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Full Length Article

Oil shale upgrading by gas-solid high density separation fluidized bed under secondary accumulation distribution

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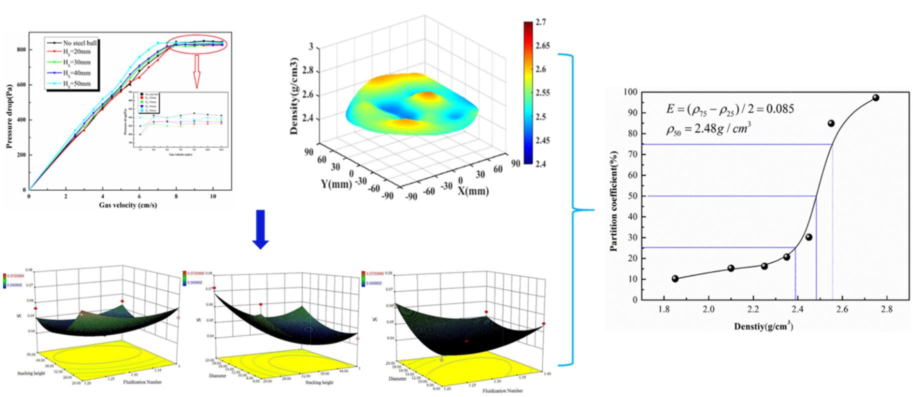
GRAPHICAL ABSTRACT



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ABSTRACT

In the separation of oil shale using gas–solid separation fluidized beds, the waste rocks fall on the distribution plate after separation and the scraper fails to discharge them in time, causing the airflow entering the bed to be redistributed. Due to its unique secondary layout effect on airflow, the existence of stacking beds is an important factor affecting the stability of the fluidized bed, and indirectly affects the separation performance of gas–solid fluidized beds. Therefore, it is necessary to carry out further research on the stacking bed to provide a strong basis for optimizing the practical operation and sorting performance of the gas–solid fluidized bed. Here, the effects of stacked beds on energy consumption, density uniformity, and bed stability were systematically analyzed experimentally. The results showed that the secondary accumulation bed has a synergistic effect on the fluidization stability of the bed and can improve the fluidization quality of the ordinary bed. Oil shale was sorted under optimized test operating conditions (accumulation height H_S = 35 mm, accumulation particle diameter D = 6 mm, fluidization number N = 1.3), and the refined mineral yield was 29.85%, oil yield was 9.42%, tail mineral yield was 70.15%, and oil yield was 1.54%. The possible deviation, E, was 0.085.

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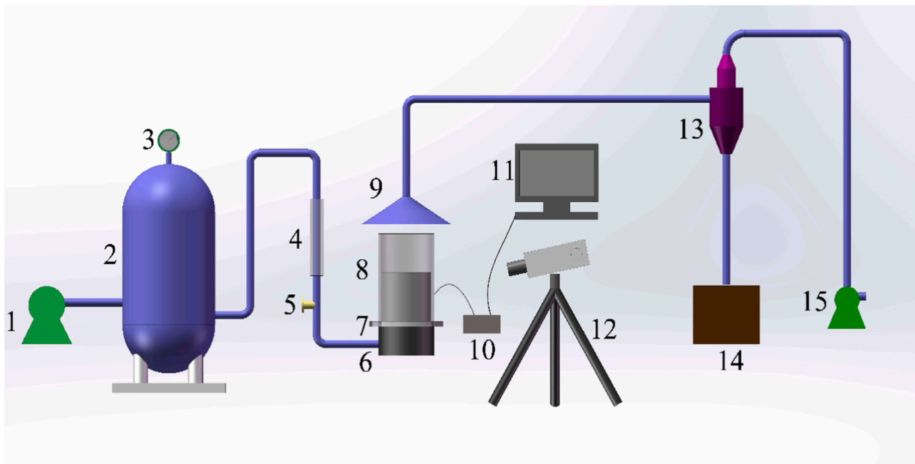
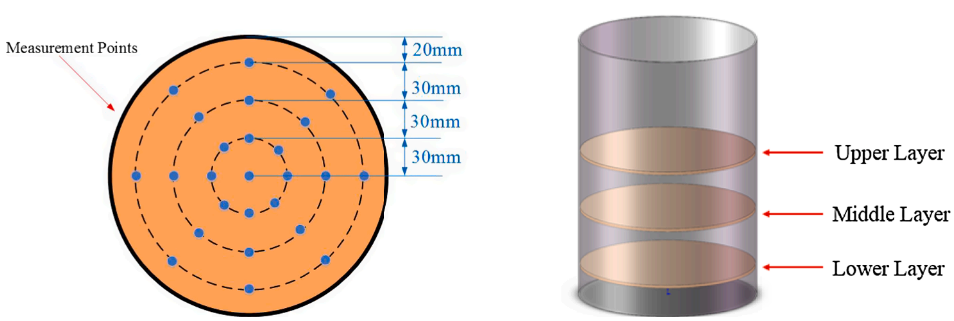
1. Introduction

Energy is the cornerstone of human survival and social development, with fossil fuels being the primary energy source for much of humanity. The supply of conventional fossil fuels such as coal, oil, and natural gas, however, is finite; therefore, it is necessary to develop unconventional energy sources such as oil shale. As a special type of sedimentary rock, oil shale is rich in organic matter. It is also abundant,



1. Blower; 2. Air bag; 3. Pressure gauge; 4. Rotor flowmeter; 5. Butterfly valve; 6. Bed air distribution chamber; 7. Bed air distribution board; 8. Fluidized bed; 9. Dust remover;10. Sensor; 11. Data acquisition system; 12. High-speed camera. 13. Cyclone dust collector. 14. Dust collection box. 15. Induced draft fan.

Fig. 1. Schematic diagram of gas–solid fluidized bed test system.



(a) Radial Test Points (b) Axial Bed Sampling Layer

Fig. 2. Bed sampling and test schematic diagram.

Table 1
Material properties of ferrosilicon powder.

Materials	Size range (mm)	Average size (mm)	True Density (g/cm3)	Bulk Density (g/cm3)	Shape factor
Ferrosilicon powder	0.074–0.3	0.205	6.17	3.24	0.47

Table 2
Sink-float test results for raw oil shale of 50–6 mm.

Density (g/cm^3)	Yield (%)	Oil content (%)	Float accumulation		Sink accumulation		$\delta_p \pm 0.1$	
			Yield (%)	Oil content (%)	Yield (%)	Oil content (%)	Density (g/cm^3)	Yield (%)
−2	9.82	18.87	9.82	18.87	100.00	3.99	2.0	11.04
2.0–2.1	5.64	13.44	15.46	16.89	90.18	2.37	2.1	5.64
2.1–2.2	3.87	6.89	19.33	14.89	84.54	1.63	2.3	3.87
2.2–2.3	5.54	5.33	24.87	12.76	80.67	1.38	2.4	7.48
2.3–2.4	2.78	2.75	27.65	11.75	75.13	1.09	2.5	8.32
2.4–2.5	4.03	1.63	31.68	10.46	72.35	1.02	2.6	6.81
2.5–2.6	15.47	1.15	47.15	7.41	68.32	0.99	2.7	19.50
2.6	52.85	0.94	100.00	3.99	52.85	0.94		
Total	100.00							