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Desalination Systems

Clients: ARAMCO – Atkins – Jubail Royal Commission KSA – Environment Agency – Qatar QIN

Desalination – An Increasing Need

Desalination has been known to history for millennia though in a limited form. The ancient Greek philosopher Aristotle observed: "salt water, when it turns into vapour, becomes sweet and the vapour does not form salt water again when it condenses". He also noted that a fine wax vessel would hold potable water after being submerged long enough in seawater, having acted as a membrane to filter the salt. Desalination was never feasible on a large scale until the modern era. Particularly in arid zones, such as the middle East, desalination forms the main source of fresh water.

Climate change is altering rainfall patterns and hence the distribution of naturally occurring fresh water. Desalination is increasingly being used to provide drinking water around the globe. Desalination plants have been built at small and large scales. Whilst a small installation might provide a few tens of litres per second the largest plants are exemplified by the Ras Al-Khair Power and Desalination Plant which generates 11.5 m^3s^{-1} of high-quality water. It is a hybrid system based on a number of MSFD and RO plants which require waste heat and electrical power. The waste heat is derived from the secondary steam generator condenser cooling attached to CCGT plants.

Desalination remains an expensive option and one that creates environmental problems that must be addressed.

Desalination Outfall Discharges

Numerous desalination processes exist but those mostly in use at commercial scale which require an outfall are Reverse Osmosis and those based on heat such as Multi Stage Flash Distillation and similar systems.

In all cases effluent is more saline than the intake water. Depending on the system used the effluent could have a salinity of up to about 60 psu,

Discharge from an MSFD Desalination plant

or nearly double that of open ocean water. Some systems, such RO, need to flush the membranes with chemicals. MSFD systems may have very large discharges with elevated temperatures but only mildly elevated salinity. The elevated salinity increases the discharge density and despite any increased temperature the plume is most likely to be denser than the receiving waters and will tend to sink.

Environmental Impacts

The elevated salinity and a sinking plume lead to potential impacts on the seabed with negative consequences for the benthic ecology. Benthic species can of course tolerate a limited change in ambient salinity and this tolerance is also time and species dependent. In some cases, the uplifted temperature has more impact than the increased salinity such as in the Gulf of Arabia where water temperatures are already very high. A further potential impact arises from the discharge of membrane cleaning chemicals such as sodium metabisulphite (SMBS). Widely regarded as lethal at only 50ppm this chemical can spread over a large area over time.

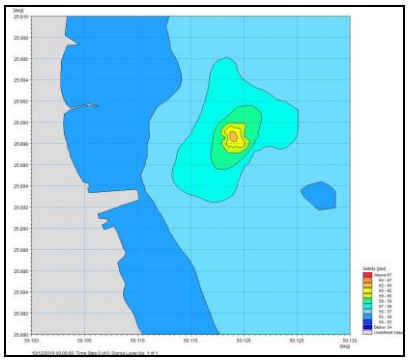
Regulatory Challenges

Two challenges must be faced. Firstly, a robust analysis is required order to convince the regulator that the environmental impact will be acceptably low if the design is to succeed. The design even at the EIA stage must attempt some optimisation of dilution and outfall location. Finally sufficient analysis is needed to support detailed design.

Regulations are generally based on limiting the zone within which high concentrations can be found which is referred to the as the zone of initial dilution. The concentration distribution is strongly influenced by the diffuser design. A poor diffuser may be 50 times less efficient at dilution than a well-designed diffuser.

Modelling Systems

TechnoEconomica has completed numerous projects in which the distributions of temperature, salinity and SMBS have been modelled with accurately calibrated 3D models. We have provided input to ecological analysis, EIAs and initial design and diffuser location and configuration optimisation.



Services Provided

- Specification of marine surveys
- Analysis of survey data
- 3-D Modelling of thermal and saline discharges
- Prediction of the long-term evolution of the salinity and temperature distribution
- Diffuser optimisation and design support
- Helping the client to navigate the regulatory issues

Contact

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