Heat recovery air conditioning is key to future building efficiency

Well designed and implemented, heat recovery air conditioning can reduce building heating costs by 40 to 50 per cent. It offers a major opportunity to cut building running costs and deliver a high quality environment for occupants, says David Dunn of Toshiba Air Conditioning...

Building owners and operators are now highly receptive to the case for heat recovery air conditioning. With year-on-year increases in energy costs forecast, and mounting pressure to cut carbon emissions, we believe that the age of high performance heat recovery has arrived.

Well designed and implemented, heat recovery systems can reduce building heating costs by 40 to 50 per cent. It is not surprising that, after years as a nice-to-have option, heat recovery is now becoming a mainstream must-have, particularly as part of an integrated air conditioning solution providing heating and cooling, such as a modern VRF system.

In the early days, the additional cost of a heat recovery option was sometimes hard to justify in terms of the savings achieved. Capital costs for heat recovery-based VRF systems are typically 10 to 15 per cent higher than standard heat pump only systems.
Today, however, the combination of high energy costs plus modern high performance systems results in a rapid return on investment. Designed correctly, payback can be achieved within two years.

The pay-back time is shortened with every increase in energy costs. And, once pay-back has been achieved, savings continue to accumulate over the equipment’s lifetime. Add this to their flexibility and other advantages, and it is little surprise that nearly two thirds of systems sold in the UK today include heat recovery.

Heat recovery was introduced to VRF air conditioning in the early Nineties. It represented a major advance, for the first time enabling heat pump systems to provide simultaneous heating and cooling on a single refrigerant circuit.

The systems harness the energy in both liquid and vapour refrigerant to cool or heat an area of a building. Energy that was previously released to atmosphere via the condenser as “waste heat” is used productively instead to warm areas of the building requiring it.

Air-borne energy in a building that is surplus to local needs is absorbed by the refrigerant, recovered and redirected using FS (flow selector) boxes, installed within the air conditioning pipe work.

These contain a compact heat exchanger and solenoid valves, which control the flow of refrigerant, according to the current cooling and heating needs of the building.
A three-pipe system is traditionally used, with a dedicated pipe for discharge hot gas, liquid refrigerant and suction gas. Two pipe systems can be used, but involve a thermodynamic compromise that can affect performance, particularly where there is a low level requirement for heating on a circuit predominantly providing cooling.

For this reason, the heat recovery system of choice uses a three-pipe configuration.

Huge improvements have been made in recent years in the efficiency of heat recovery. Traditional R22-based systems were around 5 to 10 per cent more efficient than a conventional chiller. Today’s systems can deliver 30 to 40 cent savings, with most manufacturers able to achieve SEER ratings of 7 or more. The most efficient systems approach SEER ratings of 8.

This has been made possible by improvements in system design and key components, such as the introduction of multiple inverter-controlled compressors, allowing the system to be controlled to precisely match output with demand.

Other key areas include the design of heat exchange coils and, of course, choice of refrigerant. For our part, developments in the latest Toshiba SHRM-i heat recovery system, launched in January, have resulted in improvements in performance of up to 20 per cent in EER and COP. When part load conditions are considered, the improvements are even higher (see panel).
As a result, the popularity of heat recovery has soared and around 65 per cent of VRF systems sold in the UK today offer some form of heat recovery.

Because of the efficiency advantages, smaller footprint and improved comfort levels, sales of heat recovery VRF systems for replacement project have grown over the past five years at the expense of chillers.

Alongside this, the size of VRF installations has increased as manufacturers have extended the maximum permissible pipe lengths and vertical / horizontal distances within the building.

The rise in interest in two-pipe systems seen between 2008 and 2010, as a result of the downturn in economy, has once again given way to a focus on higher performing three-pipe systems, due to rising energy costs.

The opportunity here for building owners and operators is obvious. The key is making the energy / carbon / cost-saving case clear, and designing and installing the system to deliver the greatest benefit in terms of performance and savings.

Clients are increasingly conversant with Seasonal Energy Efficiency Ratio (SEER) and Seasonal Coefficient of Performance (SCOP) values in assessing equipment performance, which helps make the case.

In terms of design, it means normally opting for a three-pipe solution over a two-pipe, for the reasons highlighted, and
designing systems to offer the maximum variance of temperature across the system, in order to benefit from true heat recovery.

This needs to take into account the orientation the building in the lay-out of the VRF system, to produce a mixed load of potential cooling and heating, thereby optimising energy performance.

It is obviously helpful to focus on applications which will benefit most from the approach. Applications with greatest potential for heat recovery are those with mixed load requirements, such as hotels.

Adjacent guests wanting different temperatures in their rooms is a perfect scenario for heat recovery, as excess energy from one room can simply be transferred to the room or rooms requiring it.

The same principle applies to offices or multi-tenanted buildings. Heat gain from computers and people in one area can be used to warm other areas, such as meeting rooms, which are naturally colder and benefit from the “waste” heat.

There are still some consultants who prefer water-based products, in order to reduce / limit the amount of refrigerant contained within a building. With advances in leak detection and better trained engineers, however, the risk of leaks is now greatly reduced. Indeed, with the latest “fail-safe” refrigerant management systems, risk is effectively eliminated.

For the future, a key area of development is likely to be in controls, not just within equipment but at building level. The trend is for integration of heat recovery within the overall building services
system, to cater for the production of hot water from waste heat and the treatment of the building as a “single energy system.”

This is still in its infancy, but we see huge scope to bring all the pieces of the jig saw together to improve energy efficiency even further in the future.

_The author is General Manager of Toshiba Air Conditioning._

**PANEL**

New three-pipe heat recovery VRF delivers world-class efficiency

Toshiba’s latest generation of super heat recovery VRF air conditioners, the SHRM-i series, is the most efficient product on the market at part-load conditions.

The ground-breaking new range becomes the new industry benchmark in the competitive three-pipe VRF sector.

Toshiba believes performance ratings for systems at full capacity can be misleading. “In the UK, air conditioning only operates at maximum capacity for a small proportion of the time,” says David Dunn, Toshiba’s commercial director.

“For most of the time, systems operate at part-load – therefore it makes sense to focus on efficiency in this range.”

The new Toshiba system boasts a world-beating EER of 6.02 and COP of 5.63 at 50 per cent load (8hp unit). This translates into a Seasonal Energy Efficiency Rating (SEER) of 8, leaving rival systems behind.

A key to its exceptional performance is the use of up to three super efficient DC twin rotary compressors in each outdoor unit, with dedicated vector-controlled inverters.
Unlike other makes, which share inverters between compressors, Toshiba uses a separate inverter for each compressor, giving ultra precise control of rotation speed in 0.1Hz increments, exactly matching output to load.

IN addition, the latest Toshiba CD rotary compressors, operating on R410A, have a performance advantage over scroll compressors.

To achieve a target load, scrolls have to initially exceed the required capacity; rotary compressors however can deliver the required output without any overshoot, avoiding energy losses.

For more details contact Toshiba Air Conditioning on 0870 843 0333, email marketing.uk@toshiba-ac.com, or visit www.toshiba-aircon.co.uk