Improved mine cooling system performance through the control of auxiliary systems

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Abstract

Title: Improved mine cooling system performance through the control of auxiliary systems

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Keywords: Integrated Demand Management; Energy saving strategies; Baseline; Simulation; Evaporator flow control; Condenser flow control; Cooling tower flow control

Industrial and mining sectors are amongst the largest single energy consumers in South Africa, making them a primary focus for implementing energy saving initiatives.

Refrigeration systems on mines are responsible for consuming up to25 % of the electrical energy consumption on a typical South African deep level mine. Ample opportunities to reduce the energy consumption of these systems exists, as many of the current systems rely on old technology and function under partial or inadequate control management.

In compiling this thesis, various energy saving strategies on deep level mines were investigated. In specific, the effects of controlling and improving the cooling auxiliaries. Scenarios were investigated and simulated, where after an optimum solution was implemented. Implementations, such as the ones covered in this dissertation, form part of the IDM (Integrated Demand Management) energy efficiency incentive introduced by Eskom, where funding is made available based on actual power saving; ensuring that the projects will be financially viable to the clients.

Reduced electrical energy consumption realised from the abovementioned projects were measured, captured and compared to the consumption before project implementation to determine the achieved savings. Savings of up to 30 % of the plant installed capacity were realised, providing average savings of up to 2.3 MW per day.

Samevatting

Titel: Verbeterde myn verkoelingstelsel prestasie deur die beheer van hulptoestelle
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Departement: Meganiese Ingenieurswese
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Sleutelterme: Integrated Demand Management; Energy saving strategies; Baseline; Simulation; Evaporator flow control; Condenser flow control; Cooling tower flow control

Die industriële-en mynbou sektore is van die grootste enkel energieverbruikers in Suid Afrika. Daarom is die sektore 'n primêre beginpunt om inisiatiewe vir energiebesparings te implimenteer.

Verkoelingstelsels op myne is verantwoordelike vir soveel as 25 % van die totale energieverbruik van 'n tipiese diep vlak myn in Suid Afrika. Genoegsame geleenthede is beskikbaar om die energieverbruik van die sulke sisteme te verminder aangesien baie van die stelsels van ou tegnologie en beperkte beheerstelsels gebruik maak.

Met die samestelling van hierdie verhandeling is verskeie strategieë vir energie besparing op diep vlak myne ondersoek. Spesifiek die beheer en verbetering van die verkoelingstelsel se hulptoestelle. Verskillende gevalle is ondersoek en gesimuleer, waarna 'n optimum oplossing geïmplimenteer is. Die betrokke implimenterings, soos in hierdie verhandeling, vorm deel van Eskom se IDM ("Integrated Demand Management") geleentheid vir aansporing tot energiedoeltreffendheid waar Eskom befondsing beskikbaarstel wat gebaseer is op werklike kragbesparings. Dit verseker dat die projekte finansieël lewensvatbaar sal wees vir die kliënte.

Die verminderde energieverbruik deur die bogenoemde projekte verkry is gemeet, opgeneem en vergelyk met die energieverbruik voor die implimentering van die projek om te bepaal wat die besparing was. Besparings van tot 30 % op die verkoelingstelsel se geïnstalleerde kapasiteit is behaal met gemiddelde besparings van tot en met 2.3 MW per dag.

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Nomenclature, sub and super scripts, Greek letter, tables and figures

Abbreviations

BAC	Bulk Air Cooler
DB	Dry Bulb
IDM	Integrated Demand Management
MCC	Motor Control Centre
PLC	Programmable Logic Controller
PVC	Poly Vinyl Chloride
VSD	Variable Speed Drive
WB	Wet Bulb

Nomenclature

A	Flow admittance [m^4]
COP	Coefficient of performance [-]
c_p	Specific heat at constant pressure [J/kg.ºC]
e	Control error [-]
h	Enthalpy [kJ/kg]
K	Gain constant [-]
m	Mass flow [kg/s]
O	Control output [-]
PL	Partial load fraction [-]
Pwr	Power [kW]
$\dot{Q}$	Cooling capacity [kW]
T	Temperature [ºC]
UA	Heat transfer coefficient [W/ ºC]

Sub and superscripts

a	Air
cond	Condenser
evap	Evaporator
i	Inlet
in	Integral
int	Integrated
mot	Motor
p	Proportional
pmp	Pump
ref	Reference design condition
o	Outlet
sat	Saturated water vapour

Greek letters

ρ	Density [kg/m^3]
φ	Saturated enthalpy/water temperature ratio [-]
Δ	Difference [-]
η	Efficiency [-]

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