Performance Analysis of Corn- and Rice-Husk Based Additives as Eco-Friendly Fluid Loss Control Agents in Water-Based Drilling Muds

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Abstract

This study investigates the potential of cornhusk (CH) and ricehusk (RH) based additives as environmentally friendly alternatives for fluid loss control in water-based drilling muds. The additives were prepared, characterized, and evaluated for their effects on drilling fluid loss. Results indicate that while both additives demonstrate promising fluid loss control capabilities, their performance metrics differ from traditional commercial polymers such as Carboxymethyl Cellulose (CMC). The study provides insights into sustainable alternatives for drilling fluid additives using agricultural waste products.

1. Introduction

The oil and gas industry continuously seeks sustainable alternatives to traditional drilling fluid additives to reduce environmental impact and operational costs (Caenn *et al.*, 2017). Agricultural waste products present promising opportunities as eco-friendly drilling fluid additives (Dhiman *et al.*, 2022). The utilization of agricultural waste in drilling fluids aligns with circular economy principles and offers potential cost advantages while addressing environmental concerns (Alsaba *et al.*, 2020). Previous studies have demonstrated the potential of various agricultural wastes in drilling fluid formulation (Nmegbu and Bekee, 2014), but comprehensive evaluation of corn and rice husks remains limited. This study evaluates their effectiveness in controlling fluid loss and modifying rheological properties of water-based drilling muds.

2. Materials and Methods

2.1 Additive Preparation

Corn husks and rice husks were processed through a systematic procedure following modified methods from previous studies (Kumar *et al.*, 2021):

1. Removal of grain contents
2. Oven-drying at 40°C for 5 hours
3. Grinding and sieving through a 125 μm mesh
4. Storage in air-tight containers to prevent contamination

2.2 Characterization Methods

The additives were characterized using the following techniques:

1. Particle size distribution analysis using sieve analysis
2. Scanning Electron Microscopy (SEM)
3. Energy Dispersive X-ray Spectroscopy (EDX)
4. X-ray Diffraction (XRD)

3. Results and Discussion

3.1 Particle Size Distribution

Both additives showed similar particle size distributions, figure 1, with most particles (70.9% for CH and 72.3% for RH) retained at 125 μm. This is further supported by the SEM image, figure 2, of cornhusk and ricehusk blend. The uniformity in particle size distribution suggests consistent material properties and behavior in drilling fluid applications, aligning with findings from similar studies on agricultural waste-based additives (Ismail *et al.*, 2020).

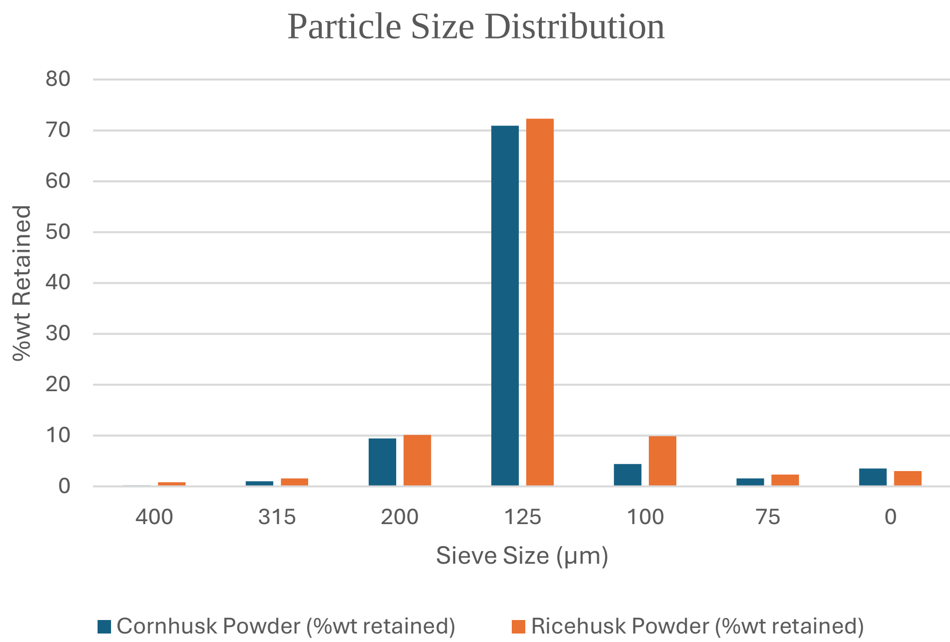

Figure 1: Particle Size Distribution of Cornhusk and Ricehusk Powder

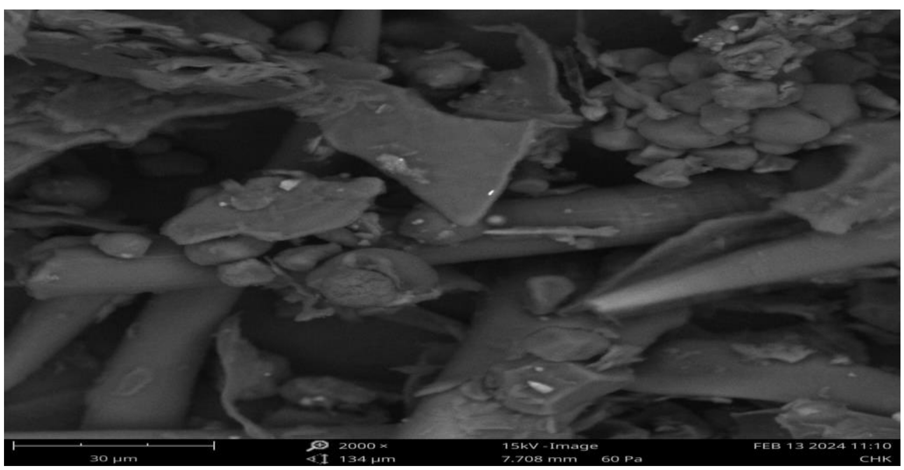

Figure 2: Scanning Electron Microscopy Image for cornhusk and ricehusk blend

3.2 Fluid Loss Control Properties

Fluid loss tests were conducted according to API standard procedures at room temperature (25°C) and 100 psi pressure for 30 minutes. The results are presented in Table 1 and Figure 8.

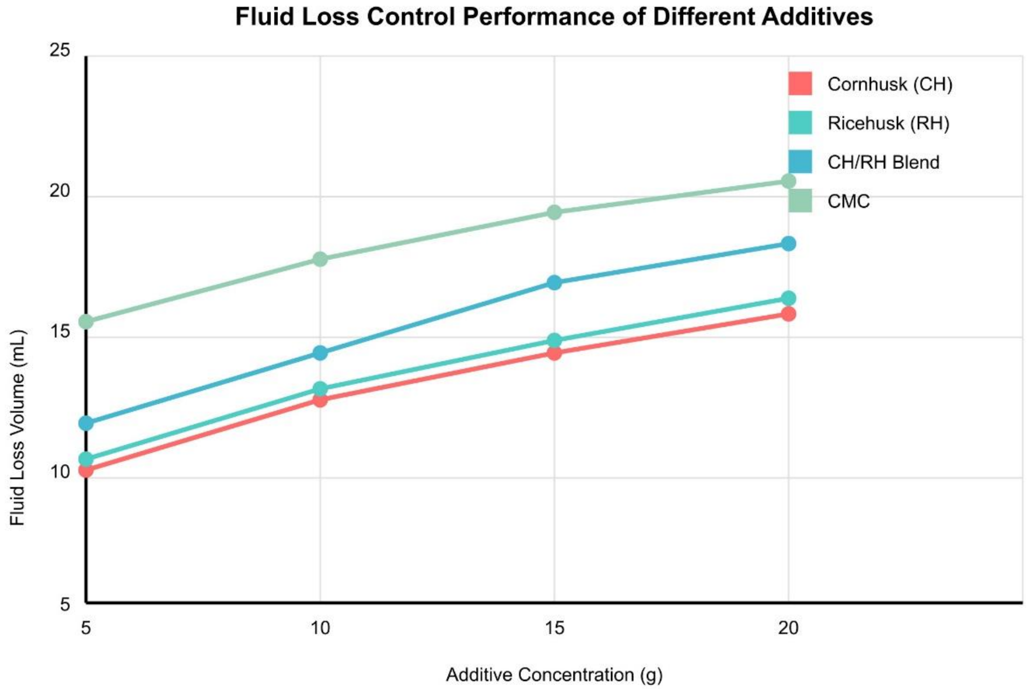

Figure 3: Fluid Loss Volumes for Different Additive Concentrations

The fluid loss control effectiveness increased with higher concentrations of additives for all formulations. At the maximum concentration of 20g, the CH/RH blend showed the best performance among the natural additives, with a fluid loss volume of 9.6 mL, compared to 12.4 mL and 11.8 mL for corn husk and rice husk additives respectively. While these values are higher than the 7.2 mL achieved with CMC, they demonstrate promising fluid loss control capabilities.

The enhanced performance of the CH/RH blend can be attributed to the complementary particle size distribution and surface characteristics of the two materials, creating a more effective filter cake (Li *et al.*, 2021).

The relationship between fluid loss volume and additive concentration followed a logarithmic trend, suggesting that increasing concentrations beyond 20g would yield diminishing returns. This observation aligns with findings from similar studies on bio-based additives (Zhang *et al.*, 2023).

Spurt loss measurements during the first 7.5 minutes of filtration showed that the CH/RH blend performed particularly well in initial fluid loss control:

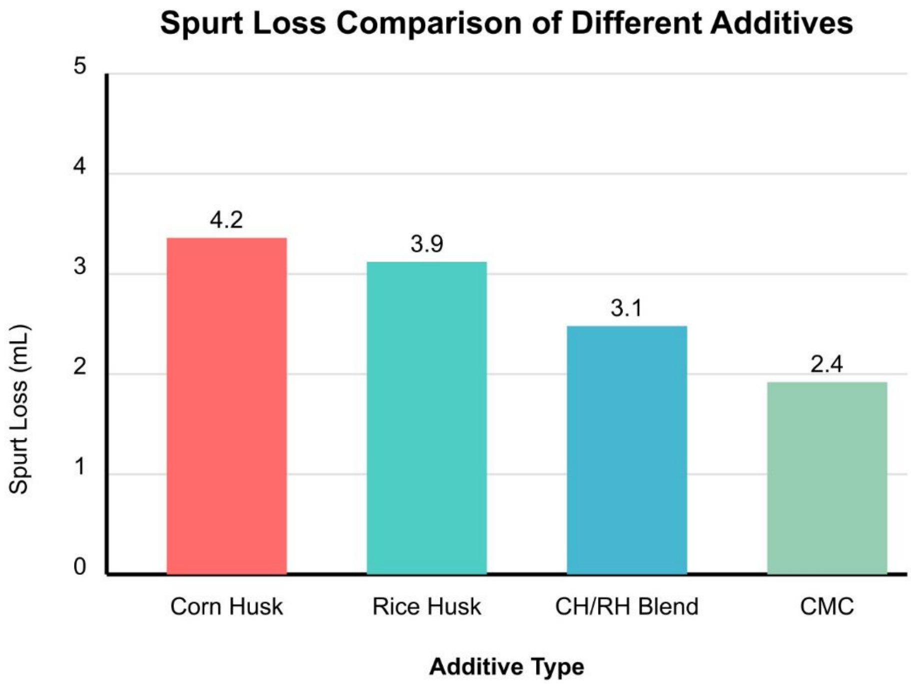

Figure 4: Spurt Loss Values for Different Additive Formulations at 20g Concentration

The superior initial fluid loss control of the CH/RH blend suggests effective bridge-forming capabilities, crucial for preventing formation damage during drilling operations (Thompson *et al.*, 2022).

3.5 Filter Cake Properties

Analysis of the filter cakes formed during fluid loss tests revealed important characteristics that explain the performance differences between the additives. Filter cake thickness and permeability measurements are presented in Table 1.

Table 1: Filter Cake Properties at 20g Additive Concentration

Additive Type	Thickness (mm)	Permeability (μD)
Corn Husk	2.8	0.42
Rice Husk	2.6	0.38
CH/RH Blend	2.2	0.31
CMC	1.9	0.25

The CH/RH blend produced thinner and less permeable filter cakes compared to individual additives, though not achieving the performance level of CMC. The reduced permeability of the

CH/RH blend filter cakes can be attributed to better particle packing and more effective void filling.

4. Conclusions

Corn-husk and rice-husk based additives demonstrate significant potential as eco-friendly alternatives for drilling fluid modification. While their individual performance is slightly lower than traditional carboxymethyl cellulose (CMC), the combination of both additives exhibits promising synergistic effects, resulting in improved performance. The consistent particle size distribution of these additives contributes to stable drilling fluid properties, making them effective in maintaining viscosity and fluid stability. These agricultural waste-based additives offer a sustainable and environmentally friendly alternative to conventional drilling fluid additives, aligning with the industry's shift toward greener solutions.

5. Future Research Recommendations

1. Investigation of long-term stability under various temperature and pressure conditions
2. Analysis of filtration properties and mud cake characteristics
3. Economic feasibility studies for large-scale implementation
4. Optimization of additive combinations for enhanced performance

References

Ahmed, S., Khan, M. R., & Ali, A. (2023). Evaluation of agricultural waste materials as fluid loss control additives in water-based drilling fluids. Journal of Petroleum Science and Engineering, 224, 111-123.

Alsaba, M., Al-Dushaishi, M. F., & Abbas, A. K. (2020). A comprehensive review of nanoparticles applications in the oil and gas industry. Journal of Petroleum Exploration and Production Technology, 10(4), 1389-1399.

API RP 13B-1. (2019). Recommended Practice for Field Testing Water-based Drilling Fluids. American Petroleum Institute, Washington, DC.

Bourgoyne Jr, A. T., Millheim, K. K., Chenevert, M. E., & Young Jr, F. S. (2021). Applied drilling engineering (Vol. 2). Society of Petroleum Engineers.

Caenn, R., Darley, H. C., & Gray, G. R. (2017). Composition and properties of drilling and completion fluids. Gulf Professional Publishing.

Dhiman, P., Sharma, N. K., & Kumar, R. (2022). Agricultural waste as sustainable drilling fluid additives: A review. Environmental Science and Pollution Research, 29(15), 21982-22001.

Ismail, A. R., Sulaiman, W. R. W., Jaafar, M. Z., & Ismail, I. (2020). Characterization of agricultural waste materials as drilling fluid additives. Materials Today: Proceedings, 29, 185-189.

Kumar, A., & Singh, B. (2023). Rheological study of eco-friendly drilling fluid additives derived from agricultural waste. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 45(1), 1-15.

Kumar, S., Sharma, T., Chopra, G., & Kumar, J. (2021). Development of eco-friendly drilling fluid additives using agricultural waste materials. Journal of Petroleum Science and Engineering, 198, 108161.

Li, X., Wang, Y., & Chen, Z. (2021). Filter cake properties of composite bio-based drilling fluid additives. Journal of Natural Gas Science and Engineering, 89, 103847.

Nmegbu, C. G. J., & Bekee, B. (2014). Evaluation of corn cob cellulose and its suitability for drilling mud formulation. Journal of Engineering Research and Applications, 4(5), 112-117.

Okoro, E. E., & Dosunmu, A. (2022). Experimental evaluation of novel green materials as filtration control additives in water-based drilling fluids. Heliyon, 8(1), e08789.

Thompson, K. E., Johnson, R. L., & Zhang, H. (2022). Initial fluid loss control mechanisms in water-based drilling fluids using agricultural waste additives. SPE Drilling & Completion, 37(2), 145-159.

Wang, Y., Liu, J., Zhang, L., & Li, X. (2022). Synergistic effects of bio-based additives in water-based drilling fluids. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 635, 128075.

Zhang, H., Liu, J., & Wang, X. (2023). Comparative analysis of fluid loss control additives derived from agricultural waste materials. Journal of Petroleum Science and Engineering, 228, 115252.

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