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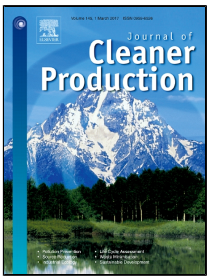

Liquid Air utilization in air conditioning and power generating in a commercial building

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PII:	S0959-6526(17)30369-4
DOI:	10.1016/j.jclepro.2017.02.143
Reference:	JCLP 9069
To appear in:	*Journal of Cleaner Production*
Received Date:	14 July 2016
Revised Date:	19 February 2017
Accepted Date:	20 February 2017

Please cite this article as: Abdalqader Ahmad, Raya Al-Dadah, Saad Mahmoud, Liquid Air utilization in air conditioning and power generating in a commercial building, *Journal of Cleaner Production* (2017), doi: 10.1016/j.jclepro.2017.02.143

Liquid Air utilization in air conditioning and power generating in a commercial building

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Abstract

Current air conditioning (AC) systems use a vapour compression system that consume a great amount of energy particularly during the peak times where most electricity suppliers facing difficulties to meet the users demands. Shifting the peak cooling demands to off-peak times using cold energy storage systems is a promising technique leads to save energy and to reduce the CO_2 emissions. This study presents new technology that uses the cold energy storage in form of liquid Air (LAir) or liquid nitrogen (LN2) to provide air conditioning and power to commercial buildings. Four different cryogenic cycles were modelled and analysis from a thermodynamic point view, and compared in terms of their, output power, cooling capacity, recovery efficiency, COP and how much energy could save when compared with the traditional AC system. The results showed that system performance when LAir is used is 21-25% higher than that of when LN2 is used, and the 4th configuration is the most effective cycle and it recovered up to 94% of the energy stored in LAir and 78% of the energy stored LN2. Compared to the conventional system at the current LAir and LN2 prices, the 1st, 2nd, 3rd and 4th cycles showed saving up to 15%, 24%, 31% and 37.5%, respectively, when LAir is used and -3.5%, 5%, 16% and 24%, consecutively, when LN2 is used.

Key words; liquid air/nitrogen; cryogenic system; air conditioning; peak demand; cold storage

1- Introduction

Conventional air conditioning (AC) systems use a vapour compression system that consumes a great amount of energy particularly during the peak times, and the demands of these systems have increased rapidly over the last few decades. Forecasts have shown that space cooling demands in Europe will increase rapidly over the next 15 years by 72% and will reach 30 times its current value by 2100 (Ahmad et al., 2016; Cox, 2012; Davis and Gertler 2015). Shifting the peak cooling demands to off-peak times using cold energy storage systems is a promising technique leads to save energy, to reduce the CO_2 emissions and to reduce the system size (Navidbakhsh et at., 2013). However, the performance of this technique affects significantly by the chosen storage medium, storage temperature and the operating strategy (Zhai et at., 2013).

There is a new cooling systems use cold storage medium in form of liquefied gases such as liquefied natural gas, air, nitrogen and CO_2 was also reported, and liquid air / nitrogen were considered as the most attractive storage