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Marine technology — Seawater desalination — Vocabulary

Navires et technologie maritime — Dessalement de l'eau de mer — Terminologie

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Foreword

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Establishing a standardized set of terms and definitions is highly important for the production of scientific and engineering publications in a technical area, including the development of standards. The absence of a standardized terminology can ultimately result in inefficiencies and a high-probability of misinterpretation.

This document defines terms and definitions used in the entire process of seawater desalination. The flow process of seawater desalination is given in Figure 1. Desalination methods are mainly categorized into distillation processes and membrane processes. Both processes involve mutual parts of water intake, pre-treatment and post-treatment, but differ in terms of membrane desalination and distillation desalination. In addition, the auxiliary terms consisting of membrane cleaning and agents dosing are essential for specific processes.

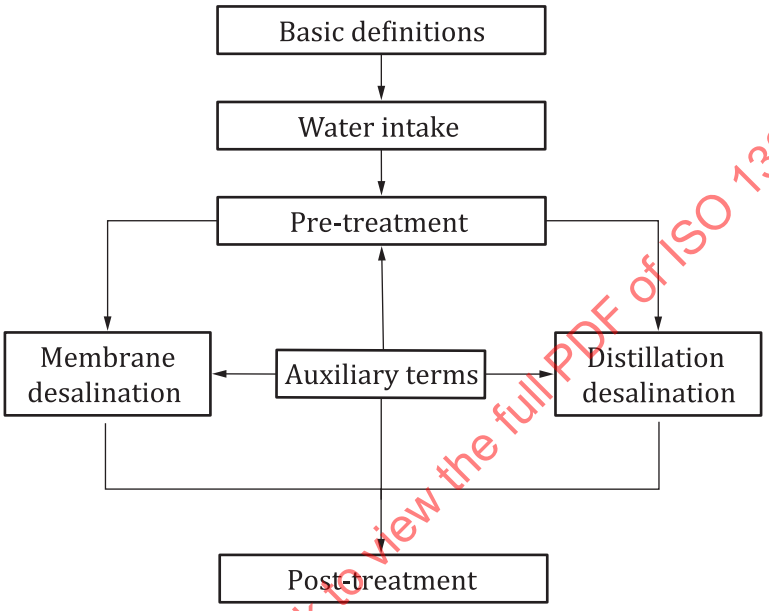

Figure 1 — Flow diagram of seawater desalination terminology

This document aims to provide guidance for unified terminology in seawater desalination; remove any obstacles to communication in management, industry and academia; and promote multi-field cooperation in more countries and regions. The objective of this document is to consolidate unified descriptions of seawater desalination activities, for the benefit of all users and stakeholders.

Marine technology — Seawater desalination — Vocabulary

1 Scope

This document defines terms and definitions for the integral seawater desalination process. It covers basic definitions, as well as specific subject matter including water intake, pre-treatment, membrane desalination, distillation desalination, post-treatment and auxiliary terms.

This document applies to all types and sizes of seawater desalination facilities and systems, and to all types of stakeholders involved in seawater desalination.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Basic definitions

3.1.1
seawater desalination
process which removes excess substances such as organisms and salts from seawater to make it usable as municipal water, industrial water and for other applications

3.1.2
seawater desalination system
set of interrelated or interacting units for *seawater desalination* (3.1.1) processes, including source *water intake* (3.2.1) system, *pre-treatment* (3.3.1) facilities, membrane and distillation separation devices, post-treatment facilities and electronic control unit, etc.

3.1.3
source water
raw water
inlet water supplied to the *seawater desalination system* (3.1.2)

3.1.4
feed water
inlet water supplied to an individual component or a device of *seawater desalination system* (3.1.2)

3.1.5
desalinated water
freshwater produced by distillation and membrane desalination plants

3.1.6
product water
water produced by *post-treatment* (3.6.3) of *desalinated water* (3.1.5) such as *mineralization* (3.6.4) and *waters blending* (3.6.5)

3.1.7
brine
concentrate (reject) stream from a membrane or a distillation device performing desalination, with a salinity that is higher than seawater

3.1.8
concentration factor
CF
ratio of the concentration of components in the retentate [concentrate, *brine* (3.1.7)] to the concentration of the total components in the feed

Note 1 to entry: Concentration factor (CF) is generally expressed by C_b/C_f, where C_b is brinewater concentration and C_f is feedwater concentration.

3.1.9
recovery rate
ratio of the permeate volume to the feed volume

[SOURCE: ISO 23070:2020, 3.10]

3.1.10
element
component containing the membrane, generally replaceable, such as hollow fibre, spiral wound cartridge or cassette

[SOURCE: ASTM D6161-2019, 5.1, modified — "hollow fibre" has been added to the definition.]

3.1.11
module
membrane *element* (3.1.10) combined with the element's housing

Note 1 to entry: The *pressure vessel* (3.4.3) contains the membrane element(s).

[SOURCE: ASTM D6161-2019, 5.1, modified — part of the original definition has been moved to Note 1 to entry.]

3.2 Water intake

3.2.1
water intake
process of withdrawing seawater from the source

3.2.2
surface intake
seawater collected from the open ocean above the seabed

Note 1 to entry: Surface intakes can be single purpose or collocated with a power plant as well as offshore submerged, nearshore submerged, or nearshore surface intakes.

3.2.3
subsurface intake
seawater collected via *vertical wells* (3.2.3.1), infiltration galleries or other locations beneath the seabed

Note 1 to entry: Subsurface intakes can be onshore (vertical wells), including vertical beach wells or deep aquifer wells, horizontal wells, radial or collector wells, and beach infiltration galleries; or offshore wells, including horizontal drains (wells), and seabed infiltration galleries.

3.2.3.1
vertical well
well which is well-drilled straight down into the underlying rock or unconsolidated coastal aquifer system

3.2.3.2
slant well
well which is well-drilled at an angle from the horizontal into the underlying rock or unconsolidated coastal aquifer system

3.2.3.3
infiltration gallery
filtering device which is a horizontal drain made from open jointed or perforated pipes, or a blocked drain, which is laid below the water table and collects seawater

3.2.3.4
tunnelled intake
seawater collected from deep water by the tunnelled structure

Note 1 to entry: The tunnel is built over the full distance from the intake structure to the diffusers offshore.

3.3 Pre-treatment

3.3.1
pre-treatment
processes such as chlorination, filtration, coagulation, clarification, dechlorination, which may be used on *feed water* (3.1.4) ahead at *reverse osmosis* (3.4.2) membrane devices and distillation devices to minimize *scaling* (3.6.2) and blockage potential and to control biological activity

3.3.2
sterilization
process which inactivates or removes all living organisms (including vegetative and spore forms) as well as viruses

[SOURCE: ISO 6107:2021, 3.539]

3.3.3
dissolved air flotation
DAF
flotation process by which low density particles are removed from seawater by using fine bubbles which are produced by the reduction in pressure of a water stream saturated with air

[SOURCE: ISO 20480-4:2021, 3.2, modified — Note 1 to entry has been removed.]

3.3.4
flocculation
formation of large separable particles by aggregation of small particles; the process is usually assisted by mechanical, physical, chemical or biological means

[SOURCE: ISO 6107:2021, 3.234]

3.3.5
sedimentation
process of settling and depositing suspended solids in water under the action of gravity

3.3.6
sand filter
device used to remove suspended solids

Note 1 to entry: Sand filter is made up of layers of inert medium, usually quartz/silica sand.

3.3.7
multimedia filter
MMF
layered filtration media in a pressurized container, used to reduce the level of suspended solids (turbidity) in incoming *feed water* (3.1.4)

Note 1 to entry: Media layers can consist of anthracite, activated carbon, quartz/silica sand and garnet.

[SOURCE: ISO 22519:2023, 3.1.3]

3.3.8
self-cleaning filter
filtration system used to reduce the level of suspended solids (turbidity) in incoming *feed water* (3.1.4), as well as automatically clean itself

Note 1 to entry: The self-cleaning filter starts automatic cleaning mechanisms according to the pre-set cleaning cycle or system differential pressure due to the accumulation of suspended solids (turbidity).

3.3.9
microfiltration
MF
pressure driven membrane-based separation process designed to remove particles and dissolved macromolecules in the approximate range of 0,05 µm to 2 µm

[SOURCE: ASTM D6161-2019, 5.1]

3.3.10
ultrafiltration
UF
pressure driven process employing a semipermeable membrane under a hydraulic pressure gradient to separate components in a solution

Note 1 to entry: The pores of the membrane are of a size smaller than 0,1 µm, which allows passage of the solvent(s) but will retain non-ionic solutes based primarily on physical size, not chemical potential.

[SOURCE: ASTM D6161-2019, 5.1, modified — part of the original definition has been moved to Note 1 to entry.]

3.3.11
cartridge filter
device used to further reject the remained foulants in the *feed water* (3.1.4) before *reverse osmosis (RO)* (3.4.2) membranes

Note 1 to entry: The purpose of the cartridge filter is to protect the RO membranes from damage.

3.4 Membrane desalination

3.4.1
high-pressure feed pump
device used to deliver *feed water* (3.1.4) to the *reverse osmosis* (3.4.2) membranes at the pressure required for membrane separation of *desalinated water* (3.1.5) from the seawater

3.4.2
reverse osmosis
RO
separation process where one component of a solution is removed from another component by flowing the feed stream under pressure across a semipermeable membrane that causes selective movement of solvent against its osmotic pressure difference

Note 1 to entry: RO removes ions based on electro chemical forces, colloids, and organics down to 150 molecular mass.

[SOURCE: ASTM D6161-2019, 5.1, modified — part of the original definition has been moved to Note 1 to entry.]

3.4.3
pressure vessel
container filled with *reverse osmosis* (3.4.2) membrane element(s)

3.4.4
booster pump
device used to deliver the water from the *energy recovery device* (3.4.5) to the *reverse osmosis (RO)* (3.4.2) membranes at pressure required for RO membrane *feed water* (3.1.4)

3.4.5
energy recovery device
ERD
device that uses the hydraulic pressure of the *brine* (3.1.7) to pressurize *feed water* (3.1.4) in a *reverse osmosis* (3.4.2) desalination unit

3.4.6
reverse osmosis train
RO train
complete *reverse osmosis* (3.4.2) installation, including membranes, high pressure feed pump and *energy recovery device* (3.4.5) operating in parallel

3.4.7
pass
process of *feed water* (3.1.4) being further desalinated by the *reverse osmosis* (3.4.2)/*nanofiltration* (3.4.13) membranes

Note 1 to entry: The multi-pass membrane system means the permeate from the former pass flows into the latter pass, which is usually used to filtrate the permeated water for improving the water quality.

3.4.8
stage
<membrane desalination> process of *feed water* (3.1.4) being further concentrated by the *reverse osmosis* (3.4.2)/*nanofiltration* (3.4.13) membranes

Note 1 to entry: The multi-stage membrane system means the concentrated water from the former stage flows into the latter stage, which is usually used to further concentrate the *brine* (3.1.7) for improving the *recovery rate* (3.1.9).

3.4.9
single pass reverse osmosis
SPRO
single pass membrane-based process to separate dissolved ions and suspended solids

3.4.10
double pass reverse osmosis
DPRO
double pass membrane-based process to separate dissolved ions and suspended solids

3.4.11
membrane rejection rate
relative measure of how much of the target constituent that was initially in the *feed water* (3.1.4) is separated from the liquid by the membrane

Note 1 to entry: Rejection is generally expressed by 1 - C_2/C_1, where C_1 is feed concentration and C_2 is permeate concentration. To make the guideline simple, the word “membrane” is frequently omitted depending on the context.

[SOURCE: ISO 23070:2020, 3.6]

3.4.12
permeate flux
rate at which water molecules diffuse through the membrane

Note 1 to entry: Permeate flux is expressed in terms of flow rate per unit area i.e. litre per square metre per hour (l/m^2/h).

3.4.13
nanofiltration
NF
crossflow process with pore sizes designed to remove selected salts and most organics above approximately 300 molecular weight range, sometimes referred to as loose *reverse osmosis* (3.4.2)

Note 1 to entry: Nanofiltration is a pressure-driven membrane separation process in which particles and dissolved molecules smaller than approximately 2 nm are rejected.

[SOURCE: ASTM D6161-2019, 5.1, modified — part of the original definition has been moved to Note 1 to entry.]

3.4.14
electrodialysis
process used for the deionization of water in which ions are removed, under the influence of an electric field, from one body of water and transferred to another across an ion-exchange membrane

3.4.15
forward osmosis
process across a semipermeable membrane which is driven by osmotic pressure difference to separate dissolved solutes from *feed water* (3.1.4)

3.4.16
ion exchange
process by which certain anions or cations in water are replaced by other ions by passage through a bed of ion-exchange material

[SOURCE: ISO 6107:2021, 3.300]

3.4.17
membrane distillation
membrane separation process driven by the vapor pressure difference between the feed side with higher temperature and the permeate side with lower temperature

Note 1 to entry: Generally, the micro-porous hydrophobic membranes are used in membrane distillation process.

3.5 Distillation desalination

3.5.1
multi-effect distillation
MED
process of evaporation/condensation in a series of evaporators/condensers (effects) where the incoming steam condenses as fresh water on one side of heat transfer tubes, while the potential heat of condensation evaporates the seawater on the other side of the tubes; the evaporated *secondary steam* (3.5.9) is conducted into the next effect to repeat the above process

3.5.1.1
multi-effect distillation plant
set of interrelated or interacting units for *multi-effect distillation* (3.5.1), including *evaporators* (3.5.1.4), *condensers* (3.5.3), vacuum equipment, instruments and meters

3.5.1.2
low-temperature multi-effect distillation
LT-MED
multi-effect distillation (3.5.1) process which usually operates at the temperature ≤ 70 °C and the absolute pressure ≤ 0,03 MPa

3.5.1.3
effect
basic unit in the *multi-effect distillation plant* (3.5.1.1) to complete the heat exchange between seawater evaporation and steam condensation for producing *desalinated water* (3.1.5)

3.5.1.4
evaporator
device used for evaporating and condensing seawater in a *multi-effect distillation plant* (3.5.1.1)

Note 1 to entry: The evaporator is mainly composed of heat transfer tubes, tube sheets and shells.

3.5.1.5
steam-jet vacuum pump
device that uses steam as the power to extract *non-condensable gas* (3.5.10) from a distillation system to form a vacuum state

3.5.1.6
thermal vapour compressor
TVC
device that uses *motive steam* (3.5.7) as the power to suck and inlet low-pressure steam from the distillation desalination device according to the Venturi effect, and make the mixture steam reach the pre-set pressure

Note 1 to entry: TVC is usually used in conjunction with a *multi-effect distillation (MED)* (3.5.1) device, which can be abbreviated as MED-TVC.

3.5.2
multi-stage flash distillation
MSF
distillation process of evaporating/condensing *feed water* (3.1.4) by passing through a series of *flash evaporators* (3.5.2.3) where the temperature and pressure are reduced stage by stage

3.5.2.1
stage
<distillation desalination> basic unit in the *multi-stage flash distillation* (3.5.2) plant to complete a single *flashing* (3.5.2.2) of *feed water* (3.1.4)

3.5.2.2
flashing
evaporation phenomenon caused by a sudden pressure drop sufficiently below the saturation pressure

Note 1 to entry: When the high-pressure saturated liquid enters a relatively low-pressure container, it will become a part of the saturated steam and saturated liquid under this relatively low pressure by a sudden pressure drop.

3.5.2.3
flash evaporator
device used for seawater preheating, *flashing* (3.5.2.2), vapour condensing and distillate collection in *multi-stage flash distillation* (3.5.2)

Note 1 to entry: A flash evaporator is mainly composed of heat transfer tubes, tube sheets, flash chambers and shells.

3.5.3
condenser
device (heat exchanger) used for condensing the *secondary steam* (3.5.9) of the last *effect* (3.5.1.3) in a *multi-effect distillation plant* (3.5.1.1)

3.5.4
demister
device, often fitted with vapour-liquid separator vessels, to enhance the removal of liquid droplets or mist entrained in a *secondary steam* (3.5.9)

[SOURCE: ISO/TR 27912:2016, 3.25, modified — “vapour stream” has been replaced by “secondary steam”.]

3.5.5
gained output ratio
GOR
mass ratio of the *desalinated water* (3.1.5) to the heating steam per unit time

3.5.6
top brine temperature
TBT
maximum brine temperature at the outlet of the first *effect* (3.5.1.3) or *stage* (3.5.2.1)

3.5.7
motive steam
high-pressure steam that provides motive power for the *thermal vapour compressor (TVC)* (3.5.1.6) in a *multi-effect distillation (MED)* (3.5.1)-TVC device

3.5.8
primary steam
steam as a heat source of each effect in a *multi-effect distillation plant* (3.5.1.1)

3.5.9
secondary steam
steam produced by heating *feed water* (3.1.4) in an *evaporator* (3.5.1.4)

3.5.10
non-condensable gas
NCG
air and/or other gas which will not liquefy under the conditions of a saturated steam process

[SOURCE: ISO 11139:2018, 3.183]

3.5.11
deaeration
partial or complete removal of dissolved air from water either under natural conditions or deliberately by physical processes

[SOURCE: ISO 6107:2021, 3.152]

3.6 Post-treatment

3.6.1
corrosion
gradual destruction or slow degradation of a substance or surface by chemical effect

Note 1 to entry: The corrosion usually happens on the surface of the *seawater desalination* (3.1.1) devices and pipelines.

3.6.2
scaling
build-up of precipitated salts on a surface, such as membranes, pipes, tanks, or heat transfer tubes

3.6.3
post-treatment
process such as *mineralization* (3.6.4) or *waters blending* (3.6.5) to *desalinated water* (3.1.5) for avoiding/minimizing pipelines *corrosion* (3.6.1) and making *product water* (3.1.6) healthy for end users

3.6.4
mineralization
process of adding minerals to *desalinated water* (3.1.5) to meet the requirements of *product water* (3.1.6) supply

3.6.5
waters blending
process of *desalinated water* (3.1.5) blending with other sources to meet the requirements of *product water* (3.1.6) supply

3.7 Auxiliary terms

3.7.1
membrane cleaning
process of removing the foulants on the membrane outer and inner surface using a membrane cleaning system, with or without chemical reagents

3.7.1.1
membrane fouling
process leading to deterioration of membrane flux due to surface or internal blockage of the membrane

[SOURCE: ISO 20468-5:2021, 3.1.9, modified — the term “fouling” has been replaced by “membrane fouling”.]

3.7.1.2
transmembrane pressure
TMP
hydraulic pressure differential (net driving force) across the membrane

[SOURCE: ASTM D6161-2019, 5.1]

3.7.1.3
pressure drop
pressure change of the influent after the treatment by a *reverse osmosis* (3.4.2) system

[SOURCE: ISO 23070:2020, 3.9]

3.7.1.4
forward flush
forward flow of *feed water* (3.1.4) or permeate with or without air across a membrane (i.e. from the feed side to the permeate side)

Note 1 to entry: The forward flush is designated to remove the deposited foreign substances (foulants) from the membrane.

3.7.1.5
backward flush
reverse flow of *feed water* (3.1.4) or permeate with or without air across a membrane (i.e. from the permeate side to the feed side)

Note 1 to entry: The backward flush is designated to remove the deposited foreign substances (foulants) from the membrane.

[SOURCE: ISO 20468-5:2021, 3.1.1, modified — the term “backwash” has been replaced by “backward flush”; in the definition, “water” has been replaced by “feed water or permeate”.]

3.7.1.6
chemical cleaning
removal of membrane foulants accumulating on the membrane surface or within the membrane pores using a chemical reagent solution

3.7.1.7
cleaning in place
CIP
membrane cleaning (3.7.1) by impingement or circulation of flowing chemical solutions, without disassembling the membrane *element* (3.1.10)

3.7.1.8
pickling
removal of oxides or other compounds from the material surface of the desalination system by chemical or electrochemical action with an acid solution

3.7.2
agents dosing
dosing chemical agents to *seawater desalination system* (3.1.2) for maintaining the operation of the device and ensuring the *product water* (3.1.6) quality

3.7.2.1
biocide
disinfectant
chemical agent used to suppress the growth or kill bacteria and other microorganisms on the inner surfaces of intake pipes, equipment, tanks, distribution channels, and other structures which are in contact with the raw seawater

Note 1 to entry: The two primary categories are oxidizing biocides and non-oxidizing biocides.

3.7.2.2
flocculant
chemical agent used to bridge the molecules or colloids suspended in *feed water* (3.1.4), and facilitate the agglomeration of small flocs into larger flocs

3.7.2.3
coagulant
chemical agent used to assemble the dispersed colloidal particles to form larger clumps, and enable these particles to settle down due to gravitational force

3.7.2.4
defoamer
chemical agent with surface active properties for reducing and hampering the formation of foam in the desalination processes

3.7.2.5
antiscalant
AS
chemical scale inhibitor or sequestering agents that minimize the potential for scale precipitation on the reject surface of membranes and heat transfer tubes

3.7.2.6
reducing agent
chemical agent used to remove residual chlorine from the *feed water* (3.1.4)