



1st International Conference on Sustainable Energy and Resource Use in Food Chains,
ICSEF 2017, 19-20 April 2017, Berkshire, UK

Comparative analysis on the energy use and environmental impact of different refrigeration systems for frozen food supermarket application

Zoi Mylona*, Maria Kolokotroni, Konstantinos M. Tsamos, Savvas A. Tassou

Brunel University London, Institute of Energy Futures, Center for Sustainable Energy Use in Food Chains, Uxbridge, Middlesex UB8 3PH, UK

Abstract

In this paper the impact on the store's energy use by different refrigeration systems, remote and centralised, is investigated as well as their environmental impact. The study is performed using the energy simulation program EnergyPlus in a reference baseline model which has been verified against measured energy and environmental conditions data. The refrigeration system of the case study includes plugged-in display cabinets to serve both medium temperature (MT) and low temperature (LT) refrigeration loads. Centralised systems are compared with the remote plugged-in refrigeration cabinets. The different refrigeration systems studied are, a) two parallel centralised systems for MT and LT loads, b) two parallel cascade systems (R134a/CO₂) for MT and LT loads and c) a transcritical CO₂ booster. The study is performed for DSY London weather file to capture the risk of warmer than a typical year consequences in centralised refrigeration systems operation. Besides these refrigeration systems, the CO₂ transcritical appears as the one of the most promising replacement in terms not only of energy use reduction due to its high efficiency in London climate but on its low contribution to global warming as well.

© 2017 The Authors. Published by Elsevier Ltd.

Peer-review under responsibility of the scientific committee of the 1st International Conference on Sustainable Energy and Resource Use in Food Chains.

Keywords: Supermarket refrigeration; EnergyPlus; Frozen food; TEWI

* Corresponding author. Tel.: +44-1895-266659; fax: +44-1895-269777.

E-mail address: Zoi.Mylona@brunel.ac.uk

Nomenclature

GHG	Greenhouse gases
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HC	Hydrocarbon
HVAC	Heating, Ventilation and Air-Conditioning
LT	Low Temperature
MT	Medium Temperature
AHU	Air Handling Unit
DX	Direct Expansion
CAV	Constant Air Volume
ach	Air Changes per hour
DSY	Design Summer Year
MBE	Mean Bias Error
CVRMSE	Coefficient of Variation of the Root Mean Square Error
N	Sample size
y_i	Measured data
\hat{y}_i	Simulated data
\bar{Y}_s	Sample mean of measured data
HP	High Pressure
LP	Low Pressure
TEWI	Total Equivalent Warming Impact
L	Annual Leakage (kg/year)
n	System operating time (years)
m	Refrigerant charge (kg)
a_{recovery}	Recovery/recycling factor (%)
E_{annual}	Refrigeration energy consumption (kWh/year)
β	Indirect CO ₂ emission factor (kgCO ₂ /kWh)

1. Introduction

Approximately half of the energy consumption in supermarkets is associated with the refrigeration system [1]. Refrigeration system which is essential for the preservation of products has remarkable negative environmental impact due to greenhouse gases (GHG) emissions: indirect emissions from electricity consumption and direct emissions due to leakages and refrigerant type [2].

Total GHG emissions from food chain refrigeration in UK are 13,720 kT CO₂, where the 35% are created from the direct emissions and 65% from indirect emissions. Retail sector is responsible for the 47% of the total emissions in the UK. Approximately 63% of direct emissions from the food chain result from the food retail sector, in particular from supermarket refrigeration systems [3].

The MTP stated that estimations showed a range of 9%-25% for refrigerant leakage in supermarkets [4]. Due to pressure from regulations and environmental agencies, these leakage rates have been reduced in recent years [5].

The high Global Warming Potential (GWP) of the hydrofluorocarbon (HFC) refrigerants commonly used in supermarkets systems, coupled with the high refrigerant leakage rates leads to significant contribution to the increase in global warming. The consequences of the release of massive amounts of synthetic refrigerants with high GWP to the environment are the main reason for the increasing interest in using natural refrigerants such as ammonia (NH₃), hydrocarbon (HC) and carbon dioxide (CO₂) which are the most prevalent in the last two decades [6].

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات