Ground-breaking conversion of critical Data Room WaterChiller from R22 to R422D / MO29

A refrigerant retrofit project, involving the conversion of a large Data Room cooling system from R22 to R422D (DuPont's M029), has been carried out by Business Edge. ***ACR Today*** *reports on a unique project*

A unique plant conversion took place last month at the corporate headquarters of a major financial services organisation in central London.

The chiller in question was originally designed and built by Mike Creamer and colleagues in 1998, just prior to the launch of Business Edge Ltd.

The Water Chiller, which has operated successfully 24/7 for 20 years, comprises two Bock F16 – six-cylinder compressors, each driven by 37.5kW Schorch motors, and equipped with 37.5 kW Yaskawa Power Inverters. The approximate cooling capacity of the plant is 400 kW.

This water-cooled machine is served by large cooling towers on the roof of the building. It is believed to be the

first VRF Water Chiller of its kind to have been constructed in the UK. The design is unusual, being based on variable speed reciprocating compressors rather than screw, scroll or centrifugal compressors.

The plant’s control system features full floating suction and floating head pressure control, delivering chilled water at a constant and precisely regulated 8°C. This was a key requirement of the project, in order to prevent excess latent cooling within the Data Rooms served.

The Data Room is critical for the organisation and the Water Chiller thus provides a vital service that underpins and supports their business.

There are several other water chillers in the building. However, as a consequence of its reliability and robustness, this is the only original machine still in operation. As a result, in view of the impending R22 phase out, the client asked Business Edge to evaluate the refrigerant retrofit options.

Mike Creamer, Managing Director of Business Edge, takes up the story: “This was an exciting challenge for us. From the beginning I had envisaged that our VRF

technology would ultimately allow the machines we were building in the late Eighties to be adaptable to alternative refrigerants in the future - and here was a perfect opportunity to at last put that into practice".

He added: "It enables the Water Chillers and DX Systems we were building at that time to maintain either precision temperature or precision suction pressure control for a group of evaporators, irrespective of changes of load at the evaporators, changes in ambient condition and indeed even a change in refrigerant characteristics."

Following initial research, Mike decided to concentrate on the Du Pont range of alternative refrigerants. Following technical discussions and a joint site visit, it was agreed that the most appropriate refrigerant would be MO29, ASHRAE Reference Number R422D.

Mike says: "Given the critical nature of the application, it was important to prepare all tools and equipment, consumables and recovery cylinders in such a way as to allow us to retrofit the machine with MO29 - and then run a performance evaluation test using the ClimaCheck Performance Analyser.

If that revealed a problem, in terms of refrigerant efficiency, performance or oil return at low refrigerant velocity, it would allow us to recover the M029 and recharge the R22 immediately, in order to keep the machine running and ensure business continuity for the client.”

The VRF technology at the site uses a special lubricating oil and expansion valve to enable the compressors to run at only a few hundred rpm for extended periods. Oil separators are fitted to each compressor. The refrigeration design of this machine is such that liquid refrigerant can actually be allowed to flash in the liquid line at low load condition without any impairment to performance.

“Return of oil to the crankcases of each compressor is vital. Given that the large shell and tube evaporator is sited below the compressors, the lift of this oil via adequate suction pipe velocity and miscibility was a key aspect to consider”.

Having made the necessary preparations and assembled tools such as recovery machines, cylinders, vacuum pumps and so on onsite, work on the conversion commenced.

The first task was to recover the R22 refrigerant from the chiller and system. We had also decided to replace a number of 20 year old peripheral items, such as shut-off valves, oil line pipework, oil filters, HP and LP safety switches at this time.

Some replacement refrigerant lines were run in copper with suitable anti-vibration loops. The remainder were run in Gomax flexible plastic tubing, terminated at each end with special brass compression nuts and olives.

The flexible lines are quick and easy to install, since the process of careful pre-shaping and routing of copper pipework, especially if one wishes to achieve a neat job, is far more readily achieved with this method.

Once all the replacement ancillary components and interconnecting pipework had been fitted, a Leak Pressure Drop Test was carried out on the entire system. Compressors were isolated via their Service Valves for the following reasons:

- These were known to be sound in terms of leak-tightness as a result of recent and regular service visits

- It had been previously noted that the compressor shaft seals occasionally leak when subject to nitrogen pressure testing, yet do not leak when under refrigerant/oil pressure. In light of this, we decided that the compressors would be checked with an Electronic Leak Detector, once the system had been charged, re-commissioned and put into service.

The Condenser Water Flow Switch had been observed sticking on occasion, so this was replaced. Special steel nipples were manufactured to facilitate this.

To protect the Compressor Shaft Seals, a Leak Test Pressure of only 8bar was applied over an extended time period, and all new joints checked with a Leak Test Solution. As a result of careful workmanship, only one leak was found among all the new joints made. This minor leak was detected at a compression joint between a Tee and the Gomax flexible tubing. This was quickly repaired and the system again pressurised for the final Leak Pressure Test. Once all the joints had been leak tested and passed, the test solution residue was carefully cleaned up.

During the extended Leak Pressure Test was under way, the electronic controller and main control panel were also

checked in readiness for ultimate start-up and re-commissioning.

Three high performance vacuum pumps were used to evacuate and dehydrate the system to less then 4mbar / 6 Torr. Having achieved a satisfactory vacuum and Vacuum Rise Test, the team then began charging the system with the new refrigerant, Du-Pont's M029, otherwise known as R422D.

Mike says: "It was fortunate that we had reached this stage without difficulty as we then received news that the temporary cooling brought in to maintain conditions in the Data Rooms was struggling, with the temperature steadily rising and already at 28°C!"

IDS / Du Pont supplied the refrigerant in high quality cylinders with a Tare Weight of 8.45kg. The net content was approximately 20kg per cylinder. The cylinders featured a single valve / single port type arrangement, with a dip tube to enable liquid to be drawn from the cylinder without the need to invert. A nice touch, reports Mike, was the inclusion of a bottle adaptor of high grade quality plastic fitted to every cylinder.

The team then used a ClimaCheck Performance Analyser to monitor the refrigerant charging process and the general running condition of the Water Chiller.

After injecting the first liquid charge directly at the large liquid line drier Schrader Valve connection, we progressively ran the machine under controlled speed conditions. This was done after ensuring that the Chilled Water Pumps and Condenser Water Pumps were operational and that the Cooling Towers were functioning.

As the Water Chiller had been out of operation for a few days, the chilled water loop and pipe work had risen substantially in temperature. The heat energy from the running Chilled Water Pumps had also contributed to this temperature rise.

Consequently, when the Water Chiller was re-started, a substantial thermal load had to be dealt with, in addition to the thermal load from the Data Rooms. Consequently, the initial pull-down of water temperatures to the design level of 8°C took a little while.

As the operating conditions settled toward normal levels, it was immediately apparent that the discharge temperature

was much lower than before when running with R22.
“While it was too early to finalise commissioning and associated readings at this point, our first impressions were very favourable. It was also pleasing to see the machine actually working and cooling the data rooms effectively!”

Mike adds: “As we gradually trimmed the refrigerant charge, superheat came under steady control and was steady at around 7K. Surprisingly, the sub-cooling was reading a negative value of approximately -0.3K.

We established that this was due to the fact that we were initially having to read the high side pressure at the liquid line connection, which led to a lower saturation pressure and temperature reading at that point (in relation to the temperature reading that was correctly being taken just before the TEV).”

The final total refrigerant charge added was recorded at 61kg. However, this was with only one of the two compressors running, and then at only 780rpm, as opposed the full speed capability of 1800rpm.

Under normal circumstances, if a higher building load were likely to be experienced, it would be necessary to conduct a Hot Day Test, fully commissioning the Water Chiller with the ClimaCheck Performance Analyser and adjusting the refrigerant charge to meet higher load conditions. However, this was a relatively warm day and the Data Room loads are fairly consistent. The team decided to make adjustments to the refrigerant charge during the next visit, which will be timed to coincide with the highest possible ambient.

After careful study and preparatory work, the conversion to the new refrigerant proved a great success. Initial readings taken with the ClimaCheck suggest the Water Chiller will operate more efficiently than on R22, “no mean achievement, as we know it was already an incredibly efficient plant – and way ahead of it’s time,” says Mike.

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