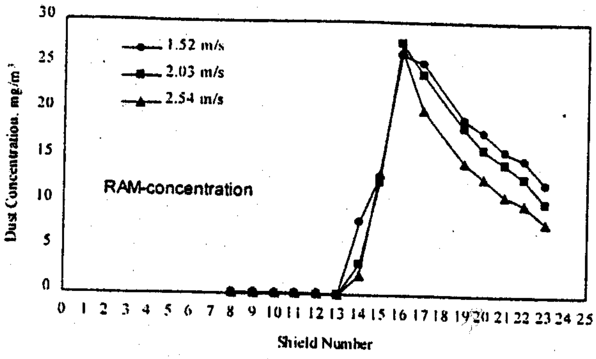

Figure 6. Average RAM-dust concentration levels along the longwall gallery in SPSS

those at the tailgate operator (shield 13). Immediately downwind of the head gate drum (shields 11 and 12), the concentration does not increase. However, it rises steeply downwind of shield 12, exposing the tailgate operator to the headgate drum dust. Immediately downwind of the tailgate operator (shield 13), the concentration increases from the tailgate drum dust source. However, after shield 16, it decreases towards the tailgate. Overall, the concentration at the return station is lowest when compared to that of tailgate operator (shield 13), 2/3rd downwind of the shearer (shield 18) and shield 19.

In Figure 6, the average dust concentrations measured by the RAMs at each shield from shield number 8 to shield number 23 are shown for the three velocities. These concentrations are calculated from the RAM plots for each experiment. The dust profile for the locations, 1/3rd upwind of the shearer, headgate operator and return location for different test conditions, were of similar pattern. As the shearer is between shield 10 and shield 16, it is evident that the shearer dust contamination of the walkway air starts between shield 13 and 14 and increases to a maximum between shields 16 and 17. The effect of increased air quantity on concentrations is more pronounced downwind of shield 16. These data indicate that the location of miners downwind of shield 14 is not advisable.

TPSS results

The TPSS experiments were performed at three air/water pressures (414 kPa, 552 kPa and 690 kPa) and three face air velocities (1.52 m/s, 2.03 m/s and 2.54 m/s). The average of the two gravimetric dust concentration measurements at the various sampling stations is shown in Figure 7 (left plot). The pattern shown is similar to that of SPSS results. As in the case of SPSS, the concentrations at the headgate operator and shearer mid-point are quite low whereas those at the tailgate operator are comparatively very high. As shown in Figure 8, for a constant pressure, increase in airflow decreases the dust concentration at the stations. On the other hand, though pressures higher than 414 kPa lead to lower concentrations at all stations except at shield 18, the effect of increasing pressure at a constant airflow on concentration is not as distinct.

In Figure 7 (right plot), the average dust concentrations

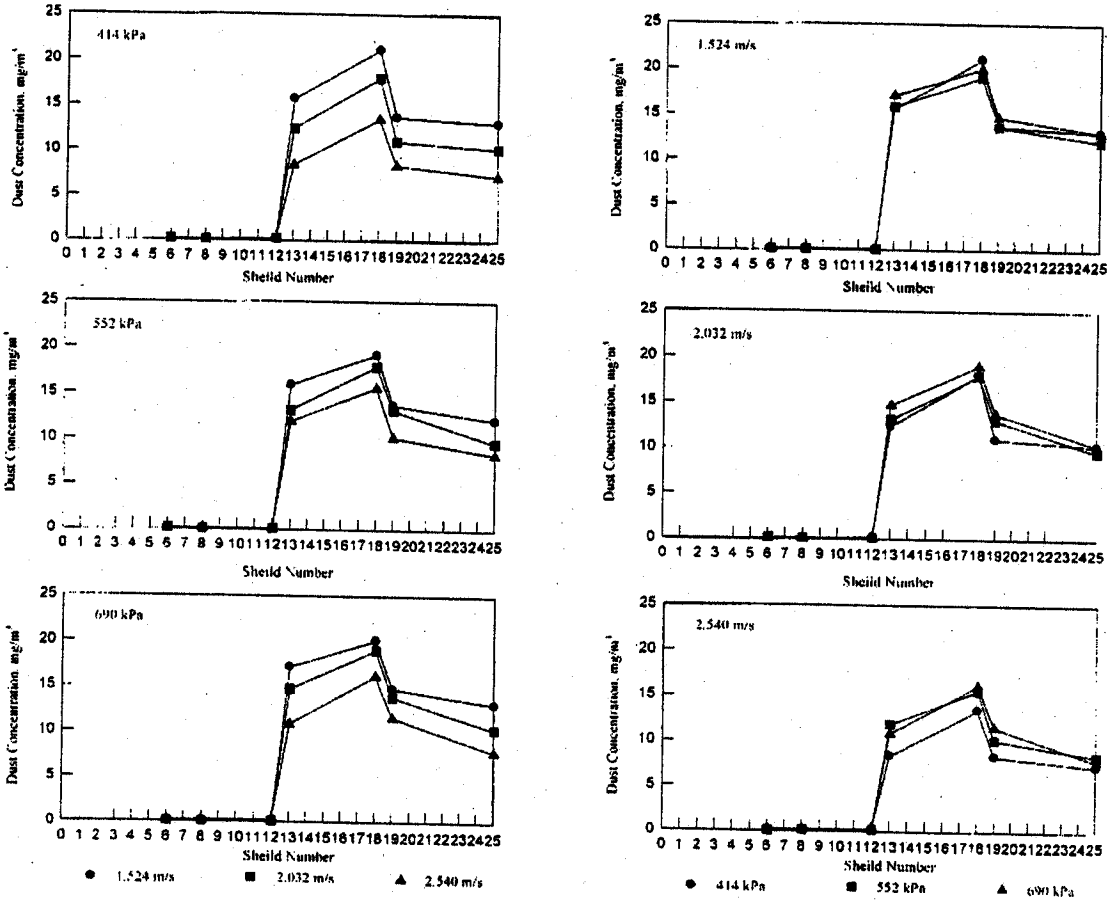

Figure 7. Average dust concentration levels (left plot) and average RAM-dust concentration levels (right plot) along the longwall gallery in TPSS

measured by the RAMs at each shield from shield number 8 to shield number 23 are shown for the three air velocities. The pattern of dust concentration increase around the shearer is similar to that noted in SPSS. Higher RAM concentrations in all the eighteen experiments (3 pressures × 3 air velocities × 2 replicates) was reached at shield 16. In all cases, these concentrations are higher than the highest SPSS concentrations (3 pressures × 2 replicates = 6 experiments). The increase in dust concentration levels between shield numbers 13 and 18, probably resulted due to the rollback of dust onto the walkway. As opposed to the experiments reported in a continuous miner gallery or a laboratory set-up[10,12], the walkway location in the longwall gallery is relatively close to the sprays for the dust rollback to influence the ambient concentration in the walkway. The decrease in the dust concentration from shield 19 towards shield 24 is due to knockdown, deposition and diffusion of the dust.

In the RAM data, the highest concentration for both TPSS and SPSS was noted at shield 16. In SPSS, this concentration was 27.74 mg/m³ at 2.03 m/s velocity. In TPSS, the experimental condition at which the highest concentration observed was 690 kPa pressure and 1.52 m/s velocity. The highest concentration was 38.61 mg/m³. RAM samplers have shown to be affected by water sprays and the smaller droplet size and greater number of droplets with TPSS may have more impact on the RAMs. Gravimetric results suggest that, in general, dust levels with TPSS were equal to or less than dust levels with SPSS (Figures 5 and 7 [left plot]).

Using the RAM data, the rates of change of concentrations in SPSS and TPSS were calculated for the following locations and are shown in Table II: (a) the rate of increase in concentration from shield 14 to shield 16, (b) the rate of decrease in concentration from shields 16 to 19, and (c) the rate of decrease in concentration from shields 19 to 23. In TPSS, the average rate of increase of concentration from shields 14 to 16 is lower with higher pressures. The average rates of decrease in concentration between shields 16 and 19, and shields 19 to 23 in TPSS are also lower at higher pressures. When SPSS results are compared with TPSS results, it is noted that there is no consistent pattern. However, the higher rates of decrease in concentration in TPSS may be the result of greater atomization of spray. These results suggest that the performance of TPSS is better than SPSS downwind of the shearer.

Water and energy consumption in SPSS and TPSS

The water consumptions at different pressures in both SPSS and TPSS are shown in Figure 8 (top plot). At all pressures, the water consumption in SPSS is higher than those in TPSS. In TPSS, at 690 kPa water and air pressure, the water consumption is 26.45 L/min. In the case of SPSS, at 1035 kPa, the water consumption is 39.74 L/min. The power consumptions in SPSS and TPSS are shown in Figure 8 (bottom plot). TPSS consumes approximately six times more power than SPSS at high pressure.

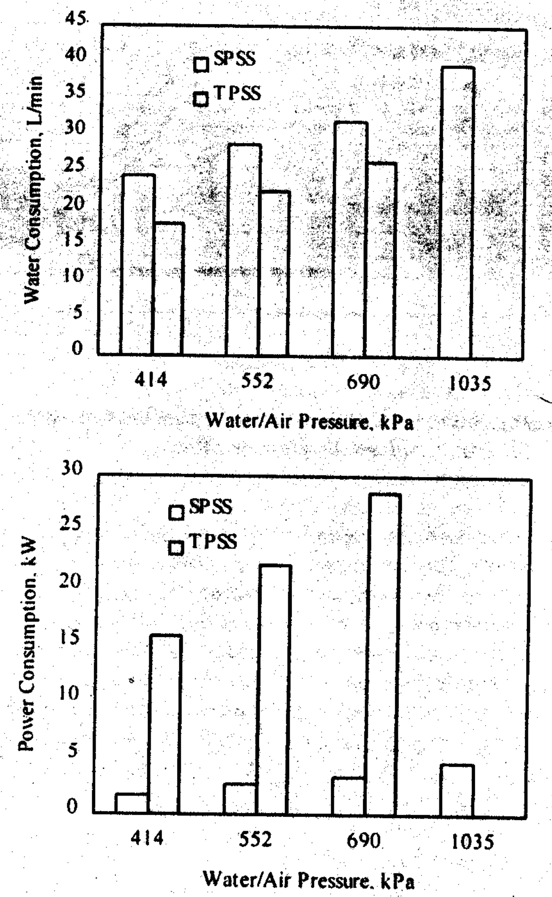

Figure 8: Water consumption (top plot) and power consumption (bottom plot) in TPSS and SPSS

Table II
Rates of change of concentration in SPSS and TPSS

	SPSS			TPSS								
	1035 kPa			414 kPa			552 kPa			690 kPa		
	Face Air Velocity, m/s			Face Air Velocity, m/s			Face Air Velocity, m/s			Face Air Velocity, m/s		
	1.52	2.03	2.54	1.52	2.03	2.54	1.52	2.03	2.54	1.52	2.03	2.54
Rate of increase, Shield 14 to 16, mg/m³/shield.	9.18	12.15	12.35	11.73	13.41	15.84	10.46	10.94	13.26	13.04	9.96	8.21
Average	11.23			13.66			11.55			10.40		
Rate of decrease, Shield 16 to 19, mg/m³/shield	2.35	3.13	4.10	2.89	3.79	7.69	4.13	3.09	4.29	5.96	3.67	1.65
Average	3.19			4.79			3.84			3.76		
Rate of decrease, Shield 19 to 23, mg/m³/shield	1.77	2.04	1.64	2.41	2.75	1.46	2.07	1.58	1.99	0.81	1.84	1.86
Average	1.82			2.21			1.88			1.50		

Comparison of SPSS and TPSS results

The highest gravimetric concentration in SPSS and TPSS experiments was at the 2/3rd downwind station (shield 18). In SPSS, this concentration was 21.34 mg/m³ at 1.52 m/s velocity. In TPSS, the experimental conditions at which the highest concentration observed were 414 kPa pressure and 1.524 m/s velocity. The highest concentration was 21.08 mg/m³.

Conclusions

The dust collection efficiencies of SPSS and TPSS were studied through experiments in a model longwall gallery. The experimental design consisted of 2 factors: spray water and air pressure, and ventilating airflow. Each factor had three levels. The differing spray characteristics of the chosen TPSS and SPSS nozzles did not allow a direct comparison of the two systems.

In the present experimental set-up, the dust rollback into the walkway may be a factor in the case of TPSS. Other important observations from this study are noted. The rate of decrease in concentration with TPSS is higher than that with SPSS. This may be due to the greater atomization of the water. Positioning of the personnel upwind of the tailgate drum is necessary to avoid high dust exposures.

The present set-up did not allow the study of conditions when coal is cut from tail to head where the potential for personal exposure is high. Changes in the experimental design are necessary to overcome some of the reasons expected for the inconclusive results. Some suggested areas are experiments with same nozzle types, same pressure conditions and higher TPSS pressures. This might have created a different air flow pattern around the shearer. While it appears that TPSS performed better than SPSS, the data is not sufficiently conclusive on this aspect.

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