TITLE: Fundamental Aspects of the Application of Carbon Dioxide in Comfort Cooling

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## ABSTRACT

This paper wishes to investigate the performance potential of the transcritical carbon dioxide cycle in comfort cooling applications. To date, several researchers have experimentally compared carbon dioxide-based systems to baseline halocarbon systems (the literature is extensive, for brevity we reference only Pettersen and Aarlien (1998), Kruse et al. (1999), and Strømmen et al. (2000)). One difficulty that arises when comparing different refrigerants is establishing the basis for experimental comparison. For example, many comparisons have been made for systems employing equal volume heat exchangers, which is not nearly as important of a constraint for residential comfort cooling as it is for automotive air conditioning.

In the paper, we will exercise an analytical approach for comparing different refrigerants based on thermodynamic and transport properties. After a brief review of the inherent difficulties in comparing different refrigerants, we will consider the four basic processes that comprise the conventional vapor compression refrigeration cycle and transcritical cycle, namely: compression, heat rejection, expansion, and heat absorption. In particular, we will examine the dependence of the compressor isentropic efficiency on

the pressure ratio, the effect of a small approach temperature in the $CO_2$ gas cooler, and the possible performance improvement from implementing counter-flow heat rejection and realistic minimization of the throttling loses in the expansion device. The paper concludes that carbon dioxide has a lower limit of the potential Coefficient of Performance than refrigerants working in a conventional vapor compression cycle.

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