SNAPSHOT

AUSTRALIAN MEAT PROCESSOR CORPORATION

AMPC SNAPSHOT – An Integrated CO_2 Production and CO_2-NH_3 Cascade Refrigeration System (2016.1038)

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Project Description

Investigate the technical feasibility of integrating a closed-loop carbon dioxide-ammonia (CO_2-NH_3) cascade refrigeration system with an open-loop CO_2 liquefaction system and the financial feasibility of integrating a CO_2 liquefaction system to a typical abattoir.

Project Content

Liquefied CO_2 is used on a daily basis in the red-meat industry to produce dry ice snow for product cooling applications. Traditionally, it has been cost prohibitive for abattoirs to invest in their own CO_2 liquefaction equipment; consequently, it is procured from specialist providers at a significant cost. Liquefied CO_2 can also be used in a cascade refrigeration system with NH_3, substituting two-stage NH_3 refrigeration systems more commonly seen throughout Australian abattoirs. As a result, CO_2 refrigeration and liquefaction systems have the potential to be combined, decreasing operational expenses for abattoir operators.

This project involved the development of a concept design for the integrated CO_2 refrigeration and liquefaction system, along with investigations into its technical and financial feasibility. The financial feasibility of integrating a CO_2 liquefaction system to an existing abattoir was investigated using a financial feasibility model. The model incorporated capital expenditure, operational expenditure and cost reductions expected, when integrating the CO_2 liquefaction system.

A financial feasibility study was later undertaken to investigate the project's payback period when employing different operating conditions and when changing particular input variables of the financial feasibility model to ±10% and extreme realistic cases of their expected value. A sensitivity analysis of the main input variables used in the model was also undertaken to determine which variables would have the largest impact upon the expected payback period of the project.

Project Outcome

Investigation into the technical feasibility of the integrated CO_2 refrigeration and liquefaction system proved the original concept to be uneconomical. This was a result of contamination concerns between the two systems, prompting the need for additional purification measures. Concerns were also raised over an oversized plate heat exchanger being used to condense liquefied CO_2 for dry ice production. Consequently, an amended system design concept was developed to remove technical concerns.

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Private correspondence with an Australian abattoir showed that there was excess CO_2 in flue gas being produced by steam boilers existing on-site. Stack gas recovery systems (SGRS) provide a method of capturing and purifying flue gas to produce food-grade CO_2 to be used for dry ice snow production. Food-grade CO_2 has the potential to decrease regular operating expenses by substituting currently procured CO_2, substituting water-based ice cooling applications with dry ice snow, substituting current cleaning methods with dry ice blasting and selling any excess CO_2 back to market.

It was determine that operating the SGRS at maximum capacity, solely to substitute currently procured CO_2, provides the lowest payback period for all possible operating scenarios. However, if demand of currently procured CO_2 does not meet the CO_2 capture capacity of the SGRS, excess CO_2 captured can be sold to market to achieve the same payback period. As these operating scenarios are heavily reliant on the market price of liquefied CO_2, a thorough market analysis into liquefied CO_2 must be undertaken to prove their financial feasibility.

Benefit for Industry

This report provides a concept design for an integrated CO_2 refrigeration and liquefaction system and an in-depth financial feasibility study into the integration of a CO_2 liquefaction system to an existing abattoir. The financial study provides details regarding the most economical operating conditions for the CO_2 liquefaction system and significantly sensitive variables to consider when integrating the system.

The integration of a CO_2 liquefaction system to an existing abattoir has the potential to provide abattoir owners with substantial cost reductions through the substitution of currently procured CO_2 or excess CO_2 sale due to the high market price of liquefied CO_2.

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