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Performance Analysis of a Sliding -Vane Rotary Compressor for a Household Refrigerator/Freezer

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PERFORMANCE ANALYSIS OF A SLIDING-VANE ROTARY COMPRESSOR FOR A HOUSEHOLD REFRIGERATOR/FREEZER

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ABSTRACT

A study of the power consumption and mass flow characteristics of a sliding vane rotary compressor for a household refrigerator/freezer is presented. The study is based on results from a computer simulation of the compressor mechanism which considers the participation of both refrigerant and oil in all fluid processes. Various modelling techniques used in the simulation are discussed. Several important simulation results are substantiated by direct comparison with experimental data from calorimeter tests for an instrumented compressor. The details available from the simulation results are used to infer causes for performance characteristics not readily apparent from the experimental data alone.

INTRODUCTION

The competitive nature of the refrigeration compressor industry encourages manufacturers to develop analytical tools for investigating product performance. Many of the analytical tools developed for the sliding-vane rotary compressor are based on work originated at Purdue University's Herrick Laboratories. Coates presented a detailed computer simulation model coupled to an optimization scheme in 1970 [1]. In 1977 Reed showed that refrigerant/oil miscibility can have a significant effect on capacity [2]. In 1978 Pandeya proposed improvements to several sliding and viscous friction loss models as well as certain flow loss models [3]. In 1982 Yee's analysis showed the significance of the re-expansion process as an energy loss [4].

Elements from the Purdue work have been combined with several analytical methods developed at Whirlpool to make a a simulation capable of predicting the details of sliding vane rotary compressor behavior in arriving at accurate estimates of capacity and power consumption. The simulation has been used to study a production compressor design for which extensive operating test data was collected.

THE COMPRESSOR

The compressor studied in this analysis is a high-side hermetic sliding-vane rotary intended for use in a household refrigerator/freezer. The compressor operates with R12 refrigerant and commercially available napthenic mineral oil. The oil is stored in a sump at the bottom of the hermetic shell. The vertical-axis compressor mechanism and drive motor are suspended above the oil sump by springs attached to the shell.

The compressor mechanism consists of a rotor which carries two movable vanes in radially opposed slots within a round cylinder. The cylinder is located such that the rotor head is nearly tangent to the cylinder wall in the region between the suction and discharge ports. The discharge port is provided with a cylindrical reed valve and stop. The rotor head, vanes, cylinder, and discharge valve are placed between parallel end plates. The end plates form a gas-tight seal with the cylinder end surfaces. Clearance is provided to allow free rotation of the rotor and vanes. The rotor shaft is supported radially by a bearing boss formed as part of the lower end plate.

The motor consists of an armature pressed onto the rotor shaft below the bearing boss and a four-pole winding supported by the lower end plate. The rotor is provided with a hollow center along its

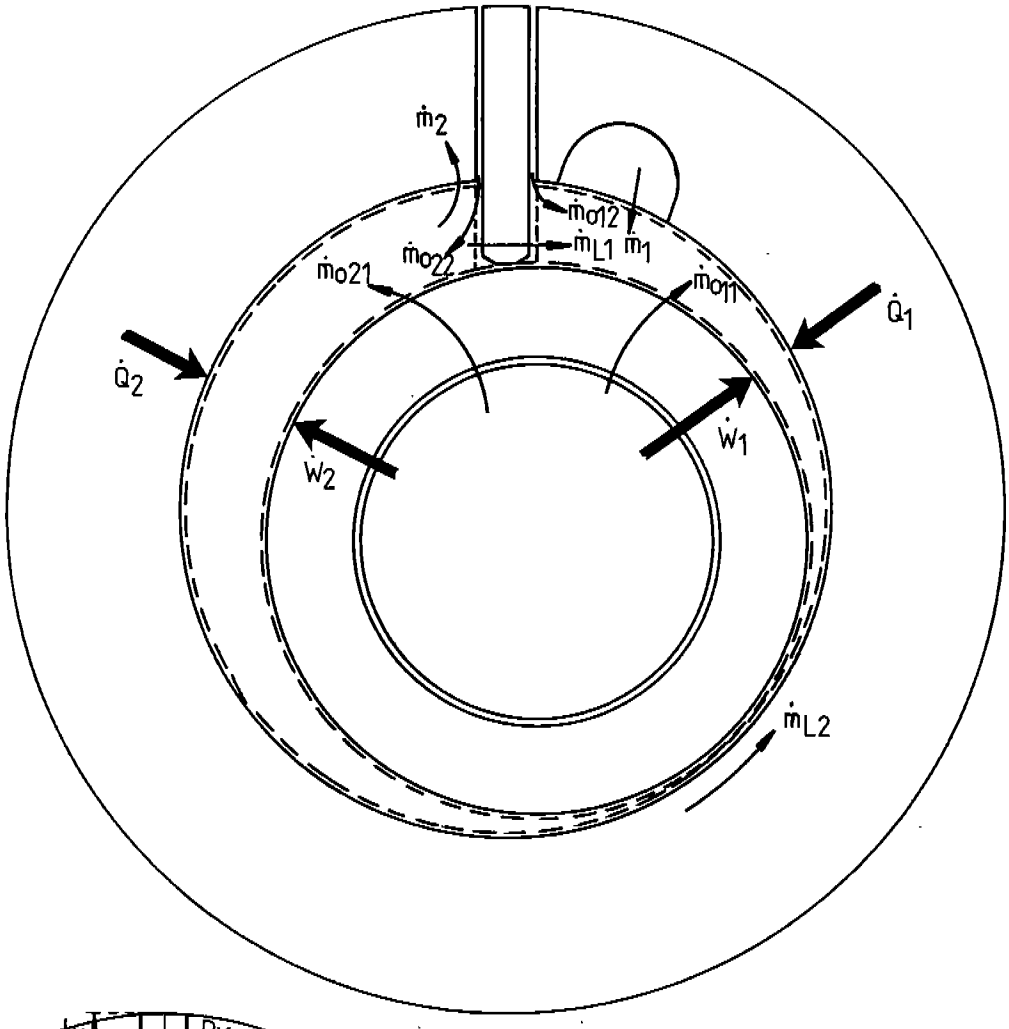

Figure 1: Control volumes

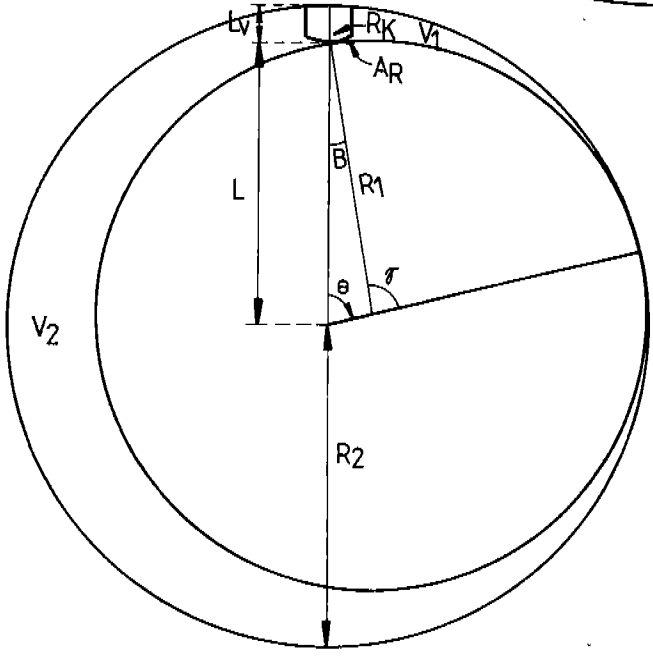

Figure 2: Geometric values

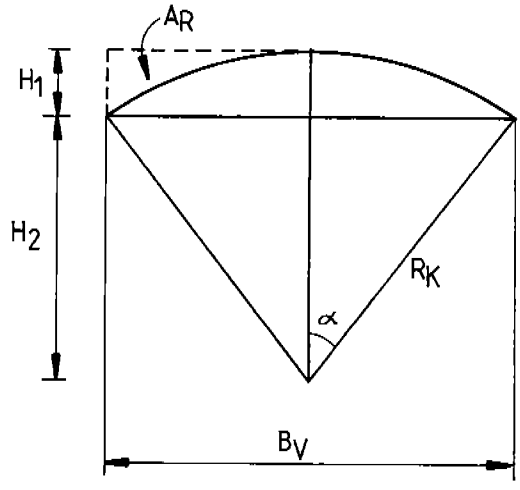

Figure 3: Vane tip