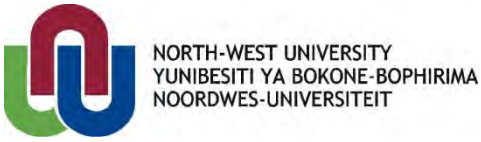
Development of an energy management solution for mine compressor systems



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ABSTRACT

Title: Development of an energy management solution for mine compressor systems
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Eskom is under increasing pressure to provide reliable and sustainable electricity. Demand Side Management (DSM), offers a short- to medium-term solution to this problem. During 2009, the mining sector consumed approximately 16% of the domestic electricity supplied by Eskom. This made the mining sector one of the major targets for Eskom-initiated DSM programmes.

The mining industry uses compressed air for a wide variety of applications and production purposes. This creates many opportunities to reduce electricity consumption and operating costs. Reducing the air-system demand may however not result in significant electrical energy savings, unless the compressed-air supply is accurately managed to meet the reduced demand.

Until recently, compressor control in the mining sector generally consisted of operating the compressors continuously, regardless of the actual demand for compressed air. Excessive compressed air is blown off into the atmosphere resulting in energy loss. This usually occurs when the compressors are operated manually.

A computer-controlled compressor management solution, which optimises the efficiency potential of the compressed-air supply, is required to obtain significant electrical energy savings. The need for such a solution was addressed by the development of an energy management solution for mine compressor systems. This solution is referred to as Energy Management System (EMS) and is capable of starting, stopping, loading and unloading compressors. In addition to this, compressor output can be controlled to maintain a desired pressure set-point.

In this study, the development and implementation of EMS on ten different mine compressor systems is presented. Automatic compressor capacity control was implemented, while an operator manually initiated compressor starting; stopping; loading and unloading, according to EMS control schedules.

Centralised compressor control is one of the main advantages offered by EMS, especially for compressed-air systems with multiple compressor systems at different geographic locations. EMS facilitated effective and sustainable electrical energy reductions for all these compressed-air systems.

SAMEVATTING

Titel: Ontwikkeling van ’n energie bestuursoplossing vir myn kompressorstelsels
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Eskom verkeer onder toenemende druk om ’n betroubare en volhoubare bron van elektrisiteit te verskaf. “Demand side management” (DSM) bied ’n korttermyn oplossing hiervoor. Gedurende 2009 het die mynbousektor bygedra tot 16% van die totale elektrisiteitsverbruik in Suid-Afrika. Mynbou is dus een van die hoof teikens van die Eskom DSM-program.

Die mynbousektor gebruik pneumatiese stelsels vir ’n wye verskeidenheid van toepassings en produksieprosesse. Daar is baie geleenthede om die elektrisiteitsverbruik van hierdie pneumatiese stelsels te verminder. Noemenswaardige besparings in elektrisiteitskoste is nie moontlik deur die druk aanvraag van pneumatiese stelsel te verlaag, sonder om die bron dienooreenkomstig aan te pas nie.

Tot onlangs het kompressorbeheer bestaan uit kontinue gebruik van die kompressors, ongeag van die aanvraag van die pneumatiese stelsel. Energie word deurgaans vermors deur oortollige saamgeperste lug wat in die atmosfeer in afgeblaas word. Dit is tipies van ’n kompressorstelsel wat volledig handmatig beheer word.

’n Rekenaarbeheerde energiebestuursoplossing word benodig om noemenswaardige besparings in elektrisiteitskoste op myn kompressorstelsels te bewerkstellig. Hierdie behoefte is aangespreek deur die ontwikkeling van ’n energiebestuur-sisteem. Hierdie sisteem staan bekend as energiebestuur-sisteem (EMS) en is in staat om kompressors aan te skakel; af te skakel; te laai en te ontlaai. Hiermee saam word die kompressor-uitset beheer om ’n gewensde druk stelpunt te handhaaf.

In hierdie studie word die ontwikkeling en implementering van EMS op tien verskillende kompressorstelsels bespreek. Outomatiese kompressor kapasiteitbeheer was geïmplementeer terwyl ’n operateur kompressors handmatig aanskakel, afskakel, laai of ontlaai volgens die EMS beheer-skedule.

Gesentraliseerde kompressor-beheer is een van die hoof voordele wat deur EMS gebied word, spesifiek vir pneumatiese stelsels wat bestaan uit verskeie kompressorstelsels met verskillende geografiese liggings. EMS het effektiewe en volhoubare verlagings in elektrisiteitsverbruik behaal op al tien die pneumatiese stelsels.

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NOMENCLATURE

ºC	Degree Celsius
A	Ampère
CRCED	Centre for Research and Continued Engineering Development
CSV	Comma Separated Values
DLL	Dynamic-Link Library
DSM	Demand Side Management
E-mail	Electronic mail
EMS	Energy Management System
ESCos	Energy Service Companies
FT	Flow Transmitter
GUI	Graphical User Interface
GW	Gigawatt
GWh	Gigawatt-hour
HMI	Human Machine Interface
i	Angle of attack
IDE	Integrated Development Environment
I/O	Input and output
IGV	Inlet Guide-Vane
kg/s	Kilogram per second
kPa	Kilopascal
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light Emitting Diode
LQG	Linear Quadratic Gaussian
m³/h	Cubic meter per hour
mm	Millimetre
mm/s	Millimetre per second
MW	Megawatt
MWh	Megawatt-hour
NERSA	National Energy Regulator of South Africa
Nm	Newton meter
OLE	Object Linking and Embedding
OOD	Object-Oriented Design
OPC	Object Linking and Embedding for Process Control
P_{in}	Total input pressure
P_{out}	Total output pressure
PCP	Power Conservation Programme
PI	Proportional-Integral
PID	Proportional-Integral-Derivative
PLC	Programmable Logic Controller
PT	Pressure Transmitter

R	Rand
R^2	Coefficient of determination
REDS	Regional Electricity Distributors
rpm	Revolutions per minute
RS-422	Recommended Standard 422
SCADA	Supervisory Control and Data Acquisition
SCL	Surge Control Line
SLL	Surge Limit Line
SMS	Short Message Service
SP	Set-point
TOU	Time of Use
UML	Unified Modelling Language
V	Volt
VGD	Variable Geometry Diffuser
VSD	Variable Speed Drive