

CHAPTER 5



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“Small is the number of people who see with their eyes and think with their minds.” – Albert Einstein

¹⁷ Photo taken by HVACI personnel at a South African mine.

5 CONCLUSION AND RECOMMENDATIONS

5.1 Summary

5.1.1 Reconfiguring mining compressed air network potential

Research proved that the continuous implementation of DSM initiatives is vital to provide for a healthy and sustainable economic future in South Africa. Furthermore, it was discovered that a mine's compressed air network is one of the ideal targets for the implementation of DSM strategies. This is due to its inefficient operation, which in turn makes it one of South Africa's major electricity consumers.

Over the years, DSM initiatives have been widely implemented on South African mining compressed air networks. These initiatives ranged from controlling the supply side, fixing air leaks to controlling the demand side. One initiative not widely implemented is the physical reconfiguration of these networks. This scenario presented major cost saving opportunities, especially on very old and inefficient mining compressed air networks.

5.1.2 Investigations and strategy development

The compressed air networks of two South African gold mines were identified for possible implementation of reconfiguration strategies. Each network consisted of at least three shafts, connected by different reticulation (piping) networks. It was therefore necessary to develop a reconfiguration strategy that would be applicable for both networks.

It was discovered that system, operational and solution analyses were required to reconfigure each network. The purpose of the system analyses was to provide sufficient information of the network's sources and requirements. Considering the information gathered from the system analysis, the network data had to be evaluated during the operational analysis to identify reconfiguration potential of each network. With all the information in hand, reconfiguration solutions were identified.

5.1.3 Theoretical analysis

Mine C's analysis presented the opportunity to relocate a compressor from an abandoned shaft to the main production shaft in the network. The strategy was based on vandalism

activities on the compressor at the abandoned shaft and a required surface delivery increase at the main shaft.

Mine D’s compressed air network could be reconfigured by connecting two shafts with an interconnecting pipeline. The solution was developed to reduce the amount of excess compressed air delivered to the network. Two options for interconnecting the shafts were presented. The options included a surface and underground interconnecting pipeline.

Simulations were developed for the compressor relocation at Mine C. The outcome of the simulations indicated that the reconfiguration solution would comply with all the network’s requirements. Furthermore, an average surface pressure increase of 40 kPa was predicted for the main shaft. This pressure would be sufficient for the predicted production increase at Mine C’s main shaft. The solution was therefore selected for implementation at Mine C.

Simulations proved that Solution B for Mine D’s network would not be viable. The surface pipeline was therefore chosen for implementation as the underground pipeline did not comply with Mine D’s network pressure requirements. However, it was discovered that the requirements would be met if the pipe diameters and compressor discharge set points were increased.

The theoretical analysis presented major cost savings potential for both mines. Both mines had salvaged equipment such as steel pipes and a refurbished compressor available that substantially reduced the implementation cost. Table 17 gives a brief summary of the proposed cost savings by implementation of the reconfiguration strategies on Mine C and Mine D’s compressed air networks.

| Proposed Cost Savings | | | | | | |
|------------------------------|-----------------------------------|---|------------------------------------|---|---|---|
| Option | Daily Average Power Saving | Financial Electricity Savings (Lifespan of Mine) | Initial Implementation Cost | Implementation Cost (Salvaged Equipment) | Implementation Cost Payback Period | Total Cost Saving (Lifespan of Mine) |
| Mine C | | | | | | |
| Solution A | 2 100 kW | R 170 000 000 | R 15 000 000 | R 6 000 000 | 6 months | R 164 000 000 |
| Mine D | | | | | | |
| Solution A | 1 900 kW | R 8 600 000 | R 10 000 000 | R 500 000 | 3 weeks | R 8 100 000 |
| Solution B | 1 400 kW | R 6 200 000 | R 10 000 000 | R 500 000 | 4 weeks | R 5 700 000 |

Table 17: Proposed cost savings for implementing reconfiguration strategies

It is evident from Table 17 that Solution A and Solution B for Mine D would not have been viable in the absence of salvaged equipment. The initial implementation cost would have

been higher than the predicted financial savings over the lifespan of the mines. This would have contradicted the initiative of reconfiguring mining compressed air networks for cost savings. A substantial increase in cost savings was achieved by using salvaged equipment.

Solution A for Mine C predicted a large cost saving over the lifespan of the mine with a relatively short payback period. Furthermore, Solution A for Mine D presented the largest daily average saving of 1 900 kW of the two proposed solutions. Solution A for Mine D also had a very short payback period and was therefore chosen for implementation.

5.1.4 Implementation and results

The reconfiguration strategies were presented to the respective mines for approval. The strategies were approved and installations to relocate the compressor at Mine C commenced in March 2013. The projected completion date for the installations is by the end of May 2014. The installations are currently in progress and no implemented results could be verified.

Installations for the proposed interconnecting pipeline at Mine D commenced early 2012. Final commissioning on the pipeline occurred by the end of October 2012. An additional control valve for optimised control was installed on the pipeline and final commissioning of the total system occurred by the end of February 2013. After implementation, a consecutive three-month PA period commenced to prove the validity of the proposed savings. Table 18 presents the actual results obtained after reconfiguring the network.

| Actual Cost Savings by Reconfiguring Mine D's Compressed Air Network | | | | | |
|---|--|---|---|---|---|
| Option | Daily Average Power Saving (PA) | Daily Average Power Saving (Fixed Leaks) | Financial Electricity Savings (Lifespan of Mine) | Implementation Cost Payback Period | Total Cost Saving (Lifespan of Mine) |
| Solution A | 1 700 kW | 2 000 kW | R 9 400 000 | 18 days | R 8 900 000 |

Table 18: Actual cost savings after reconfiguring Mine D's compressed air network

According to Table 18 an average daily power saving of 1 700 kW was achieved during PA. After the PA, Mine D fixed major air leaks in the underground network at 1#, resulting in an improved saving of 300 kW. If the mine continues to rectify the air leaks, a predicted cost saving of R8.9 million could be achieved over the lifespan of the mine.

The proposed power saving on Mine D's compressors was predicted with an average error margin of 12%. The error margin decreased to 9% after the leaks in the network were fixed.

These error margins display an accurate analysis of the network and interpretation of the proposed solutions. Due to the successful implementation on Mine D's compressed air network, it is safe to state that substantial cost savings can be achieved by reconfiguring mining compressed air networks.

5.2 Future work and recommendations

The study focused on reconfiguring mining compressed air networks for cost savings. In particular, the surface compressed air networks of two South African mines were reconfigured. The author is of the opinion that reconfiguration procedures could be applied to any large industrial system that uses a complex or old compressed air reticulation network.

Furthermore, reconfiguration strategies could be applied to underground reticulation networks in the mining industry. These underground networks are very old and intricate, which makes them ideal targets. Some of the pipe sections are not even being used anymore, which wastes compressed air to be constantly pressurised. Compressed that could have rather been converted into electrical energy savings.