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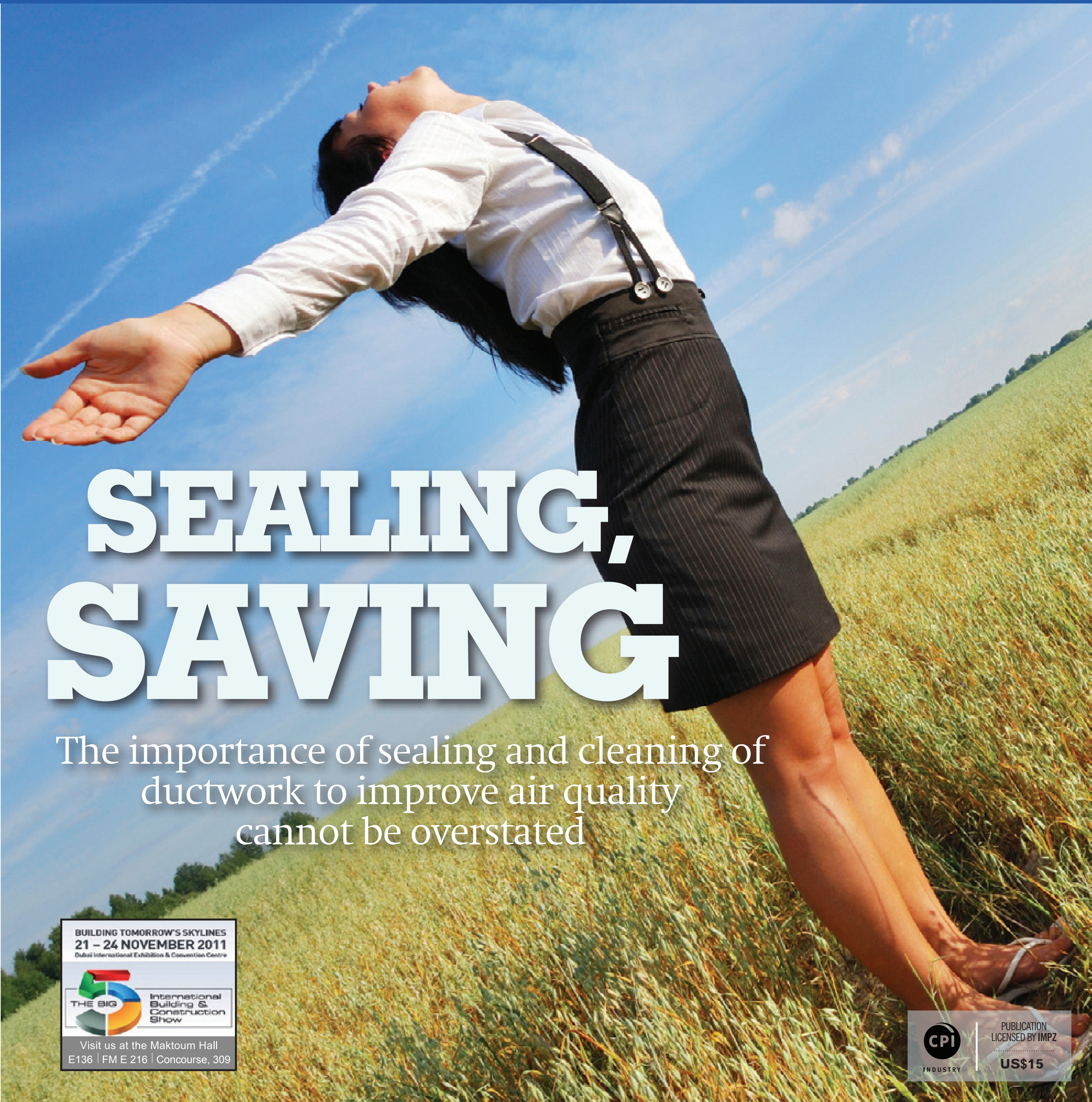
KEY PERSPECTIVES ON THE REGION'S HVACR INDUSTRY NOVEMBER 2011



SEALING, SAVING

The importance of sealing and cleaning of ductwork to improve air quality cannot be overstated

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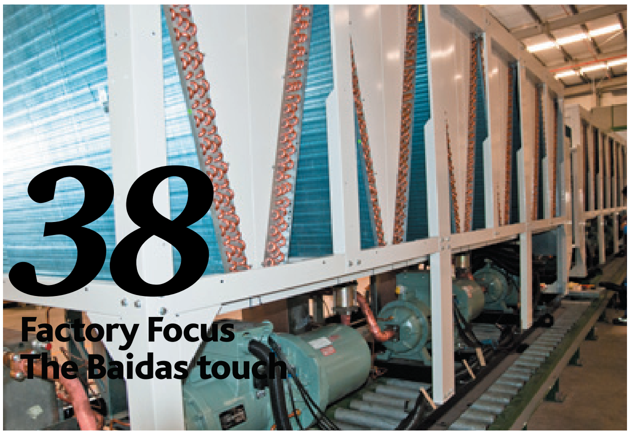


Part 2

GETTING THE DESIGN RIGHT

In this concluding portion of his two-part article, Aslan Al-Barazi focuses on solar water heating systems and general design guidelines

When designing a SWH system, one of the important design parameters required is the DHW average daily demand. Another important parameter is the cold water temperature design entering the SWH system. This temperature is critical to the optimum design of the system and should be chosen as accurately as possible, considering the variance in the cold water temperature from source during winter and summer time as well as during the day and at night. Normally, this is water coming from DEWA, ADWEA, SEWA or FEWA and should be checked with the authorities for the correct temperature variance; or, it should be averaged out on a monthly or yearly basis.

In the case of the design of storage tanks, the preference is for structures that are tall and relatively thin rather than short and wide. This is for optimised thermal stratification to occur, a phenomenon recommended for use in solar water heaters that takes place due to density difference between hot and cold water. In other words, tall and thin cylinders will ensure that the lighter hot water will be on top of the cylinder whereas the heavier cold water will remain at the bottom of the cylinder, where it should also be noted, the solar heat exchanger should be located, plus the cold water draw-off, which is being pumped into the solar panel circuit. In such a storage tank design, solar thermal energy transfers efficiently to the cold lower part of the storage tank in a section of the tank, termed as the dedicated solar water heating volume as opposed to the auxiliary water heating volume, located above or, possibly, in a separate storage tank.

Another important key design feature in a SWH system design is the controls in the system. In order to ensure the hot water reaching the source is always consistent and not fluctuating due to weather conditions or late-night hot water demands, it is key to ensure proper coordination between the SWH and back-up heating source through the appropriate usage of automatic controls. In other words, the automatic controls ensure that the hot water reaching the tenant is consistent and not fluctuating. When viewed from another angle, when the hot water becomes too hot, the automatic controls prevent the system from getting too hot and allow the hot water to come conditioned, as required and, therefore, eliminate the risk of scalding.

> THE PIPING BETWEEN SOLAR PANEL, STORAGE TANK, AUXILIARY HEATING SOURCE AND HOT WATER TAP SOURCE SHOULD BE AS CLOSE AS POSSIBLE TO EACH OTHER.

Solar water heating applications are not only limited in design to DHW but may also be integrated to extended hot water project requirements, such as swimming pool water heating, and particular types of washing machines and dishwashers, which allow for independent hot water supply to the units, as well as other applications.

SOLAR FLAT PANELS OR EVACUATED TUBE COLLECTORS?

This is a frequently asked question, and the answer is largely dependent on the region one is in (cold or hot), as well as the delta T temperature the design requires. Evacuated tube collectors (ETC) are normally used for cold or very cold regions as well as for industrial applications. For our region, a solar flat panel is more than sufficient. A solar flat panel normally achieves hot water temperatures, ranging from 50ºC to 80ºC, which is more than suitable for our region, considering the abundant sunlight in our region. ETCs are also much more expensive than the flat-panel systems.

Another important design consideration is aesthetics of the building. In the case of villas with an inclined roof, the panels may be installed ‘flush with the roof’ as an integral part of the roof surface, whereas the ETCs will literally bulge out of the roof surface.

In terms of International Standards applicable on a SWH panel, Solar Key Mark Certification is the key standard in Europe; in the US, it is the Solar Rating and Certification Corporation (SRCC).

Another element that needs attention is the manufacturing process. Indeed, the welding of solar panels deserves consideration. Some manufacturers, for example, excel in terms of quality by providing laser welding in the critical part between the solar absorber and integrated pipe heat exchanger, as well as laser cutting automated manufacturing techniques and methods for highest quality duration, seconded by a long-term warranty of up to 10 years for the solar panel.

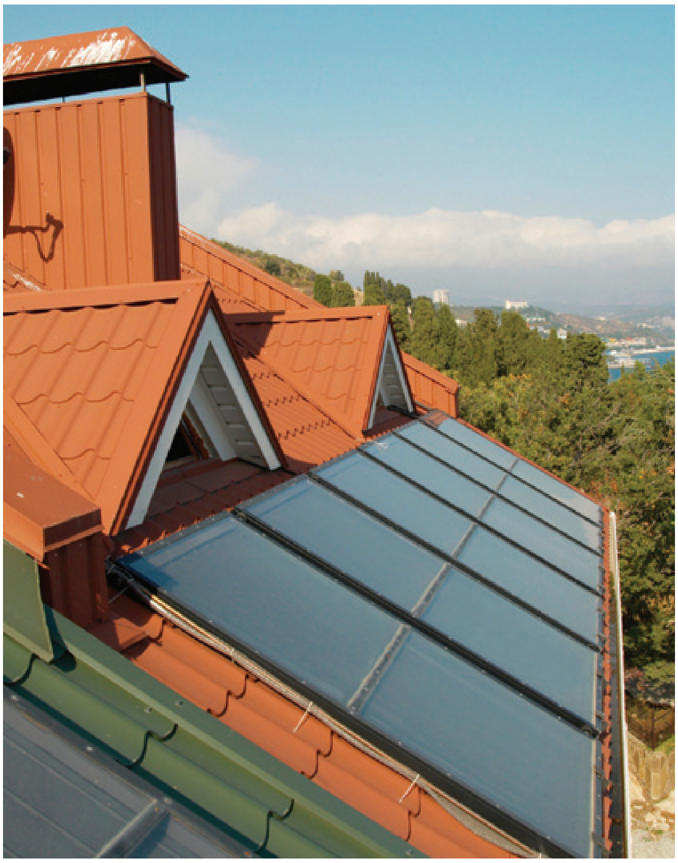
With regards to the choice between a thermo-syphoning (natural convection) system and a system utilising a solar pump, also known as Forced Draft System, the latter would clearly be preferred in our region. There will be a little extra energy spent on the pump, which is around 2-5% in ratio compared to the total solar energy produced by the solar panel (unless the pump is also run by an inbuilt Solar PV). In either case, an electric or solar PV pump is worth it from a safety design point of view as well as a flexibility of design and choice of allocation of the solar panel, relative to the storage tank and related system. Additionally, a solar pump-run system will mean that when the solar panel overheats up to a point, the solar pump speed (if VFD-driven) can be increased accordingly and can remove the heat from the solar panel as fast as possible.

WITH REGARDS TO THE CHOICE BETWEEN A THERMO-SYPHONING (NATURAL CONVECTION) SYSTEM AND A SYSTEM UTILISING A SOLAR PUMP, ALSO KNOWN AS FORCED DRAFT SYSTEM, THE LATTER WOULD CLEARLY BE PREFERRED IN OUR REGION

Consequently, this cools the solar panel somewhat, allowing further heat gain. The removed heat is, then, transferred to the storage tank or other areas, including swimming pools, washing machines and dishwashers or heat dump areas. A solar pump-run system has the added advantage of placing the solar panel and storage tank flexibly whereas with a thermo-syphoning system this is not the case, as it is governed by the laws of natural convection, wherein the solar panel must always be located below the storage tank for natural convection to occur efficiently. In the latter case, not only does the risk of overheating substantially increase in very hot summers, but even the speed of heat transfer is much slower than a solar pump-run system.

Solar factor and system efficiencies are inversely related to each other. If you have fewer solar panels, the solar energy will, in theory, be fully transferable to the final hot water taps. But as the solar panels (solar factor) increase for the same project demand, excessive heat potential starts to occur and heat wastage and unnecessary heat build up (at the solar panel, storage tank as well as the system itself). Heat losses from the solar panel to the system and to the storage tank begin to occur. There is a trade-off between increased solar factor, system efficiency and value for money on the project.

From our regional weather perspective, several design points need consideration. Given how dusty the region can get, it is important to regularly clean the dust from the solar panels either manually or with an automated, self-cleaning device. As the weather is continuously humid and corrosive, it is useful to consider corrosion-free material for all steel components in the solar panel and other exposed heat exchangers (stainless steel) as well as pipes (FRP), continuously humid and corrosive, it is useful to consider corrosion-free material for all steel components in the solar panel and other exposed heat exchangers (stainless steel) as well as pipes (FRP),



perspective

and storage tanks if they are exposed to the outsider air.

How does an engineer size the number of solar panels and total required square area for their given project?

1. First, he would calculate the annual average consumption of hot water per household (40-50 litres is the average daily use per person)
2. Next, he would multiply this by the solar factor (a solar factor of around 60-70% can be assumed in this region)
3. He would, then, calculate the average available solar energy per unit area of a solar panel unit (at the set angular tilt of the panel). He would note the solar irradiation value (around 1800-1900 kWh/m^2) at the given tilt angle of the solar panel (a 20-degree angle tilt can be assumed)
4. The engineer then needs to know how much of this value remains at the final destination point at the hot water taps after all system energy losses are computed. He needs to multiply figure 3 by the calculated or assumed system efficiency for the final destination point of the solar energy from solar panel to the hot water tap point (system efficiency can be assumed around 35-40%)
5. He can, then, calculate the required solar panel square area per individual household. This value is reached by dividing the total hot water demand relying on solar factor (2) by the system efficiency per solar panel unit area (4). It is not uncommon to arrive at a figure around 1-1.1m^2 (solar panel area)/resident in this region.

FROM OUR REGIONAL WEATHER PERSPECTIVE, MANY DESIGN POINTS NEED CONSIDERATION. GIVEN HOW DUSTY THE REGION CAN GET, ONE NEEDS TO REGULARLY CLEAN THE DUST FROM THE SOLAR PANELS EITHER MANUALLY OR WITH AN AUTOMATED SELF-CLEANING DEVICE

LARGE SOLAR SYSTEM DESIGN VS SOLAR DOMESTIC WATER DESIGN

Large capacity applications such as hotels, hospitals, and commercial or mixed-use large buildings differ in solar design from a small domestic use application on several fronts. Solar panels are normally split into rows in a parallel or series circuit formation, as opposed to a long sequential line formation of panels, so as not to make the pump work too hard in pumping the fluid across the whole line of resistance of solar panels.

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