Modeling of an Electromagnetic Oscillating Compressor

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For energy conservation in refrigeration and air-conditioning systems, based on vapor compression cycles, capacity modulation is necessary. In addition, individual components of the system have to be improved. Although electromagnetic linear motor compressors are supposed to be most suitable for this purpose, they have not found wide acceptance because the interaction of various design parameters is not completely understood. In this paper, the nonlinear behavior of the electromagnetic linear compressor is investigated and described in analytical form. Cyclic simulation, based on the linear load model as used in this paper, is less accurate than numerically integrated simulation in the time domain, but can provide better physical insight of the interaction of the system design parameters. In addition, the computer time required is much reduced.

The compressor was divided into three sub systems: electromagnetic, mechanical and thermodynamic. The phenomena for each part were described in terms of lumped-parameter models. These models include the coupling effects between sub systems. Heat transfer was not modeled but is indirectly included in the polytropic coefficient.

A semi-conductor half-wave rectifier was included as a part of the analysis because the compressor available for the experiment was designed with a diode. Considering the final application, the differential equations of the model were solved by using the harmonic balance method. The harmonic balance showed good results for the diode case in the range of operation tested. The cyclic simulation based on the linear load model and the harmonic balance method seems to be applicable to the final design objectives of the compressor.

The behavior of the compressor without a diode becomes less nonlinear, thus making the use of the harmonic balance method and linear load model for final design performance studies even more attractive.