Filtration+Separation November/December 2016

Desalination

Desalination technology in power generation

The International Desalination Association (IDA) is predicting that within a year, 93% of all new power generation plants will be based on membrane technology using reverse osmosis. This article investigates both the use of desalination technology and filtration and separation technology on power generation sites.

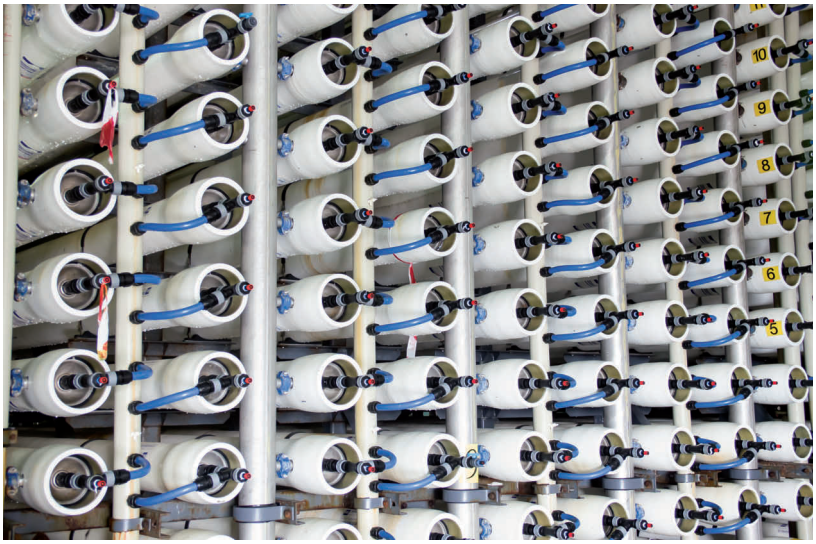
There are some recent large-scale projects where power generation has been co-located with potable water production and other projects where filtration and separation technology has been used to deal with treated water required to feed into the power system, or where wastewater treatment is required and minimal or zero liquid discharge projects are needed. These projects involve recycling and reusing water on site to reduce their environmental impact and increase energy efficiency.

Here, industry experts involved in delivering the advanced technologies employed in the sector, discuss aspects of some of the projects and future developments in the industry.

Global trends

According to the IDA, an increase of 3.7 million m^3 per day of desalination capacity was added globally from June 2015 to June 2016. There has been an increase in large scale projects resulting in almost 60% of the new capacity being installed on utility projects. The main industrial applications for desalination technology during 2015 were in refining/chemicals, pulp and paper, and power, with the latter accounting for approximately 100,000 m^3 per day of new capacity for stand-alone systems specifically installed in the power industry.

The IDA is predicting that in the current year, only 7% of all new plants going online will incorporate thermal processes, while the majority will be based on membrane technology utilizing the reverse osmosis (RO) process. Out of the 11 new thermal plants likely to come on stream, only three will include multi-



Reverse osmosis membrane technology – predominantly used in desalination systems. (Image: Fat Jackey/Shutterstock)

stage flash (MSF) distillation; the majority will employ multiple effect distillation (MED) technology.

Manoj Sharma, vice president and general manager at Aquatech International said: "Over the last 20 years, desalination on a large scale has always included thermal technology like MSF, particularly in the Middle East. However, in the last 10-20 years, RO has taken over from thermal on the large-scale projects because it is more energy efficient. We are seeing thermal technologies being phased out except for industrial applications where waste heat is available."

This discussion of the application of desalination technology within the power industry covers two areas: the large utility projects where power generation and potable water production facilities are co-located, and smaller stand-alone niche projects where desalination technologies are deployed within the power generation system.

Co-location projects

Tom Pankratz, industry consultant and co-author of the IDA yearbook, explained that co-locating power plants and large scale desalination systems producing potable water may allow the two facilities to share infrastructure, particularly cooling water intakes and outfalls, and, in the case of thermal systems, the desalination plant can use some of the low-pressure steam available.

Membrane desalination using RO generally uses less electricity, has a lower capital cost and does not require cooling water, so has become the dominant technology, replacing many thermal plants. In the Middle East, most of the recent power plants in countries that are part of the Gulf Cooperation Council (GCC) have been developed in conjunction with a desalination plant by the private sector. These are referred to as independent water and power projects (IWPP) and the government gives the developer a sovereign guarantee to buy the water and electricity outputs at a fixed price for 25-30 years.

Leon Awerbuch, director and dean of the desalination academy at the IDA, has identified a number of key projects which are major IWPP developments.

The Tianjin co-located plant in China (Image: IDA)

Tianjin Beijing

One of them is the power and desalination system located in South China in the Hangu District along the Bohai Sea. The power plant is a highly efficient, large-scale engineering system, comprising power generation, seawater desalination, built by IDE Technologies Ltd, and salt production from the MED plant blowdown (brine) stream.

"The plant is managed as an integrated system and is representative of a developing model in China. Traditionally, power, seawater desalination and salt production from brine had all been seen as independent processes," Awerbuch explained. The facility includes eight desalination units providing a total plant capacity of 200,000 m^3 per day and one of its key features is the independent operation of the electrical power station.

The 4 x 1000 MW ultra-critical coal-fired power station uses a sliding pressure control system. In this system, the boiler steam is regulated using pressure control in proportion to the generator output. This operation mode enables the steam quality at the turbine inlet to be altered while maintaining constant volume flows.

"Tianjin is capable of varying its electrical power generation during times of peak water demand and vice versa," Awerbuch added. "As a result, the desalination plants can operate across a range of steam supply conditions, adjusting output between 40% and 100%. The change in motive steam pressure also affects the gained output ratio (GOR) of the plant in the range of 11 (1 unit-weight of steam generating 11 of desalinated water) to 15, but the units operate at full water production of 25,000 ton per day at all motive steam pressures. The power consumption is 1.5 kWh per ton of distillate."

Az Zour North

Phase 1 of this project is a co-located plant in Kuwait that was fully commissioned in June 2016, the successful result of the first public-private partnership in Kuwait. The Az Zour North facility is Kuwait's first independent power station and desalination plant, providing 10% of the country's energy capacity and accounting for around 20% of its desalination capacity. The project took two years to build and involved the construction of a combined cycle gas power plant generating 1500 MW and a seawater desalination plant with a capacity of 486,000 m^3 per day incorporating MED technology.

Leon Awerbuch explained what is unique about this plant: "The desalination units are some of the largest commercially operating MED units. There are 10 SIDEM MED desalination units, each generating 49,300 m^3 per day. But most importantly, there is the ability to lower the process power consumption. This can drop to 0.9 kWh per m^3 with a GOR of 11."