

# The use of simulations to identify operational improvements on deep level mine compressed air systems

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## **Abstract**

As operational costs of deep level mines increases and gold ore grades decrease, profitability in the gold mining sector is becoming difficult. Electricity tariff increases have contributed a rise in cost to operate a mine. Compressed air systems utilise a large portion of a mine's total energy. It has been shown that many deep level mine compressed air networks have large inefficiencies and often can not meet performance set-points. Therefore improving the efficiency could result in a reduction of operational costs by reducing the energy required to produce compressed air. Additionally an improvement in service delivery could be achieved.

Previous studies have shown the usefulness of simulations to develop improvements for large mining systems. J. Marais developed a simplified "vessel" model of a mining compressed air system. CJR Kriel created a simulation using KY pipe software to validate intervention proposals. AJM van Tonder developed an innovative component model to simulate dynamic compressor selection (DCS).

A simulation methodology was developed to achieve the study objects. Firstly an investigation into the compressed air system is performed. Next a model is developed in software to accurately recreate the system outputs. Finally an proposed method of improvement is simulated, analysed and quantified in terms of improvements in energy savings and service delivery.

Two case studies were evaluated. For each case study a variety of methods of improvements were simulated. In case study by reducing air used by refuge bays in simulation, a reduction of 1 MW E.E. would be achieved with addition to an improvement of 18 kPa to system pressure.

The study showed that simulation is a important tool for identification improvements in large compressed air systems. The value of simulation is the ability to accurately predict outcomes of interventions without doing costly tests on an actual system.

# Contents

<b>Abstract</b>	<b>ii</b>
<b>List of symbols</b>	<b>iv</b>
<b>Acronyms</b>	<b>v</b>
<b>Glossary</b>	<b>vi</b>
<b>1 Introduction and background</b>	<b>1</b>
1.1 Preamble . . . . .	1
1.2 Background on deep level mining . . . . .	1
1.3 Mining compressed air systems . . . . .	1
1.4 Simulations in industry . . . . .	1
1.5 Problem statement and objectives . . . . .	1
1.6 Dissertation overview . . . . .	1
<b>2 Literature study</b>	<b>2</b>
2.1 Preamble . . . . .	2
2.2 Inefficiency identification methods . . . . .	2
2.3 Review of operational improvements implemented in compressed air systems . . . . .	2
2.4 Use of simulation to identify improvements in mining systems . . . . .	2
2.5 Conclusion . . . . .	2
<b>3 Developing a simulation methodology</b>	<b>3</b>
3.1 Preamble . . . . .	3
3.2 Investigation . . . . .	3
3.3 Model development and verification . . . . .	3
3.4 Implementation of method . . . . .	3
3.5 Conclusion . . . . .	3
<b>4 Results and validation</b>	<b>4</b>
4.1 Preamble . . . . .	4
4.2 Case study: Mine A ( <a href="#">Kusasaletu</a> ) . . . . .	4
4.3 Case study: Mine B ( <a href="#">Beatrix 123</a> ) . . . . .	4
4.4 Validation of results . . . . .	4
4.5 Conclusion . . . . .	4
<b>5 Conclusion</b>	<b>5</b>
5.1 Conclusion . . . . .	5
5.2 Limits of this study . . . . .	5
5.3 Recommendations for future studies . . . . .	5
<b>A Something</b>	<b>6</b>
<b>B Something else</b>	<b>7</b>

# List of symbols

# Acronyms

# Glossary

# Chapter 1

## Introduction and background

### 1.1 Preamble

### 1.2 Background on deep level mining

#### 1.2.1 Mining profitability

Background on rising mining costs (energy, wages, etc), falling ore grades and Eskom tariffs.[1]

#### 1.2.2 Mining systems and energy

Focus on mine electrical energy users. Compressed air and its inefficiencies

#### 1.2.3 Need to improve service delivery

### 1.3 Mining compressed air systems

v

#### 1.3.1 Compressed air in operation

#### 1.3.2 Characteristic inefficiencies

#### 1.3.3 Inefficiency identification methods

#### 1.3.4 Instrumentation and measurements

### 1.4 Simulations in industry

### 1.5 Problem statement and objectives

### 1.6 Dissertation overview

# Chapter 2

## Literature study

### 2.1 Preamble

### 2.2 Inefficiency identification methods

Johan Marais benchmarking method.

#### 2.2.1 Summary

### 2.3 Review of operational improvements implemented in compressed air systems

#### 2.3.1 Summary

### 2.4 Use of simulation to identify improvements in mining systems

KY pipe -i PTB .

DCS

Kobus von tonder

SW

Matthews v. Niekerk

Jeandre Jonker

#### 2.4.1 Summary

### 2.5 Conclusion



## Chapter 3

# Developing a simulation methodology

### 3.1 Preamble

### 3.2 Investigation

#### 3.2.1 Layouts, Data from SCADA Instrumentation, etc.

#### 3.2.2 Manual measurements, audits and approximations

#### 3.2.3 Mining schedule philosophies - (drilling, blasting shifts, etc.)

#### 3.2.4 Summary

### 3.3 Model development and verification

#### 3.3.1 Compressed air component models

#### 3.3.2 Simulation inputs

#### 3.3.3 Verification of model

#### 3.3.4 Summary

### 3.4 Implementation of method

#### 3.4.1 Analyses of data

#### 3.4.2 Quantifying operational improvements

#### 3.4.3 Summary

### 3.5 Conclusion

## Chapter 4

# Results and validation

### 4.1 Preamble

### 4.2 Case study: Mine A ([Kusasaletu](#))

#### 4.2.1 Background

#### 4.2.2 Scenario 1. Refuge bay simulation

#### 4.2.3 Scenario 2. Closing off levels/stopes

#### 4.2.4 Scenario 3. Periodic simulation

#### 4.2.5 Summary

### 4.3 Case study: Mine B ([Beatrix](#) )

#### 4.3.1 Background

#### 4.3.2 Compressor set points

#### 4.3.3 Control valves set points

#### 4.3.4 Summary

### 4.4 Validation of results

### 4.5 Conclusion

## Chapter 5

# Conclusion

### 5.1 Conclusion

### 5.2 Limits of this study

### 5.3 Recommendations for future studies

# Appendix A

## Something

Appendix B

Something else

# Bibliography

- [1] P.N. Neingo and T. Tholana. Trends in productivity in the south african gold mining industry. *The Journal of the South African Institute of Mining and Metallurgy*, 2016.