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Capital Cost Evaluation for Optimum Process Design of Cryogenic Air Separation

Diploma Thesis
by
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1 Introduction

Air separation technology, or – more generally speaking – gas separation technology, lies at the heart of the modern process industry. Highly pure oxygen and nitrogen ore uses in many industrial applications. Modern power generation processes, such as the currently developed OXICOAL process, rely on incineration with pure oxygen to produce flue gases with very high carbon dioxide content for further storage. Nitrogen is essential to many widely used processes such as the production of ammonia in the Haber-Bosch synthesis, as fertilizer or in many organic reactions.

2 Air Separation Technology

There are several ways besides cryogenic air separation to produce highly pure liquid or gaseous nitrogen and oxygen. In this chapter different competing technologies and their main field of applications will be discussed. The mainly used technologies asides from the cryogenic process are pressure swing adsorption (PSA) as well as membrane processes the so called gas permeation (GP).

Fig. 2.1 illustrates the most economically viable processes depending on product purity and product stream volume. It is important to remember, that PSA and GP processes exclusively produce gaseous products whereas cryogenic air separation may yield liquid or gaseous product streams. It can be seen, newer air separation processes cannot supply the high quality or quantity of the cryogenic process. Due to that cryogenic air separation is thought to be the main supplier of highly pure gases in industrial quantities for years to come

add citation

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2.1 Membrane Processes

find paper: DOI: 10.1002/cite.330480804

The separation of mixed gases by membrane process is called gas permeation. Its main strength in comparison with alternative processes are the low energy consumption and the possibility to produce flexible mobile units. As mentioned before it is not however capable of producing high quantity highly pure product streams. As Fig. 2.1 illustrates the main application for the gas permeation process are moderate product streams at intermediate purities.

2.2 Pressure Swing Adsorbtion

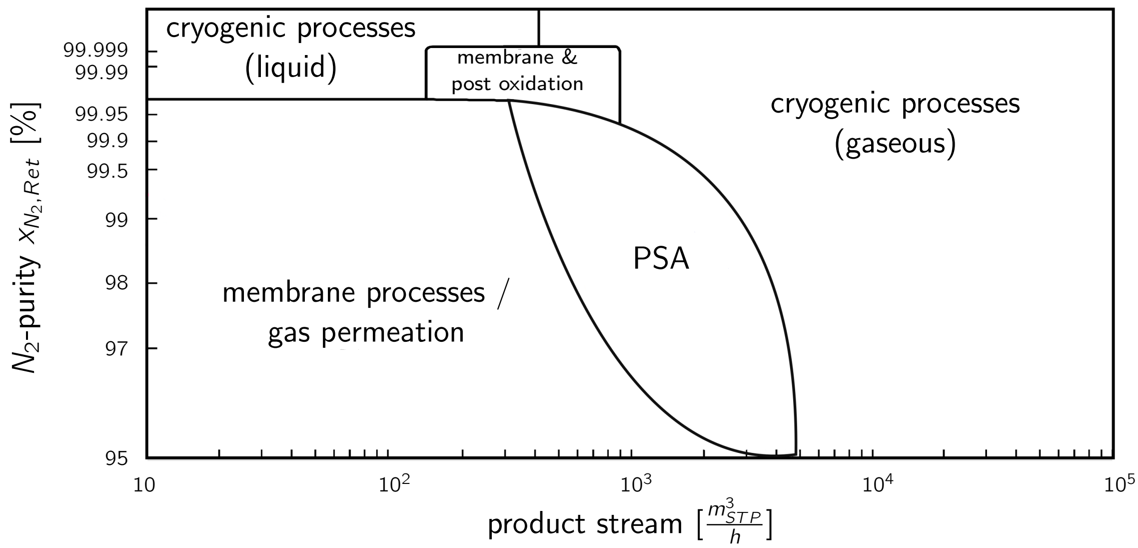

Figure 2.1: Comparison of Air Separation Technologies.

addref: http://dx.doi.org/10.1016/0376-7388(93)E0193-N

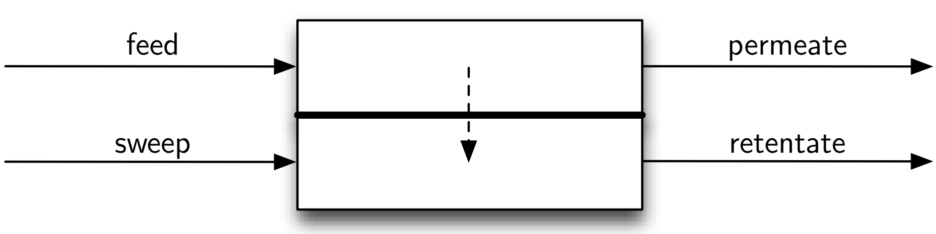

Figure 2.2: Gas permeation process.

3 Cryogenic Air Separation

3.1 Process Model

3.2 Uncertainty in Process Modelling

3.3 Capital Cost

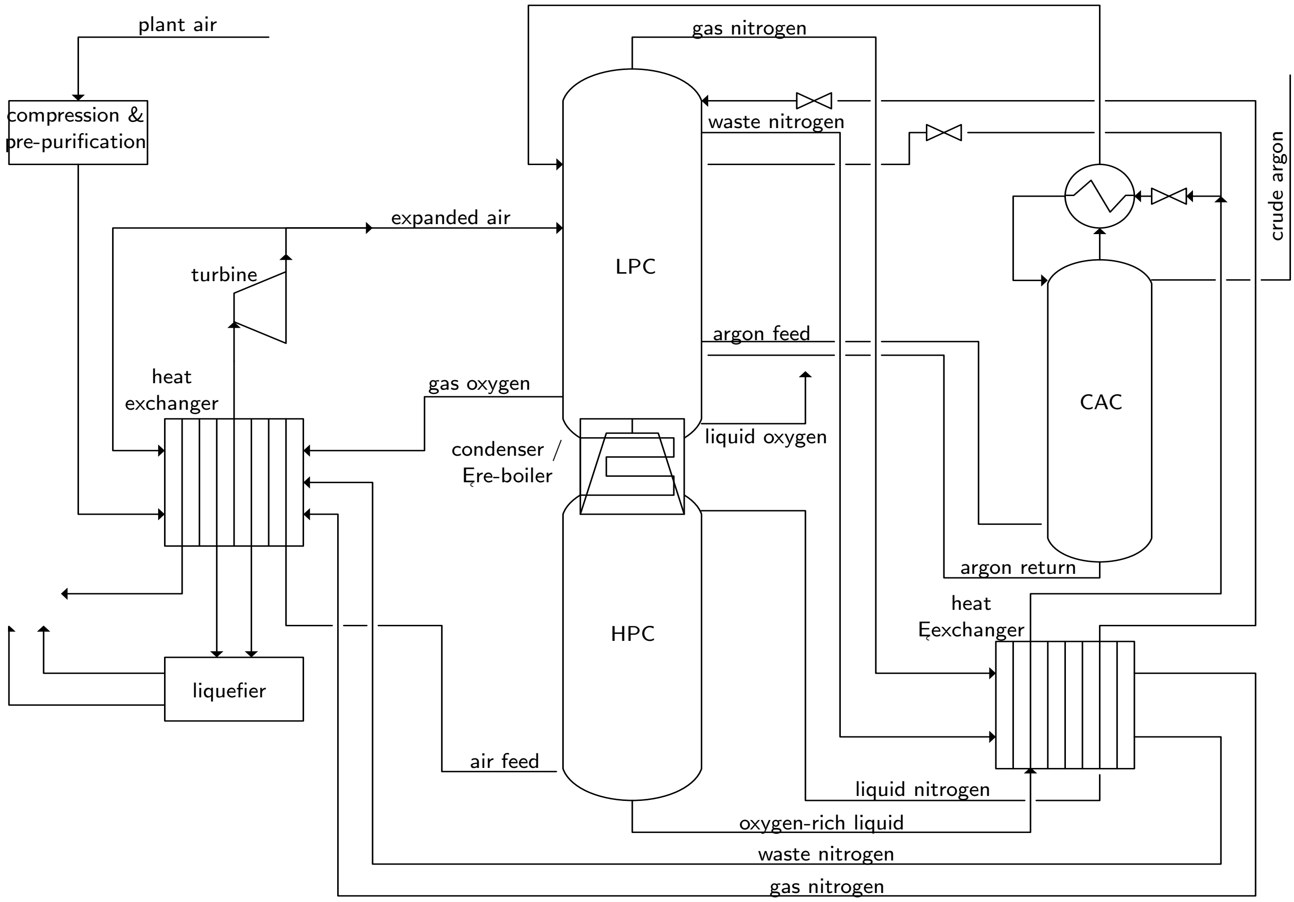

Figure 3.1: Schematic representation of the cryogenic air separation process.

4 Conclusion and Further Research

Todo list