Reduction of Respirable Dust Toxicity Using Dust Control Additives--Optimizing Additives and Applications Beyond Coal

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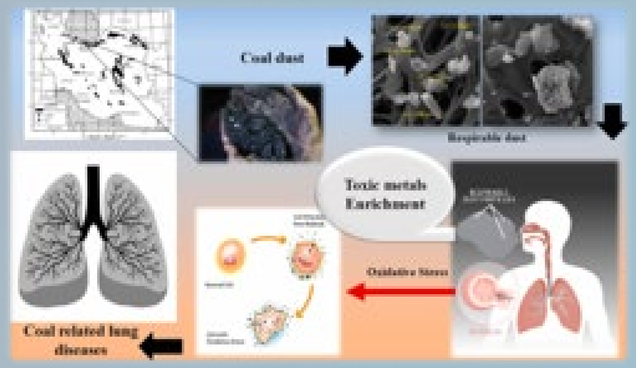
INTRODUCTION

- Respirable dust consists of airborne particles typically < 10µm
- Exposure to airborne respirable dust in coal mines leads to coal workers' pneumoconiosis (CWP).
- Coal dust particles oxidize, producing reactive oxygen species like hydroxyl radicals (•OH), which cause oxidative stress and lung tissue damage, contributing to dust toxicity.
- The Mine Safety and Health Administration (MHSA) has implemented new regulations to reduce the exposure of mine workers to respirable dust.
- Conventional techniques such as improved ventilation and wet dust collection reduce large particle concentrations. However, ineffective in mitigating respirable dust toxicity.
- Chemical dust Additives, such as carboxy methyl cellulose (CMC), offers a more effective and targeted approach.



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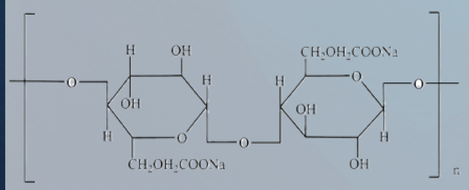
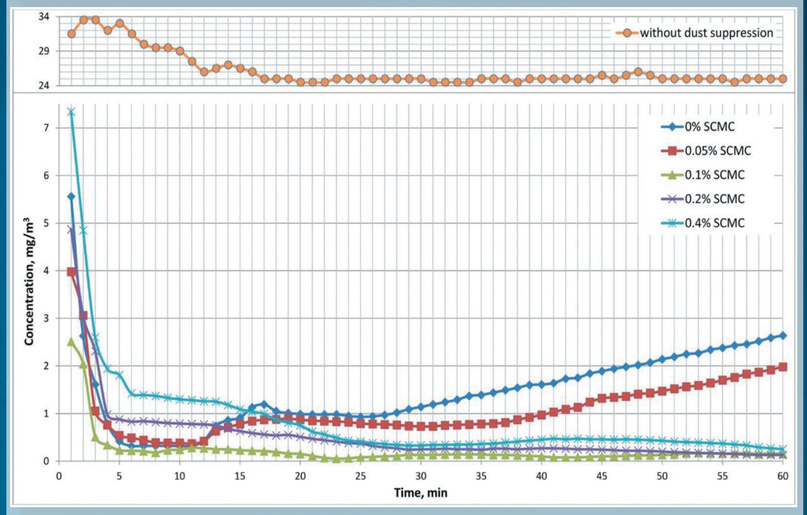
RESEARCH OBJECTIVES

- Determine the most effective type and dosage of CMC for the reduction of (•OH) generation in coal dust and other mineral dusts.
- Conduct performance tests in varying pH levels, water qualities, and simulated lung fluid to evaluate the effectiveness of CMC-based
- Investigate the application of CMC-based dust suppressants in non-coal mining environments.

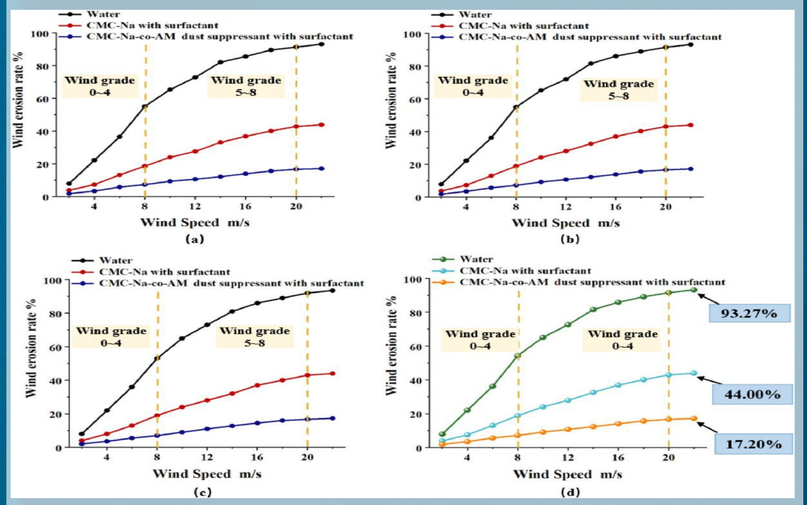


Xu and Pei, 2017

PREVIOUS STUDIES



Borowski et al, 2020



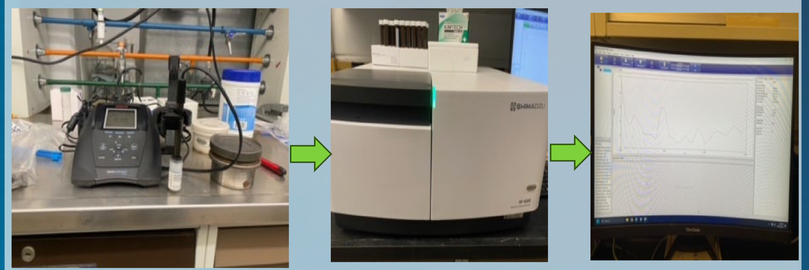
Nie et al, 2022

RESEARCH GAPS

- CMC is not a good wetting agent
- Numerous studies have been conducted on SCMC. However, none has addressed the effect on reduction of (•OH) generation in coal dust and other mineral dusts.
- Limited resources on free radicals derived from different coal rank which plays a significant role in coal dust toxicity.

FUTURE WORK

- Optimizing different types of CMC with commercial suppressant at different pH and dosage.
- Enhance dust wettability and reduce (•OH) generation in coal dust and other mineral dusts.
- Explore different surface chemistry properties (such as surface area, different functional groups) of coal dust particles.



REFERENCES

1. Borowski, G., Smirnov, Y., Ivanov, A. & Danilov, A. Effectiveness of carboxymethyl cellulose solutions for dust suppression in the mining industry. *Int. J. Coal Prep. Util.* **42**, 2345–2356 (2022).

2. Xu, L. & Pei, Z. Preparation and Optimization of a Novel Dust Suppressant for Construction Sites. *J. Mater. Civ. Eng.* **29**, 04017051 (2017).

3. Zazouli, M. A. *et al.* Physico-chemical properties and reactive oxygen species generation by respirable coal dust: Implication for human health risk assessment. *J. Hazard. Mater.* **405**, 124185 (2021).

4. Johann-Essex, V., Keles, C., Rezaee, M., Scaggs-Witte, M. & Sarver, E. Respirable coal mine dust characteristics in samples collected in central and northern Appalachia. *Int. J. Coal Geol.* **182**, 85–93 (2017).

5. Nie, W. *et al.* Carboxymethyl cellulose sodium gel: A modified material used to suppress coal dust pollution. *Environ. Res.* **215**, 114234 (2022).

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