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Environmentally friendly steam generation using VHTHPs at a pharmaceutical research facility

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Abstract

This paper presents a case study where steam at 1 MPa and 183°C (~140 psi/360°F) is produced using very high temperature heat pumps (VHTHPs) at a pharmaceutical research facility. Steam as an energy carrier has many benefits, and steam systems are also flexible when it comes to the primary source; steam can be generated using heat from combustion of fossil- or renewable fuels, nuclear reactors or directly from electricity. Generating steam using a heat pump can reduce greenhouse gas emissions. At full-scale operation the potential reduction in CO₂-emissions is more than 80%. The heat source for the heat pumps is mainly waste heat from cooling compressors at around 40°C (~100°F). The refrigerant is a natural refrigerant R-704 (Helium). Helium has both global warming potential (GWP) and ozone depletion potential (ODP) equal to zero and the toxicity and flammability classification of Helium is "A1". The working medium stays a gas throughout the cycle, which makes the heat pump process very suitable for use as VHTHPs while the heat pumps are highly adaptive to any changes in the sink or source temperatures.

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1. Introduction

Health is central to a functioning society and connects us all. The pharma industry is a global industry given the possibility to provide health solutions valid to patients all around the globe. Being global in the health sector, one has to address the global issues affecting people's health. AstraZeneca recognises the strong connection between a healthy planet and healthy people and works with environmental protection. AstraZeneca's approach doing this is to follow the science, using science-based targets. The greenhouse gas emission targets are in line with limiting global warming to 1.5 degrees. A big part of lowering CO₂ emissions is to move from the use of fossil fuel to renewable energy. In the pharma industry steam is commonly used to provide the utility needed. Due to the temperature needed, steam is usually produced with fossil fuel, on site, and accounts for a large part of the energy usage at a pharma plant.

AstraZeneca Gothenburg have historically used fossil fuel for steam production with a switch from oil to natural gas in 1997. In 2018 a new switch took place, this time from fossil natural gas to biogas, to produce steam with a low carbon fuel. A technical part of the upgrade was to pursuing steam production using high lift heat pumps - a more efficient, more robust, less expensive and if possible, even more sustainable solution.

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