INFLUENCE OF LUBRICATING OIL ON HEAT PUMP PERFORMANCE
Data Capture, Analysis and Control Aspects

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Summary

A microprocessor based data logging and control system for the detailed examination of heat pump performance is described and some preliminary results are discussed of its application to the complex problem of determining the influence of lubricating oil on system performance. Results are presented which illustrate the powerful data analysis software which has been developed, and the relationship between data collection and analysis is demonstrated.

1. INTRODUCTION

The fundamental objective of this contract was to investigate the effects of varying the oil circulation in the evaporator and in the compressor of a heat pump system. The test rig therefore consists of a water-to-water heat pump which provides facilities for varying the oil concentrations as required. It also provides the essential facilities for recovering the oil and refrigerant from the liquid which has been removed from the heat pump. The design is an extension and development of a previous system which has been described elsewhere (1). The underlying scheme is a water-to-water heat pump, with an oil injection stage in the condenser liquid line, two liquid separation stages in the compressor suction and discharge lines, and two oil and refrigerant recovery systems. Figure 1 shows the layout of the system, though for simplicity, only the evaporator oil circuit is shown (the compressor oil circuit is virtually identical). The test rig is extensively instrumented and is microcomputer controlled to ensure the stability of the operating conditions. This of itself is not a trivial operation, as the system involves a number of dynamically interactive loops, which makes precision control of its behaviour difficult to achieve. Further complications arise when account is taken of the general requirement to make calorimetric measurements to acceptable accuracy (that is, to better than 5%), and of the particular need in this work to determine the fluid state points accurately, especially at the evaporator outlet. The reasons for this will be discussed later, but the result is that temperature and pressure measurements must be made with a precision which is not normally fully appreciated.
2. DATA ACQUISITION AND INSTRUMENTATION

The acquisition and measurement of data are different in nature. Measurement means the production of electrical or other signals which quantitatively represent the properties being examined. That is, it is involved with the behaviour of the sensors and transducers. By contrast, data acquisition refers to the collection of these measurement signals and their recording in a form which is appropriate to the needs of the experiment. Neither problem can be considered in isolation because of the very strong interaction between the two.

Five types of measurement are being made: temperature, pressure, fluid flow rate, and electrical and mechanical power. For the temperature and pressure measurements, both absolute and differential measurements are required, to a degree of accuracy and resolution that depends critically on the purpose for which that reading is being made.

This point about the accuracy of the measurements has already been mentioned, and can be illustrated by two examples.

Measurement of the performance of any heat pump system requires an accurate knowledge of the heat transferred at the evaporator and condenser. Indeed, any quoted performance figures will be useless even for commercial purposes unless they are accurate to much better than 4%. Since both the electrical power input and the water flow rates through the heat exchangers can be measured to within 1% under normal conditions, traditional error analysis shows that this accuracy can be achieved by measuring the temperature difference across the heat exchanger to within 3.5%. Since this temperature difference can be as low as 5 K, then either it must itself be measured to within 0.2 K, or the