The development of the centre-mounted scrubber for Joy mechanical miners at Khutala

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Synopsis

The introduction of the Guidelines for the Compilation of a Code of Practice for Mechanical Miner Sections precipitated a flurry of activity to meet and maintain the stipulated requirements of the guidelines. This, coupled to the Department of Minerals and Energy (DME) Directive issued in 1977, spurred the mining industry into activity to meet the laid down parameters.

One of the requirements of the guidelines was the reduction of dust levels to below 5mg/m^3. A lot of developmental work was done to find suitable arrangements that would ensure compliance with the guidelines. The initial experimentation laid a solid foundation for the development and refinement of the current generation scrubbers and dust suppression technology that has seen the dust readings decline industry wide to the required levels.

Further work by the OEMs on dust suppression systems was refined by the CSIR-Miningtech, resulting in the standard stipulated in COL 518 (Mechanical Miner Environmental Control1). The improvement in environmental conditions in the coal winning headings improved in leaps and bounds, and that lulled the entire industry into a false comfort zone with no further work being done to refine and improve the dust suppression technology.

The development of the centre-mounted scrubber was sparked off largely by the vacuum cleaner principle. In observing a cleaner vacuuming the carpets, one of the managers remarked that the current approach to dust suppression was flawed in that we allow the dust to be airborne, and then hope to capture it. Dust should be captured at source in the same way that a vacuum cleaner does.

Introduction

Despite the unparalleled success of the current generation scrubber boxes, the incidents of damage to the scrubber boxes is phenomenal, and shows no signs of abating. In today's economic climate it is no coincidence that commercial considerations are given prominence.

The scrubber box, as an 'optional extra' to the continuous miner, is not integrated into the design of the machine. It stands out on the machine, exposing it to damage. The reluctance of the continuous miner manufacturer to redesign their machines to make the scrubber an integral part of the machine, coupled with the short-sighted view of the scrubber box suppliers and the indifference of the mining industry has contributed to the status quo being perpetrated.

The need to integrate the dust suppression system into the continuous miner drove the desire to design the centre-mounted scrubber. The prohibitive cost of maintaining and replacing the scrubber boxes had to be challenged at one time or another. The machine design, or alternatively, the positioning of the scrubber box had to be revisited to integrate the scrubber into the overall design of the CM. The main aim being to protect the scrubber from continual damage it is exposed to sitting on the side of the CM. Although rub-rails reduced damages to the scrubber boxes, they never completely eliminated it.

Design Considerations

The first tentative approaches looked at reducing the size of the scrubber box while maintaining the same volumes and effectiveness. The efforts in this direction were all in vain when first the quantity could not be met, and the noise pollution factor became more pronounced. The demister vanes, when the quantities were eventually achieved, failed to remove water from the scrubbed air. The next alternative would have to be the repositioning of the current scrubbers where they will be less susceptible to damage.

After lengthy experimentation on the various positions to mount the scrubber, the area above the flight chain conveyor was found to be the most suitable. The Type-30 Engart scrubber box was turned on its side, and the geometry of the box was altered to draw air from beneath the cutter boom, and the exhaust was angled to one side to avoid discharging air over the flight chain conveyor. Two air movers were installed on the sides to confine the dust below the cutter head. The water from the sump is discharged directly onto the flight chain conveyor, wetting the coal before it is tipped into the shuttle car.

The spray configuration was altered from the spray fan system to the old block spray system. The combination of the scrubber and sprays induced flow patterns around the cutter head drawing air from above the cutter head to the scrubber intake below.

System Effectiveness

Initial results showed compliance with the $5mg/m^3$ requirement. The scrubber effectiveness met the required criteria. The good results did not last long though. After the test phase the dust counts exceeded the $5mg/m^3$.

Because the emphasis and spotlight had shifted from the machine, maintenance wasn't done with the same dedication, as was the case during the test phase. Remedial measures were put in place to address the maintenance of the machine, but that had only limited success. On further investigation, it was established that the system had inherent limitations.

Furthermore, the extraction point below the boom worked effectively when the CM sumped in at the top and while shearing the upper portion of the coal face. During the cutting of the lower portion of the face and the trimming of the floor, the dust roll back was high. The dust-laden air had no means of getting to the scrubber intake. This accounted for the fluctuating readings that followed, from very good to very poor readings.

To address the problems that were encountered, the following modifications were done:

- A maintenance regime was implemented to ensure optimal operation of the scrubber at all times.
- The crew was trained to clean the screens in situ.
- The scrubber intake was repositioned to be above the cutter boom when the boom is completely lowered.

The above changes brought about some measure of decency to the dust readings, but did not entirely resolve the maintenance issue, which from time to time fell into neglect. A way had to be found to engineer the human factor out of the dust scrubbing effectiveness of the system.

Second Generation Centre Scrubber

Having sorted out the basic fundamentals, the second generation centre-mounted scrubber was not long coming. It was proved in principle that the centre-mounted scrubber had the potential to work without major damage to it. The challenge laid in finding means to keep the system clean for sufficiently long periods to reap the systems benefits.This would also negate the influence exerted by the human factor on the effectiveness of the system. To this end, the following refinements were adopted to further improve the scrubber box.

- The scrubber box was equipped with a high pressure back flush system to clean out the screens without having to open the scrubber box.
- The spray configuration was altered by replacing the two air movers with L-brackets.
- The scrubber inlet was slanted to reduce entrance velocities and to provide scrubber intake when the cutter head is shearing heights less that 1 metre or trimming the floor.
- The scrubber delivery was angled away from the shuttle car operator.

Results of the second generation dust suppression system

The CM equipped with the second generation dust suppression system is now in operation for just over three months, and has recorded the following average dust readings taken over a full month:

November 1999 -	2.09 mg/m^3
December 1999 -	3.69 mg/m^3
January 2000 -	2.26 mg/m^3
February 2000 -	2.62 mg/m^3

The above results have been achieved without once having to open the scrubber box for cleaning purposes. On occasions the scrubber box was opened for inspection, it was found to be clean.

Cost comparison

The repair costs for standard scrubber boxes average about R0.11/ton. The centre mounted scrubber averages R0.04/ton, most of which were incurred in the development stages.

There has been no catastrophic failure due to operational damage. The only exposure to catastrophic damage appears to be a fall of roof.

Methane concentrations during coal winning operations

Most of the methane readings recorded during a five-day test period were below the accuracy level of the sensors used. As a result the logger created graphs that were inaccurate.

Concluding remarks

The principle behind the success of this dust suppression system is not rocket science. It applies the same curtain principle as the Kloppersbos system. Only in this case, the cutter boom is used as the curtain.

The main selling point of this system is the intake point that is as close to the source as possible. The system becomes more effective when the cutterhead is up during sumping at the

Noise measurements performed at operator's side of machine

Position	Scrubber Working No Cutting (dB)	Scrubber Working Cutting (dB)	Background Noise (dB)
At Operator	96	104	74
3m away	94	102	72

top and the subsequent shearing of the upper half of the coal seam when most of the dust is generated.

Because of Khutala's low gas emission rates, it cannot be conclusively said that the ventilation arrangement in the coal winning heading is sufficient to dissipate methane. Further tests would have to be done to quantify the systems effectiveness with regard to methane dissipation.

It was subsequently discovered that the scrubber box design is only suited to JOY HM17 and not the HM9s and HM21s (which comprise a sizeable portion of the Khutala continuous miner fleet) due to the pivot point that is positioned further back than the HM17s. The final decision to implement the system mine-wide seems to have been torpedoed by the systems inability to fit onto the other machines. Moreover, the dust reductions achieved, (viewed in terms of the economies of scale for Khutala) with the centre scrubber do not warrant the establishment of a new series of dust scrubbers especially for the JOY HM9.

Refinement of the system is ongoing to find a design suited for the entire JOY fleet.

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References

Belle, B. K., du Plessis J.J.L, "Mechanical Miner Environmental Control: Summary Report and Appendix", SIMRAC Draft Final Report Project No. 518.