CHAPTER 1 PROBLEM IDENTIFICATION AND BACKGROUND

1.1. INTRODUCTION

Steel, metal and petrochemical industries all require large amounts of air products such as oxygen and nitrogen. Kotz *et al.* [1] states that oxygen and nitrogen are annually among the top five chemicals produced in the United States. Cryogenic air separation plants are, currently, the only efficient and economically viable method of producing air products on large scale (Smith *et al.* [2]). Because transportation adds considerably to the cost, plants are usually constructed on-site and located close to the point of consumption.

It is also a fact that plants of this nature are generally energy intensive, especially the large tonnage plants, and it has been found that relatively small improvements in plant energy efficiency may lead to significant energy cost savings.

1.2. ENERGY MANAGEMENT AT CRYOGENIC AIR SEPARATION PLANTS

The energy crises of the early 1970's necessitated significant improvement of energy management efforts at these energy intensive plants and initial efforts were mostly aimed at energy conservation through introduction of better technology available for that time (Birmingham *et al.* [3]).

As a consequence of this, intentional consideration to improved plant energy efficiency has been given during its design phase ([4], [5], [6]); this is manifested by the fact that energy efficiency increased by approximately 9.1% from 1980 to the late 80's, [4], and from 1997 to 2001 Air Liquide reports a 10% decrease in power consumption of its cryogenic air separation plants. [7].

Since the 1970's, energy optimization techniques have been given elevated importance in the design phase of cryogenic air separation plants and numerous studies addressing the issues surrounding improved energy optimization have been widely publicized (refer to Birmingham *et al.* [3], Biddulph [8], Gupta *et al.* [9] and Sarkar [6]). It is also a fact that all these studies are almost solely aimed at improving the energy efficiency of the plant through intervention at the design phase of the cryogenic air separation plant. Although there have certainly been significant improvements in plant energy efficiency during the past years, as stated earlier, not much have been written on how proper maintenance of this energy efficiency should be conducted and needles to say, proper energy management.

The aim of energy management is defined by Thuman *et al.* [10] as the reduction of energy expenditure for the purpose of reducing product cost; this would ultimately lead to an increase in competitive performance and it becomes clear that, by employing effective energy management, much more benefit can be drawn by the relevant stakeholders and consequently also makes business sense.

This energy management effort should not only be confined to the design phase of the plant, but should be a continuous action, applying it throughout the whole productive part of the plant's life-cycle.

With today's relatively high, and continuously increasing, energy prices it not only becomes a necessity but also makes business sense to maintain and continuously improve the plant's energy efficiency. Managing the plant's energy expenditure and efficiency would be the correct response to the already high and ever-increasing energy cost and may reduce overall input cost dramatically.

To make this managerial action value-adding, there needs to be an effective and continuous energy management program in place that aims to reduce the plant's energy expenditure so as to ultimately reduce product cost.

1.3. DISSERTATION OBJECTIVES

The dissertation objectives are as listed under the main and specific objectives in the sub-sections that follow.

1.3.1. Main objective

The main objective of this dissertation is to present a structured framework which would enable effective management of energy cost and efficiency on cryogenic air separation plants.

1.3.2. Specific objectives

The main objective is accomplished by addressing several key specific objectives:

- Present a model for energy management at cryogenic air separation plants.
- Introduce the theory behind an energy policy.
- Introduce an energy management strategy.
- Present an efficient energy audit process.
- Derivation of a mathematical model for the cryogenic air separation plant.
- Defining performance indicators, which would assess the success of the energy management program.
- Present the means for conducting energy systems maintenance on relevant equipment on the plant.

1.4. DISSERTATION STRUCTURE

This dissertation is structured in accordance with the energy management model.

Chapter 2 introduces the reader to some of the various technologies available today for producing air products and also elaborates on the basic theory behind cryogenic air separation.

The main processes within the air separation plant are described as well as the equipment used in realizing these processes.

Chapter 3 introduces the energy management model and, more specifically, the energy management system. This chapter sets the scope for the chapters that follow and gives a brief introduction of what each one entails.

Chapter 4 describes the organizational structure of the energy management program as well as the components it's comprised of. It also elaborates on energy management planning and introduces the concept behind the energy policy and strategy. In this chapter, components of the energy policy strategy are described in detail and selected concepts are explained by means of case studies.

In chapter 5, the managerial function of leading is described as well as a few issues surrounding employee motivation. Also included in chapter 5 is the theory behind energy management controlling where concepts surrounding energy standards, detection of deviations and correction of deviations are elaborated on.

The last chapter, chapter 6, concludes the dissertation objectives and ends with recommendations with regard to selected topics.

Lastly, the case studies presented in this study are with reference to the oxygen plant at Sasol Secunda in South Africa, unless otherwise stated.