ABSTRACT

Vapour-compression water chilling machines of large capacity (megawatts of refrigeration) are extensively utilised for process cooling in the manufacturing, chemical and food industries, and for cooling hot mines. If these machines under-perform, not only may the costs of consequent losses in production be considerable, but products or working conditions may degrade or become unsafe. Performance monitoring instrumentation, including water flow meters, fitted to machines on site may be infrequently calibrated, though. Therefore, the *apparent* performance of a machine, indicated by the measurements in its water circuits, should be verified through independent, confirming measurements in its refrigerant circuit.

For custom-built machines with screw compressors, though, there is a difficulty with so verifying apparent performance. The oil cooling load of screw compressors is large, and so must be taken into account in such verification. If the oil is cooled by water, it is easy to measure oil cooling load, but not if the oil is cooled by condensed liquid refrigerant in a thermosyphon 'loop', because of the two-phase flow of the refrigerant there.

This research report describes a study done on a water chilling machine with a screw compressor, using ammonia as refrigerant, at KDC East Mine, Westonaria, South Africa. This study was of a proposed, alternative way of determining the oil cooling load – by measuring flows and properties in the *oil circuit.* The oil cooling load so determined could be independently verified by measurements in the water circuit of this machine's oil-to-water cooler.

The chief problem in determining oil cooing load from measurements in the oil circuit is that the 'oil' is not pure lubricant, but a solution of oil and refrigerant. Therefore the most accurate available methods of predicting the thermophysical properties of oil-ammonia solutions were identified and employed.

The oil cooling load hence determined agreed within 0.43 per cent with that determined on the water side of the oil cooler. It was hence used to correct the coefficient of performance (COP) calculated from measurements in the machine's refrigerant circuit. This corrected refrigerant-circuit COP, with the estimate of total mechanical power input to the machine, were then used to indirectly estimate the machine's water chilling load. This indirectly estimated load compared very closely, within 1.12 per cent, to the apparent water chilling load determined from the measurements in the machine's water circuits.

It is concluded that in this study, oil cooling load could be determined with satisfactory accuracy from measurements in the oil circuit. Hence, this proposed technique offers promise of being a useful and practicable development, enabling apparent performance of such machines to be more conveniently verified than hitherto.

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