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## ABSTRACT

This paper describes a flow-visualization technique that was employed to qualitatively evaluate the gas flow pattern inside a small, low side, hermetically sealed, reciprocating refrigeration compressor. The applicable compressor designs are those in which the suction gas from the evaporator is dumped into the compressor shell, and is then drawn through a muffler into the suction plenum of the compressor. The physical separation of the muffler inlet from the suction gas inlet serves to reduce compressor noise and also provides an easy and convenient means of separating any liquid (compressor oil or liquid freon) from the freon gas.

For the flow visualization studies the compressor housing was replaced by a clear plastic shell. Atmospheric air seeded with white smoke was the working fluid. The suction inlet and muffler were from a representative compressor. The flow pulsations were modeled by connecting the muffler outlet to the input plenum of an auxiliary compressor. The flow patterns in the vicinity of the muffler inlet were recorded with a video camera. The mixing of the inlet gas with the gas circulating inside the muffler was studied. The effect of alignment and offset of the muffler inlet relative to the suction inlet, the effect of muffler size, and the effect of a shroud around the muffler were studied.

For this design only a part of the suction gas entering the shell goes directly into the muffler. The remainder is "spilled," and circulates inside the shell, and is superheated by the relatively hot motor and compressor. Part of the superheated gas is drawn into the muffler on each intake stroke of the compressor, and is mixed with the unspilled flow. Theoretical estimates show that for the small compressor considered here, a 10F increase in suction gas temperature results in approximately a one percent decrease in compressor efficiency.

To study the flow pattern of the suction gas in transit between the suction inlet and the muffler inlet, flow-visualization was used. The flow pattern was recorded on video tape and compared for the following cases:

1. The muffler inlet in alignment with the suction inlet,
2. The muffler inlet misaligned relative to the suction inlet,
3. Different offset between the aligned muffler inlet and suction inlet,
4. The use of a shroud around the muffler to partially baffle the flow in the vicinity of the muffler, and
5. The use of a larger volume muffler instead of the standard muffler, with an increased inlet hole diameter and increased outlet passage diameter.

Reference 1 describes the flow-visualization study and also contains the video tape produced as part of that study. The results were used to guide a companion study of detailed temperature and pressure measurements inside an actual working compressor.

In a companion study (Ref. 2), Meyer made temperature, pressure, flow rate, and power consumption measurements on a modified compressor to quantitatively evaluate the effects that are indicated by the flow-visualization study. That work evaluated the effect of misaligned muffler and suction inlet and the effect of a shroud around the muffler. A theoretical heat transfer and mixing model was programmed and the numerical results were compared with the measurements.

From the visualization results and the detailed measurements of Ref. 2, a flow mixing parameter, $\delta$, is defined and estimated for the various geometries and flow conditions considered. $\delta$ is the fraction of unspilled flow so that a value of $\delta = 1$ represents no flow spillage (a direct connect). Measurements in Ref. 2 indicate that $\delta = 0.5$ is typical of off the shelf compressors. The flow-visualization studies indicate that values of 0.8 to 0.9 could be achieved by some design improvements.

## References


1. Srikanth, Ramanujam, "How the Design of the Suction Return Affects Compressor Efficiency", MSME, Purdue University, 1987

2. Meyer, W. A., "An Investigation into Heat Transfer Processes in a Small Hermetic Refrigeration Compressor", MSME, Purdue University, 1987.