# A GENERIC FRAMEWORK FOR CONTINUOUS ENERGY MANAGEMENT AT CRYOGENIC AIR SEPARATION PLANTS

by

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## SUMMARY

Steel, petrochemicals, metallurgy, explosives, food and many other industries require large amounts of air products such as oxygen and nitrogen. Cryogenic air separation technology is, unlike other air separation technologies, in a mature stage of its life cycle and currently the only practical means available for mass-production of these air products. Inherent to its operation, cryogenic air separation plants are generally energy intensive and power input is considered the main factor on which the ultimate production cost will depend. Experience has shown that relatively small improvements in energy efficiency on these plants generally result in significant reduction of production cost.

This dissertation discusses the means for effective energy management at these plants, aimed at ultimately reducing the electrical cost per quantity of air product produced. It introduces a model, aimed at the manager responsible for energy management at plants of this nature.

At the core of the model is the definition of the energy management structure, which consists out of the following main managerial functions: organizing, planning, leading, and controlling.

Organization implies a formalized intentional structure of roles and positions whereas the planning process entails setting up the energy policy and defining the energy strategy. The managerial function of leading involves leadership, motivation and communication and in controlling, the energy manager sets energy standards, measures performance and initiate appropriate corrective actions.

## KEYWORDS

Cryogenic Air Separation plant, Energy Management Model, Energy Policy, Energy Strategy

## OPSOMMING

Die staal industrie, petrochemiese maatskappye, metallurgie, plofstofvervaardigers en die voedselbedryf benodig groot hoeveelhede gasprodukte soos suurstof en stikstof. Kriogeniese lugskeiding tegnologie is, anders as ander lugskeidingstegnologieë, in 'n volwasse stadium van sy lewenssiklus en is huidiglik ook die enigste praktiese manier beskikbaar vir massa produksie van die laasgenoemde gasprodukte. Inherent tot sy prosses, is kriogeniese lugskeidingsaanlegte normaalweg energie intensief en energie-inset word normaalweg beskou as die hoof faktor waarop die uiteindelike produksie koste sal afhang. Ondervinding het bewys dat relatiewe klein verbeterings in die energie effektiwiteit van hierdie aanlegte normaalweg lei tot beduidende verlagings in produksiekoste.

Hierdie verhandeling bespreek 'n metode waarop effektiewe energiebestuur by hierdie aanlegte toegepas kan word en is daarop gemik om die uiteindelike energie koste per uitsetprodukhoeveelheid te reduseer. Dit stel 'n model bekend wat gemik is op die bestuurder wat verantwoordelik is vir energiebestuur by hierdie aanlegte.

Die definisie van die energiebestuurstruktuur vorm die kern van die model, en bestaan uit die volgende hoof bestuursfunksies: organisering, beplanning, leiding en beheer.

Organisering impliseer 'n geformaliseerde en beplande struktuur van take en funksies, terwyl die beplanningsprosses die bepalling van die energiebeleid en formuleering van die energiestrategie insluit. Die bestuursfunksie van leiding sluit in leierskap, motivering en kommunikasie en in die beheer funksie stel die energiebestuurder energiestandaarde vas, meet prestasie en inisieër relevante korrektiewe aksies.

## SLEUTELWOORDE

Kriogeniese lugskeiding, Energiebestuurmodel, Energiebeleid, Energiestrategie

## LIST OF ABBREVIATIONS

| Abbreviation | | Meaning |
|---|---|---|
| AC | - | Air Compressor |
| Ar | - | Argon |
| AR | - | Average Recovery |
| ASU | - | Air Separation Unit |
| CB | - | Coldbox |
| CBM | - | Condition-based maintenance |
| $CO_2$ | - | Carbon Dioxide |
| CT | - | Current Transformer |
| FTM | - | Fixed-Time maintenance |
| GAN | - | Gaseous Nitrogen |
| GOX | - | Gaseous Oxygen |
| He | - | Helium |
| HP | - | High Pressure |
| IA | - | Instrument Air |
| Kr | - | Kripton |
| LOX | - | Liquid Oxygen |
| LP | - | Low Pressure |
| MG-set | - | Motor-Generator set |
| MP | - | Medium Pressure |
| $N_2$ | - | Nitrogen |

List of Abbreviations

| | | |
|---|---|---|
| $Nm^3/h$ OR $nm^3/h$ | - | Normal Cubic Meters per hour. This is the flow of a commodity (gas or liquid) at normal conditions (0°*C* and 1.013 *absolute bar*). |
| $O_2$ | - | Oxygen |
| OC | - | Oxygen Compressor |
| OEM | - | Original Equipment Manufacturer |
| PM | - | Preventive Maintenance |
| PT | - | Potential Transformer |
| tpd | - | Tons per Day |
| $WN_2$ | - | Waste Nitrogen |
| Xe | - | Xenon |

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