTRODUCTION AND OVERVIEW

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1. Polution of Raw Water and its Measurement

Raw water extracted from natural water resources, that is surface waters and springs such as sweet water, brackish water, or seawater, contains, in addition to soluble salts, a number of chemical compounds which could cause problems when used as service water in industry or for drinking water. Such objectionable substances are as follows.

(a) Particulates in suspended or colloidal form.
(b) Inorganic compounds which precipitate or give rise to encrustations when their concentration is increased, the water is heated, or if the pH is changed.
(c) Organic compounds which, as they decay or decompose or due to their toxic properties, degrade drinking and service water systems.
(d) Bacterial pollutants which are the cause of heavy growths of microorganisms and, thus, the formation of coatings and slime in pipelines, reservoirs, and heat exchangers.

Before using drinking and service water, these contaminating constituents have to be removed, for which purpose corresponding treatment measures are required. However, their influence on the treatment process itself also has to be taken into consideration, in that scaling and fouling in the thermal and physical desalination process have to be suppressed.

The necessary conditions for proper design of these treatment processes is a knowledge of the water composition, both as regards its ionogenic, non-polluting constituents and

its particulate, colloidal and organic contents, particularly to the extent that these could be linked to possible malfunctions of the treatment process.

For this purpose, prior to the design, planning, and commissioning of treatment and desalination plants, water samples have to be taken and analyzed as appropriate. The scope of the analysis depends on the treatment objectives, that is the nature of the process to be employed, but also on site-specific conditions, such as fluctuations in the salt content and water temperature, as well as the effects of any municipal and industrial effluent discharges into the water to be treated. Whereas in all cases both thermal treatment and membrane processes require a careful check of the variation in the salt content and temperature fluctuations, when applying membrane processes, apart from determining the water's scaling characteristics, particular attention has to be paid to its propensity for fouling and above all for promoting biological fouling. It is therefore necessary for the latter process, apart from the classical methods of analysis as standardized in many countries in the world, to conduct further tests which are more directed at establishing the colloidal fouling tendency, such as the determination of fouling factors by membrane filter methods.

For proper design of such pre-treatment stages which protect the downstream desalination plants against operational upsets due to scaling and fouling, it is necessary to assess as a whole the results and findings from analyses with regard to ionogenic constituents, aggregate parameters, and the colloidal fouling tendency, in addition to evaluation of the individual analyses, as only in this way will it be possible to predict the scaling and fouling potential of raw water.

2. Raw Water Extraction Installations

Pre-cleaning of raw water starts with selection of the location and manner of water extraction, continues with preparatory measures, such as removal of coarse suspended solids by screening and microscreening, and then proceeds to chemical and physicochemical treatment possibly with fine cleaning of the water before it is supplied to the main treatment process. Here too the nature of this process fixes to a decisive degree the type and extent of these treatment stages. Whereas for thermal desalination processes, such as multistage flash (MSF) and multieffect distillation (MED) in their various designs, it is sufficient to extract service water from open intakes with coarse, fine and possibly micro screening with chlorination either separately (subsequently) or integrated into the intake together with pretreatment installations. This will provide the required pretreatment measures for the removal of particulate and fouling pollutants, in these two processes; however membrane processes require more thoroughgoing cleaning efforts. In particular, correct selection of the water extraction location and the design of the extraction installations can decisively influence the expense of the fine-cleaning technologies to be installed ahead of membrane processes.

Examples of such extraction measures are as follows.

(a) Shore wells, by means of which seawater extracted from wells near to the shore is pre-filtered.
(b) Infiltration galleries located in the water or near to the shore and generating a pre-

filtration effect by way of drainage lines with appropriate bedding of the extraction pipes in permeable soil strata.

With such installations, the screening and microscreening usual for surface extraction may be dispensed with and, if the filtering effect of these systems is effective enough, the extent of fine cleaning can be appropriately reduced.

3. Measures to Prevent Biofouling

Also forming an important part of pre-cleaning are the chemical measures to prevent biological growth in condensers, raw water holding tanks, filters, and the desalination plants themselves. To this end, predominantly oxidizing chemicals are employed and, above all, chlorine in the form of a chlorine-containing solution generated from the seawater in electrolytic chlorine plants or of sodium hypochlorite solution, calcium hypochlorite, or gaseous chlorine evaporated from liquid chlorine bottles or vats, which is then injected as a gas into the water.

In addition, in order to hinder organic growth, chlorine dioxide, ozone, or chloramine - generated by simultaneous injection of chlorine and ammonia - may be used. However, up to now the latter-named chemicals have been applied usually only in individual cases and for plants of low throughput. Ozone, which has found extensive use in the treatment of drinking and bathing water, has up to now hardly ever been used for the pre-treatment of brackish water and seawater and is more likely to be encountered in the extraction of water from rivers and wells. Also, chemicals which counteract organic and biological growth, so-called biocides, as frequently used for suppressing biological growth in cooling water circuits, have up to now scarcely been taken up for pre-treatment. Where membrane processes are the main desalination method, then in these cases particular attention has to be paid to the membrane compatibility of the substances used, that is, no substances which promote fouling by side reactions and agglomeration should be employed.

Most membrane desalination processes are susceptible to lengthy exposure to oxidizing substances. An attack of these chemicals on the membrane separation layer can bring about impairment of permeate quality or a drop in plant throughput. For this reason, within pre-treatment plants using such desalination processes, measures for the removal of oxidants are necessary for dechlorination or elimination of other oxidizing agents. Such equipment usually consists of chemical dosing devices by means of which reducing agents, such as sodium bisulfate, are injected or fixed bed filters containing filtration layers, which absorb and degrade chlorine compounds.

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