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by

Hicham Johra

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1. Foreword

The aim of this lecture note is to give an overview of the Coefficient of Performance (COP) of conventional vapour-compression heat pumps for building applications (space cooling, space heating and domestic hot water production). The COP data has been collected from various experimental and numerical studies reported in peer-reviewed scientific journals and conference papers, technical information from manufacturers and academic documents (Ph.D. and Master theses). The COP of different heat pumps is presented as a function of the temperature span (temperature lift) between the heat source and the heat sink.

2. Introduction

Heat pumps are an excellent solution to supply heating and cooling for indoor space conditioning and domestic hot water production. Conventional heat pumps are typically electrically driven and operate with a vapour-compression thermodynamic cycle of refrigerant fluid to transfer heat from a cold source to a warmer sink. This mature technology is cost-effective and achieves appreciable coefficients of performance (COP). The heat pump market demand is driven up by the urge to improve the energy efficiency of building heating systems coupled with the increase of global cooling needs for air-conditioning.

For heating and cooling systems, the Coefficient of Performance is the ratio of useful heating or cooling power (or energy) provided to work power (energy) input to the system. The COP is adimensional (no unit). The equation of the Coefficient of Performance (COP) for heating and cooling systems is as follows:

$$COP = \frac{|Q|}{W}$$

Where Q is the useful heating or cooling power (or energy) provided (heat removed from the cold heat source/reservoir for cooling systems; heat injected into the warm heat sink/reservoir for heating systems), and W is the net work power (or energy) input to the heating/cooling system. Higher COPs correspond to higher energy efficiency and thus lower energy usage and operating costs.

3. Overview of COP for conventional vapour-compression heat pumps in buildings

One can see in *Figure 1* that vapour-compression heat pumps typically have a Carnot efficiency between 40% and 60% for temperature spans compatible with building applications: indoor space conditioning and domestic hot water production (temperature span of 20-60 K). Vapour-compression heat pumps thus typically have a COP ranging between 2 and 5 for common building applications.

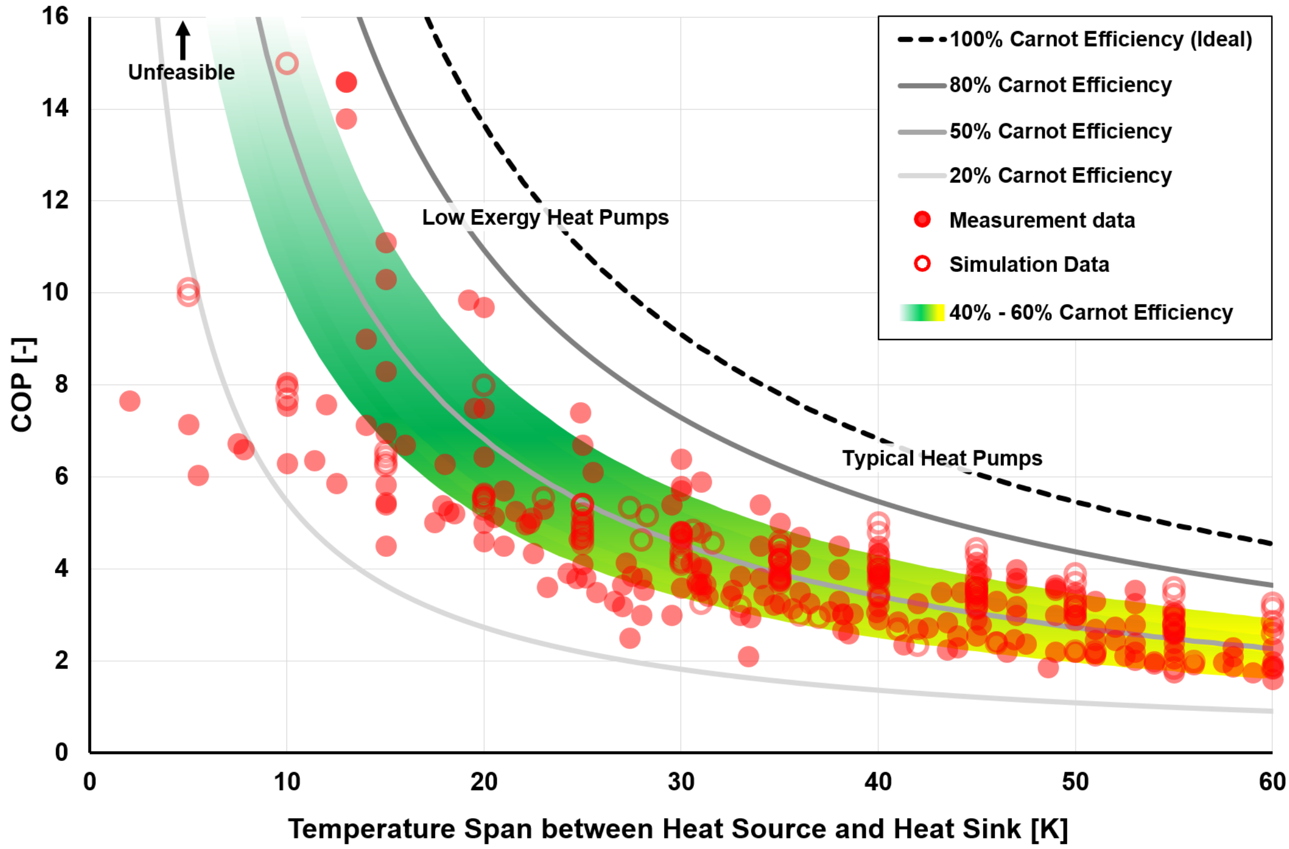

Figure 1: *Performance overview of conventional vapour-compression heat pumps for building applications: Coefficient of Performance (COP) as a function of the temperature span (temperature lift) between the heat source and the heat sink. Data collected from [1][2][3][4][5][6][7][8][9][10][11][12][13][14][15][16][17][18][19][20][21][22].*

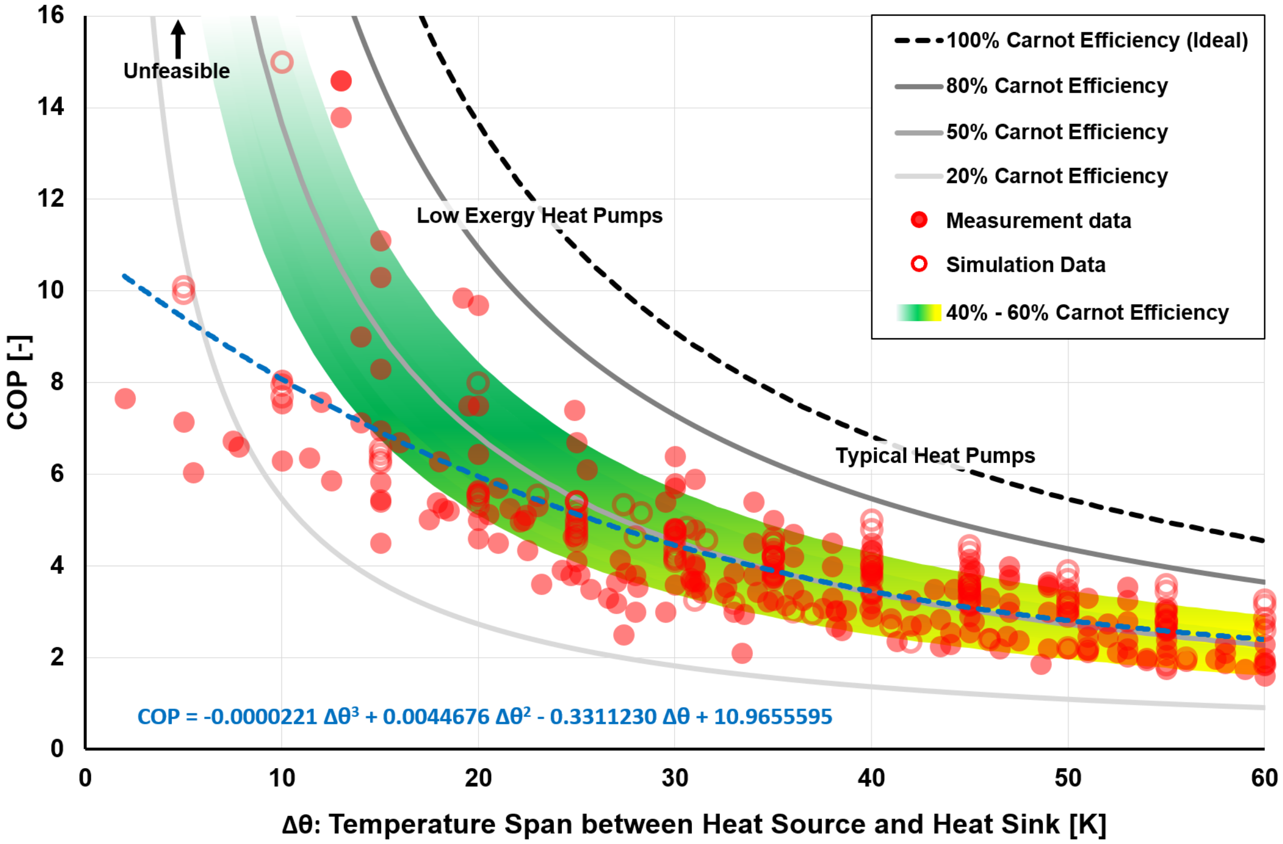

Figure 2: *Performance overview of conventional vapour-compression heat pumps for building applications: Coefficient of Performance (COP) as a function of Δϑ: the temperature span (temperature lift) between the heat source and the heat sink; polynomial fitting curve. Data collected from [1][2][3][4][5][6][7][8][9][10][11][12][13][14][15][16][17][18][19][20][21][22].*

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