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SUPPORTING THE MARKET IN DESIGNING SOLAR THERMAL SYSTEMS

The recent increase in the uptake of commercial solar thermal systems in the UK has predominantly been driven by local authority planning consent requirements for up to 15% of the building's energy requirement to be derived from some form of renewable technology. This has revealed a huge knowledge gap amongst designers, engineers and contractors within the heating and ventilation sector regarding the design of non-domestic solar thermal systems. Yan Evans, Technical Director of Andrews Water Heaters and Potterton Commercial outlines some critical design issues that need to be addressed to ensure a successful installation.

The issues detailed below are some of the key factors to consider when designing the more complex solar thermal solutions that are now appearing in the designs of commercial buildings to support reduced energy usage and carbon dioxide emissions. As a solutions provider into this sector of the renewables market, we cannot overstate the importance of involving suppliers, such as ourselves, in the early stages of a project's development. . This could be during the feasibility stage, when formulating the performance specification or when developing the final mechanical design, through to installation and system commissioning.

When designing larger solar thermal solutions for commercial applications, such as, schools, colleges, office developments, hotels and larger residential schemes, there are a number of issues that need careful consideration over and above those of a domestic solar hot water system. These considerations include the solar collector array configuration, the selection of the storage cylinder, hydraulic design and the control strategy. /MORE

Every day we are consulted on these aspects and provide applications engineering support, thereby assisting in bridging the knowledge gap whilst helping to educate the market.

Collector Configuration

For large solar thermal systems it is not possible to connect the entire solar collector array in a series configuration. This is due to a combination of internal thermal expansion within the collector header and high pressure loss across the array. The latter would require that a larger circulator be used for the solar heat transfer fluid, leading to higher 'parasitic loss' negating some of the carbon reduction benefit. Therefore, a large number of collectors would need to be connected in a combination of series and parallel circuits. On flat roof applications, the optimum angle of inclination to maximise the solar gain is between 30^{O} and 45^{O} from the horizontal when facing due south. When positioning rows of collectors, care must be taken to ensure sufficient spacing so as to prevent the collectors from shading each other during certain times of the year. Direct flow evacuated tube collectors offer greater flexibility with regard to installation as they can be placed flat on a roof and each tube rotated by +/- 25^{O} to optimise orientation and collector absorber angle, thereby significantly reducing occupied roof space.

Solar Storage Cylinders & Legionella Control

One of the key elements of the solar thermal system is the hot water storage cylinder. In the commercial arena, due to the higher daily hot water demands, the volume of stored water is inevitably much larger than for cylinders used in domestic solar thermal solutions, and can amount to several thousands of litres. To maximise the contribution to hot water production the solar cylinder should ideally be selected on the basis of the daily hot water demand. The daily hot water demand can be partly determined with reference to CIBSE Guidelines and BS6700.

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The ‘Size-IT’ programme developed and distributed by Andrews Water Heaters can also be used as an indicator and during 2009 a section is being designed to provide guidelines on the selection of solar thermal systems, Including storage and collector array sizing for glazed flat plate and evacuated tube collectors.

Selecting the capacity of the solar cylinder in this manner will result in an average of around 30% to 40% of the hot water load being satisfied by the solar thermal system. This percentage is referred to as the Solar Fraction (SF). A well designed solar thermal system may be able to achieve a SF of 100% in the summer months alleviating the need to burn fossil fuel in a boiler or water heater to generate hot water. In the colder winter months the SF may be as low as 15% requiring energy from the primary heating appliance to meet the hot water demand.

In the commercial sector M&E, public health engineers have to design hot water systems in compliance with L8 legislation. Solar thermal systems are no exception as they can present risk of legionella bacteria developing. During certain times of the year, due to the lower available solar irradiation, the temperature of the stored water can be as low as $20^{O}C$. Water temperatures of between $20^{O}C$ and $45^{O}C$ promote the development of legionella bacteria and this risk must be appropriately managed and mitigated. Therefore the solar thermal system must be controlled such that heat from the primary heating appliance is supplied to the solar cylinder at 60℃. This is the correct temperature to pasteurise the cylinder and must be held for a period of time, usually an hour.

Selecting the correct volume of stored water per m^2 of solar collector array is a critical factor in the success of the solar thermal installation. For glazed flat plate collectors the rule-of-thumb is 50 litres of stored water per m^2 and for evacuated tube collectors the value increases to 70 litres. The latter is due in part to the higher thermal efficiency offered by evacuated tube collectors. In both instances the ratio is selected to optimise the Solar Fraction but also to prevent frequent collector stagnation.

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Hydraulic Design

It is not simply an issue of using larger pumps with higher pressure loss capabilities in commercial solar thermal solutions compared with domestic systems. The configuration of the collector array, the diameter of the main flow and return pipework, the flow rate of the heat transfer fluid (a pre-mix of 60% water and 40% glycol), the volume of the solar cylinder and the surface area of the indirect coil in the solar cylinder, all have an influence, not only in energy transfer from the solar circuit but also in preventing the solar collectors from stagnating too frequently, leading to damage to the absorber in the long term. All these issues must be considered and help is on hand from manufacturers and solutions providers.

Mixture of Technologies

Some of the above issues are not at all obvious to many engineers which could raise design and practical issues during the period of installation. Although a mature concept within the domestic sector, the use of solar thermal systems on commercial buildings is still relatively new. Local authority planning consent and ever demanding building regulations will continue to accelerate the use of such systems to assist in delivering low carbon heating and hot water solutions.

Life is, undoubtedly, becoming increasingly complex and difficult for the building services engineer. In some cases a combination of technologies within the commercial plant is necessary to deliver the desired reduction in carbon dioxide emissions. Some technologies work well together, others do not, and caution must be applied when considering combinations of heat sources. For example the combination of a solar thermal solution for the production of hot water and a ground source heat pump for low grade heating (such as under-floor heating) offers of an excellent combination as the heat sources are not in conflict with one another. However care needs to be taken when considering for example combined heat & power (CHP) solutions and solar thermal.

During summer months when the performance of the solar thermal system is at its peak, the CHP unit also requires access to a certain amount of hot water load to sustain operation.

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In this situation, if not sized and selected correctly, the two technologies would ‘fight’ against each other to gain access to the load.

The commercial heating sector has some interesting times ahead with equipment manufacturers and solutions providers having a huge role to play in ensuring that the low carbon solutions selected are appropriate for the application and deliver real emission reduction benefits.

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(By-line for Building Services & Environmental Engineer)

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