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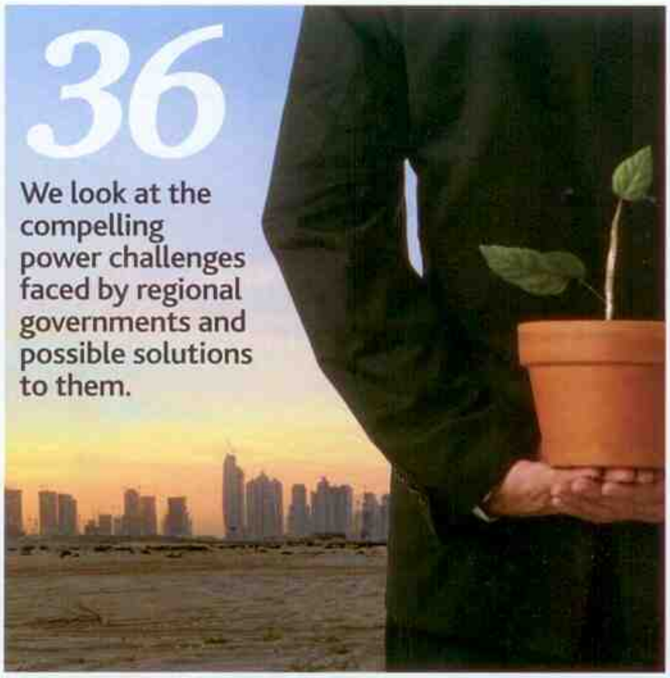

We look at the compelling power challenges faced by regional governments and possible solutions to them.

INSIDE:
The Climate Control Conference, Al Khobar
EVENT CATALOGUE

PLEASE NOTE
Due to unavoidable circumstances, Part 8 of our Spotlight section on air filtration will appear in the October issue.
–Editor

A TOWERING SOLUTION

Seawater cooling tower system design is decidedly an economical and greener alternative to the conventional direct seawater cooling, especially in the OGP sector, argues Aslan Al-Barazi. He demonstrates that it has other collateral advantages, as well.

INTRODUCTION

Seawater cooling is regularly used in the Oil, Gas & Power (OGP) Sector in the Gulf region in the form of direct (once thru) seawater cooling. However, there is another alternative – the conventional design may be altered to make it a seawater cooling tower system design – rendering it a more cost-effective, optimum and environmentally friendly solution. There are several salient reasons why seawater cooling tower system design has an advantage over direct seawater cooling. This article compares the two systems in the context of the region.

SEAWATER COOLING TOWER VERSUS DIRECT SEAWATER COOLING

In the UAE, Qatar and the neighbouring Gulf region, most of the coastline is shallow till a distance of around one kilometre. Cold water is found in volumes sufficient for industrial cooling purposes, particularly on a large scale, only beyond this point. This aspect needs to be taken cognisance of in the context of seawater cooling. In the case of a direct seawater cooling system, 100% of the seawater enters the intake, and is then fully discharged at a different location.

In contrast, seawater cooling tower system design only requires five per cent of makeup water to run. This means that not only is the seawater intake station's overall cost substantially reduced in the latter case, but so is the cost associated with related expenses, like equipment, energy, and operations and maintenance.

Another advantage of seawater cooling tower system design is that it has a positive impact on the marine environment, as it serves a dual purpose:

- It protects the fish, which generally prefer seawater intake habitats, owing to the availability of abundance of food, and, thus, face the danger of being sucked into the system, when in close range.
- It eliminates the chance of plant shutdown due to fish intake abundance.

A seawater cooling tower system also ensures that the bleed rate (approximately 2 ½% of the total water flow) returned to the sea will have the same temperature as the ambient temperature of the seawater. In comparison, direct seawater cooling system normally increases the seawater temperature by at least 10°C, if not more. Here, it should be noted that recently, the government authorities in the UAE have put in place a Delta T regulation for seawater return temperatures of 5°C above the temperature of the ambient sea. However, in reality, it is a difficult regulation to comply with. This is because even though the Delta T is reduced, it comes at the cost of higher cold sea water flow rate, as the following heat transfer formula demonstrates:

$Q = mc(t2-t1)$ clearly

shows, where Q = heat rejection, m = sea water (mass) flow rate, c = specific heat capacity of water, and (t_2-t_1) is the Delta T change of temperature in the sea.

Thus, by reducing the allowable Delta T of the seawater discharge temperature through regulations, more cold seawater flow rate is required to match the same heat rejection design requirement, which translates into higher pumping/piping costs. Add to this the environmental effect of overall seawater thermal heating, and it becomes an open-and-shut case.

For the sake of a credible debate, it can also be argued with a certain degree of veracity, that the cooling tower, too, discharges heat into the ambient air through evaporation, instead of into the sea. It, then, boils down to the question: Which is less damaging to the overall environment – heat discharge into the air or the sea?

Given the fact that the Arabian Gulf is inherently shallow and relatively stagnant compared to the Indian Ocean, it is evident that the Arabian Gulf faces a greater risk of being prone to environmental damage in the region, as there is a plethora of marine life and ecosystem directly affected by over-heating of seawater – one of the fallouts of direct seawater cooling.

On the other hand, in the case of seawater cooling towers, the heat is discharged into the air through the process of evaporation. It may, therefore, be argued that the effect on the environment is more indirect – that too, only in the long-term, affecting the overall global cycle, as opposed to the short-term regional cycle, as is the case with direct seawater cooling, where the marine environment is directly affected due to rise in the seawater temperature.

Another tangential, but pertinent, point that needs to be noted here is that the effect of an increase in seawater temperature on the environment is particularly damaging in the case of some of the big projects, which typically have seawater flow rates in the range of one to two million gallons per minute. The environmental damage is multiplied in our region, as already explained above, with an average Gulf Basin depth of only 35 to 40 metres. The problem is compounded as the water is comparatively stale, as it has been observed that in the Arabian Gulf region, it takes an average of three to five years for the Gulf water to renew itself. This is due to the fact that the water has only a small bottleneck area to discharge at the Strait of Hormuz. The discharge takes place with the aid of the North Westerly winds, whilst tackling opposing forces of the incoming Indian Ocean water currents from the other side inwards to the Arabian Gulf.

Another important point is that the sea temperatures in the winter can absorb the direct once thru seawater cooling heat rejection due to lower winter sea temperatures. This is not so in the long summer months, when the temperature of the sea is already high. This has an adverse effect vis-à-vis the marine ecology. To add to it, the substantial sea water temperature increase from the heat rejection of the direct seawater cooling is enough to destroy major marine life and ecology.

During summer, the seawater temperature can reach between 36°C and 40°C in coastal areas, with a further 5°C increase from once thru direct seawater cooling. This computation is applicable, of course, in the case of a best-case scenario, if the regulations put in place are strictly followed. But realistically speaking, the temperature of the water can rise between 41°C and 45°C. This is sufficient to destroy any marine environment in the vicinity, considering the fact that most forms of marine life cannot survive above 41°C. The situation becomes further exacerbated if we factor in the oxygen reduction in the water.

In this context, rise in temperature of the seawater due to direct seawater cooling implies that the same discharge hot water will, over time, "recirculate back" and increase the temperature of the cold seawater intake temperatures required for the process, thereby degrading the thermal performance on the given industrial project, as well. On the other hand, seawater cooling towers would return the discharge bleed rate or blow down seawater at the same temperature as the sea itself, or even lower, if required.

SEAWATER COOLING TOWER IN DC APPLICATIONS

Seawater cooling towers are also advantageous when considered for district cooling applications. Traditionally, district cooling uses

A SEAWATER COOLING TOWER BLEED RATE IS ONLY TWO PER CENT COMPARED TO 100% THERMALLY POLLUTED WATER IN THE CASE OF A DIRECT SEAWATER COOLING.

copious amounts of potable water, which is scarce in the region. In cases where Treated Sewage Effluent (TSE) water is a potential source for district cooling (which in itself is a topic of debate), there is normally not enough of it available or enough generated on a typical project to meet the required demand.

Assuming that it is, by the time it is turned into "polished TSE", after removing all the harmful elements from it, it works out to be as expensive as potable water. Reverse osmosis could be a solution, but it, too, is prohibitively expensive and generates a lot of carbon emission, which obviously is harmful to the environment.

Opting for seawater in district cooling design not only eliminates the problem of water scarcity but also has many advantages: the first one is cost reduction. The amount of water used in district cooling is estimated to be anywhere from 60,000 gallons per minute up to, but not limited to, one to two million gallons per minute. Out of this, water makeup is required at a rate of two per cent on an average of the water flow for potable water. This amounts to a hefty bill of millions of dirhams per year to the end user in water cost alone, apart from the operating cost of the plant room, in the case of potable water.

Seawater cooling tower, if used in a district cooling system, directly reduces the overall desalination water plant design cost, as also sizing and demand for water. Moreover, the overall energy cost empowering the desalination plants is also substantially reduced, when the desalination capacity is reduced. This, in turn, reduces the related power and space required for the desalination plant. The turbine's carbon emissions are also consequently reduced due to the reduced size of the turbine. Therefore, it can be deduced that seawater cooling tower proves to be a green alternative also due to the indirect reduction of turbine carbon emission.

A GREEN INNOVATION

The latest innovations and technological advancement in the seawater treatment process also aid in cutting costs and reducing collateral damage to the environment. A few companies in the sector use a technologically advanced water treatment process, which does not require treating the entire volume of seawater entering into the seawater intake. Instead, it requires to be treated only at the "surface level" of the seawater intake screen products. As an analogy, one can say that if you want to paint a room, you don't need to fill the room with paint, but paint only the walls. Thus, technological innovation presents yet another green solution. It can be deemed an alternative to chemically treating the seawater, whether in direct seawater cooling or seawater cooling tower system design.

The new technique does not involve the use of oxidants, ferrous sulphate or anti-scaling agents. The given product has the standard and proven characteristics of anti-fouling, anti-corrosion, anti-scaling, mussel-repellent qualities, apart from being biodegradable. The system works by migrating to the internal surfaces within the hydraulic system, forming a protective film at the molecular level, which provides treatment and protection of the system. This ensures that public safety is considerably enhanced by limiting or eliminating the use of chlorine by-products. Apart from this, marine life is also protected, particularly from harmful destructive chlorides. Also, heavy metal discharge is restricted and CO_2 emissions are reduced. Furthermore, it has no adverse effect on the human DNA. This becomes significant from the tourism point of view, in cases where sea resorts are located in the vicinity of industrial projects.

This aspect is particularly pertinent, considering the fact that there is only a limited seabank area available in the UAE, Qatar and the neighboring Gulf countries, where the industrial sector and the tourism industry have to compete in some cases for the same or neighbouring seabank area. It is, therefore, not uncommon to see an industrial project and a sea resort nestling together.

As stated earlier, a seawater cooling tower bleed rate is only two per cent compared to 100% thermally polluted water in the case of a direct seawater cooling. The effect of the industrial pollution on the neighboring tourism project, therefore, is only a fraction in the case of sea water cooling tower.

CONCLUSION

In conclusion, it can be stated that a seawater cooling tower system design is a proven technology that works well, thanks to several advantages stretching across several parameters already enumerated. But like all systems, it requires a proper design analysis from both technical and commercial aspects, and needs to be reviewed on a case-by-case basis. Each project needs to be evaluated, taking into account the parameters available to operate the system in an optimum manner for the benefit of the environment and the end user. ■

AN ASIDE

There is still the niggling question regarding old oil, gas and power installations that needs to be addressed. They generally operate with an outdated system design, with a Delta T of 10°C or more above the sea temperature. This may take the seawater temperature to 50°C or more. In such cases, it would be advisable to add a Seawater "Helper" Cooling Tower just before the seawater channel discharge, in order to reduce the temperature of the sea to within acceptable environmental limits.

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