Efficiency of soap-light diesel oil emulsion as collector in coal floatation

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Abstract: In the present work efforts were made to enhance the recovery of cleans with reduced ash percent using soap-light diesel oil emulsion as collector in coal flotation. Flotation tests were carried out at plant condition using diesel oil as collector and soap-light diesel oil emulsion as collector at plant conditions. From the results it is inferred that soap-light diesel oil emulsion recovered 80.4% of the cleans by weight along with 14.82% ash of cleans by nullifying the use of frother in flotation experiments whereas diesel oil recovered 37.4% of the cleans by weight along with 12.21% of cleans ash. Conclusively soap-light diesel oil emulsion enhanced the efficiency of flotation.

Keywords: soap- light diesel oil emulsion, cleans, recovery, ash percent.

Introduction

on account of curtailment of high-grade metal ores, without physical separation as a former step in uprooting the valuables directly from ores accounts for high energy consumption and along with higher cost. As a result, physical separation techniques draw much attention as they aid in upgrading the metal grade and makes it easier to extricate valuables from gangue materials. gravity concentration, dense medium separation, magnetic separation, sensor-based separation etc were few processes by which physical separation can be achieved more over it takes the advantage of physical properties such as shape, size, density, colour or light adsorption, magnetic susceptibility, and electrical conducting properties etc. For example, in extraction of magnetic materials thought there are minute yet they get extracted when passed through magnetic poles of a magnet they will attach to that magnetic material, this magnetic property they exhibit allows them to be removed from gangue material with ease [1]. Many industrial processes, at some stage, generate or utilize fine particles locomote in size from over a hundred pn to but one pm. it's usually needed later to get rid of them from liquid streams, since they contribute to fouling, coking and erosion; they conjointly cause foaming, entrainment and emulsion stabilization issues. Their unharness may additionally cause potential environmental issues. This is typically the case in mineral processing; ultra-fine particulate, however, exists in water and waste material, too, needing removal before it's created potable or is discharged. The availability of an efficient separation technology is crucial, thanks to the impact on downstream operations and products quality. Flotation is one in every of the processes obtainable for the separation of particulate from dispersions; it's extensively utilized in mineral extraction, and to a lesser extent in waste material treatment a pair of [2].

Soaps in industrial practise

For the use of collector in forth flotation of salt type minerals soap of mixed fatty origin or soap-light diesel oil are used as collectors. Either vegetable oils or tall oil are used in making soap that is used in forth flotation process. Homogenous fatty acids such as stearic acid, oleic acid, linolenic acid, linolic acid and palmitic etc are the constitutes of vegetable oils and tall oil [3]. In industrial practices what's being used as oleic acid/sodium oleate is in fact homologues of fatty acids derived from oils and fats.Fatty acids are commonly known as oils and fats and are found as esters of glycerol in nature. total fatty matter (TFM), iodine value (IV), and relative measure of unsaturated bonds present in the oil or fat are the certain physical and chemical properties used to characterize fatty acids and soaps [4]. Micelles are initially spherical with the nonpolar, hydrocarbon chains of the fatty acids oriented towards the core of the micelle and the polar part towards the solvent (water). Sharp change in the physical properties of the solution (surface tension, viscosity, conductivity, etc.) against the concentration of the solute indicates the CMC formation. Collectors in forth flotation are described as soaps whose polar part (carboxylate functional group) attached to a nonpolar part (hydrocarbon chain) [5].

critical micelle concentration (CMC) of the solute is the concentration at whichsodium salts of fatty acids are water soluble at which molecules form into aggregates known as micelles [6]. It is observed that as collectors in soap flotation saturated fatty acids works more efficiently than unsaturated fatty acids [7]. soap for flotation is specified as follows according to the plant observations at Jhamarkotra plant process that is Iodine Value 88 to 93, Titer Point 22 0C to 25 0C and total fatty matter 60 to 65 such soaps are noted to contain 4% to 10% stearic acid, 16% to 23 % palmitic acid, 37% to 48% oleic acid, maximum 27% linoleic acid and maximum 1.5% linolenic acid [8].

Experimental

Materials

The coking coal fines lying in the settled ponds nearby an operating coking coal washery was taken for the detailed flotation tests (Bhowra coking coal sample). The ‘as received’ sample was sun-dried and put through a series of coning-quartering to obtain a representative feed sample for proximate and ultimate analysis. BIS norms were followed to carry out the proximate analysis of the sample on air dried basis. The results of the proximate analysis are shown in Table 1.

Reagents

Reagents used are of commercial grade. Sodiumhydroxide (98 per cent NaOH, Na2 CO 3 0.5 per cent max) , diesel oil and MIBC are brought from chemical store at CIMFR Lab,Dhanbab. palm oil is brought from near by store 50% saturated fatty acids, with 44% palmitic acid (C16:0), 5% stearic acid (C18:0), and trace amounts of myristic acid (C14:0. Light diesel oil is supplied by ONGC plant at Bokaro.

Soap-light diesel oil emulsion preparation

Palm oil is the fatty acid used to prepare soap emulsion. To prepare soap-light diesel oil emulsion palm oil and light diesel oil mix is taken in the ratio of 1:1.2 and is saponified by adding sodium hydroxide adjusting the pH of 6% solution 11.

Froth Flotation Procedures Adopted

The coking coal fines lying in the settled ponds nearby an operating coking coal washery was taken for the detailed flotation tests. Diesel oil is used as collector, MIBC (methyl iso-butyl carbonyl) as frother and sodium benzoate as modifier. The Table 1 shows the proximate analysis of the sample tested.Table 1. Proximate analyses of the feed coal sample.

Table 1 Proximate analysis of the sample

	Proximate (%)			
	Moisture	Vol. Mat	Ash	Fixed Carbon
Fines	2.06	25.58	25.96	54.54%

Batch flotation studies were carried out in Denver D12 sub aeration flotation machine. The coal slurry at a pulp density of 30-35% is conditioned with diesel oil at the rate of (1.25 kg/t) of coal. The diesel oil termed as collector is dispersed, collided and adsorbed on to the coal surfaces due to mechanical agitation in the conditioner. In some installations, the collector is emulsified before feeding to conditioner. The conditioned pulp is then diluted to the desired level (10 to 15%) in the pulp density adjusting tank (PDAT) and then brought to the flotation cell. Frother, normally MIBC is added at the rate of 0.25 kg/t of coal. The conditioned coal particles attach with the air bubbles and reach to the top of the cells to be skimmed off. The impurities in the form of tailings are taken out from the cell. The beneficiated coal fines in the form of froth are collected and vacuum filtered. The samples were dried, weighed and analysed for ash. Table 2 shows the results obtained by standard flotation reagents and dosages, while Table 3 shows the results obtained by using soap-light diesel oil emulsion as collector in coal flotation in the absence of collector.

Table 2: Flotation of coal fines using standard chemicals and dosage

Expt No	Dosage,ml		Cleans			Feed Ash
	Collector (C)	Frother (N)	%wt	% Ash	Efficiency Index	
1	0.25	25	50.2	8.76	44.9	26
2	0.3	25	56.04	9.17	49.2	26.2
3	0.35	25	61.22	10.09	48.2	24.8
4	0.25	30	58.94	9.93	48.5	25.6
5	0.3	30	60.88	10.48	47.9	24.4

For testing the coal fines with soap-light diesel oil emulsion as collector dosages such as 1,5,10,15,20 ml per 250 grams of coal sample respectively was added and tested the same above procedure is adopted to carryout flotation using soap-light diesel oil as collector and no frother is used in the experimentation. The results are given in Table 3 and also plotted as shown in figures to analyse the recovery patterns. In flotation kinetic studies, five floats were collected at cumulative time intervals of 5, 10,15 20,25,30 respectively and the results are given in Table 3 and also plotted as shown in figures to analyse the recoveries.

Table 3: Flotation of coal fines using soap-light diesel oil emulsion

Sl.no	conditioning		cleans		Rejects		Feed	combustile	Non–combustile	Efficiency
	Collector dosage	Collector dosage-ml	Wt%	Ash%	Wt%	Ash%	Ash%	Recovery	Recovery	Index
01	Soap emulsion	1 ml	8	9.96	92.0	46.0	43.1	12.7	1.8	10.8
		5 ml	77.6	14.14	22.4	52.1	22.6	86.1	48.5	37.7
		10 ml	80.4	14.82	19.6	63.6	24.4	90.6	48.9	41.7

		15 ml	80	14.93	20.0	52.3	22.4	87.7	53.3	34.4
		20 ml	82	15.35	18.0	63.3	24.0	91.3	52.5	38.8

Table 4: Flotation kinetics using soap-light diesel oil emulsion

Sl.no	conditioning		cleans		Rejects		Feed	combustile	Non–combustile	Efficiency
	soap emulsion dosage ml	Flotation time seconds	Wt%	Ash%	Wt%	Ash%	Ash%	Recovery	Recovery	Index
01	15 ml	5	26	14.32	74.0	46.0	37.8	35.8	9.9	25.9
02		10	28.8	14.45	71.2	52.1	41.3	41.9	10.1	31.9
03		15	15.6	13.93	84.4	63.6	55.9	30.4	3.9	26.5
04		20	2	28.97	98.0	52.3	51.8	2.9	1.1	1.8
05		25	1.2	58.87	98.8	63.3	63.2	1.3	1.1	0.2
06		30	1.6	64.43	98.4	78.6	78.4	2.6	1.3	1.3

Results and Discussions

Following are important points to be made from the results of all the tests conducted on -0.5mm coal fine using conventional and soap-light diesel oil emulsion as collector.

Effect of Variables

Effect of Collectors

Collectors are flotation reagents used to hydrophilizing selectively the surface of the targeted mineral particles, in order to allow the contact and adhesion between the particles and air bubbles that are recovered in the froth [9]. In order to have water repellence the type of collector added and the dosage of the collector plays a vital role in flotation. Though coal is a natural hydrophobic material yet it needs addition of collector in order to achieve preferable wetting and to obtain selectivity.

To assess the effect of a soap light diesel oil emulsion as collector over the conventional diesel-oil Figure a have been plotted for the test results data obtained at varying levels of collector dosages against the cleans recovery of diesel oil as collector. Figure b have been plotted for the test results data obtained at varying levels of collector dosages against the cleans recovery of soap diesel oil emulsion as collector. On making the comparison, it is clearly seen from the plots of a that the soap light diesel oil emulsion gives better results at all the dosage levels tested. Further, the use of soap light diesel oil emulsion in place of diesel oil has adduced in:

- Increased yield of clean coal.
- Increased recovery of combustible material (RNA %)
- Increased reduction of ash % of clean coal
- Increased Gross Calorific value (GCVEB) and

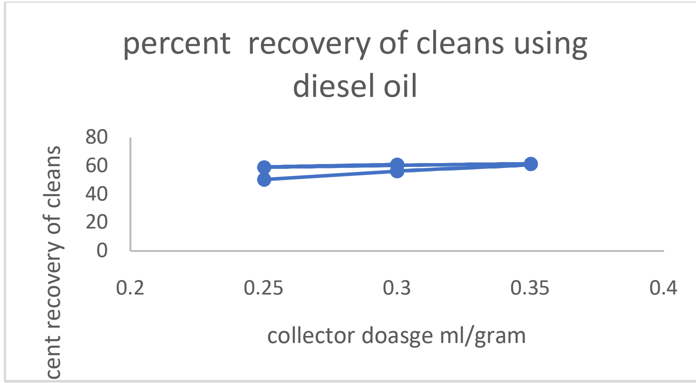

Fig-a recovery of cleans by weight with diesel oil

From the graph it is evident that with increasing the dosage of the collector ash percent of the cleans increases at a point it decreases and then increases suddenly. These collectors primarily consist of carbon and hydrogen elements in the form of –CH, –CH2, –CH3, and named as hydrocarbon oils. Since they are water immiscible, they will be broken into small droplets on agitation and get adsorbed quickly on the surface of the high-rank hydrophobic coal particles consisting of macerals. On the other hand, it is difficult to adsorb these oils onto the coal surface of the low-rank-oxidized coals (or the oxidized coals in general), because of the presence of hydrophilic sites on the surface of coal.

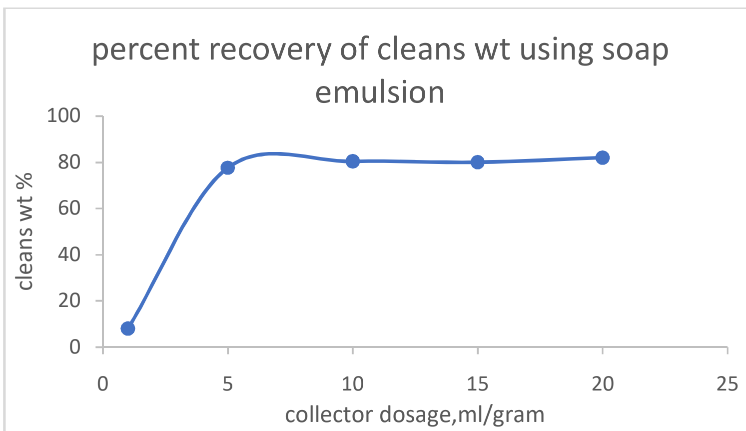

Fig-b recovery of cleans by weight with soap light diesel oil emulsion

From the graph(fig-a) it is evident that as the dosage of the collector increases the percent recovery of cleans is increasing which is directly proportional each other. Light Diesel Oil (LDO) is used (Glembotski et al, 1972) as an extender of the hydrocarbon chain of the collector[10].With the increased addition of soap light diesel oil dosage, the minuscule bubble-droplets in the pulp increase correspondingly which adhere on to the surface of both feebly and strong-hydrophobic coal particles thus resulting in increased yield[11].The reason is that the driving forces of adsorption of soap anions are electrostatic attraction between the polar part of the collector and surface charge on the mineral, thermodynamic forces, which originate due to the incompatibility of nonpolar part with polar water and the ability of soap anions to chemisorb on the mineral surface[5].

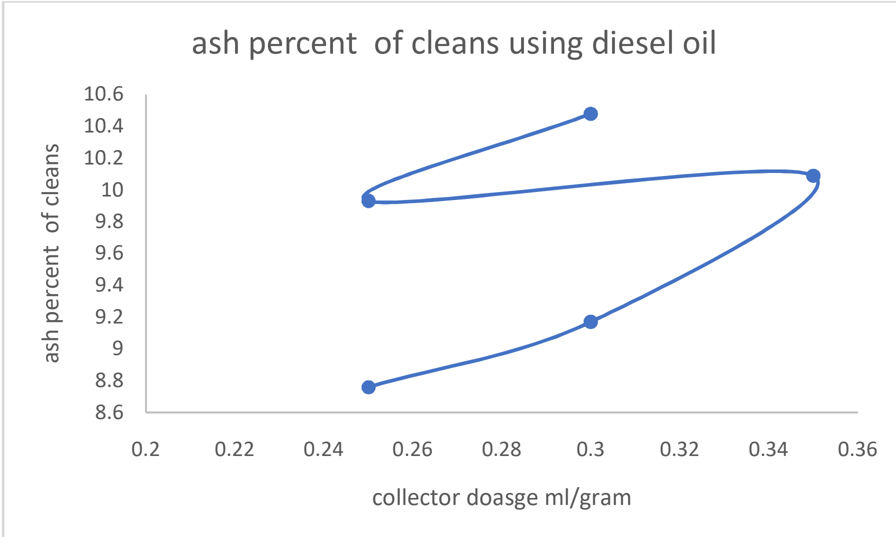

Fig-c ash percent of cleans by with soap light diesel oil emulsion

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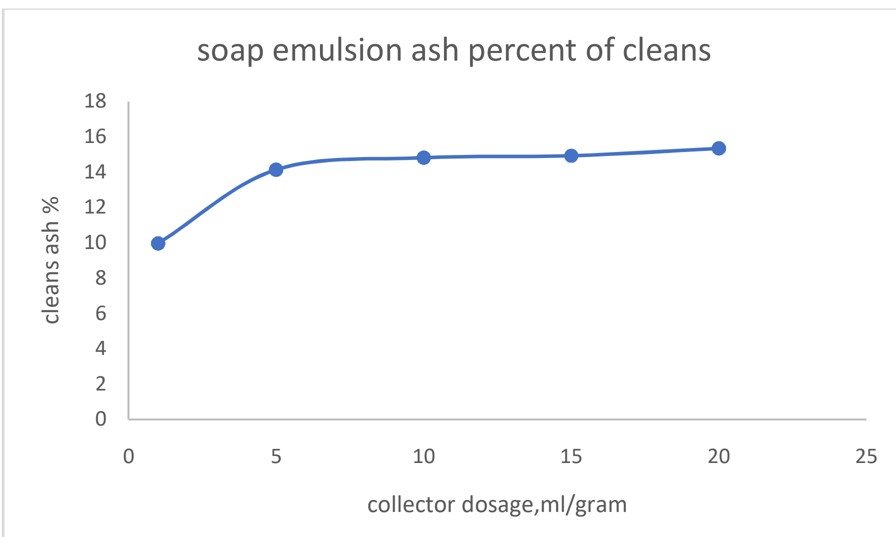

Fig-d ash percent of cleans by with soap light diesel oil emulsion

From the graph it is evident that with increasing the dosage of the collector ash percent of the cleans increases simultaneously. Which shows a behaviour is directly proportional to each other? The property of higher selectiveness of soap light diesel oil emulsion to coal has resulted in the removal of more mineral matter, which is evident from the position of lines shown in Figure b. Reduction in ash with a simultaneous increase in yield has been the main reason for improved Gross Calorific value of the clean coal product [11].

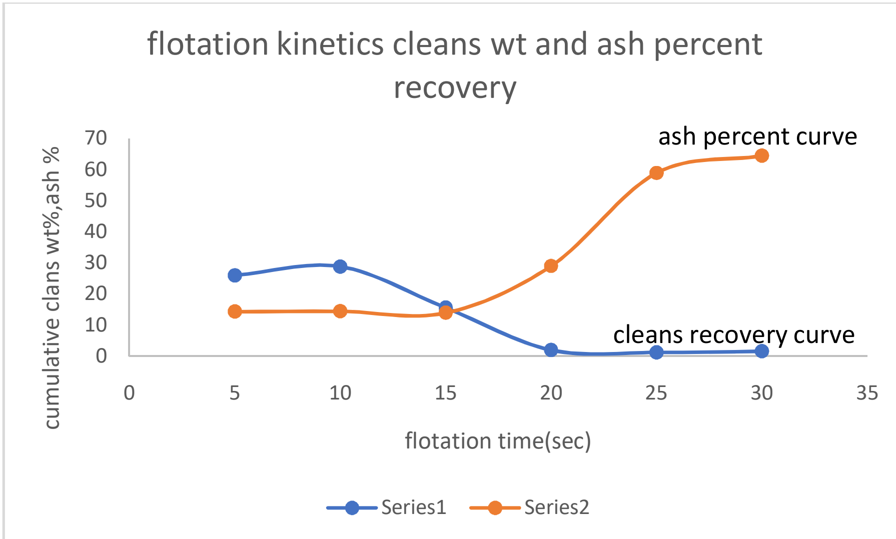

Fig-e flotation kinetics using soap-light diesel oil emulsion

From the graph it is evident that as the time of flotation increase the recovery of cleans increases to certain point and then reduces due to the entrainment of rejects into cleans and the ash percent increases due to the presence of rejects in the recovery.

It is well known that froth flotation is a rate process that follows of first order classical equation. Therefore, the grade of the floatable fractions remaining in the cell decrease with prolonged flotation, which means that the concentration (or the percentage) of hydrophobic particles reporting to concentrate increase with increased time of froth collection.

Conclusions

Soap-light diesel oil emulsions yielded higher recoveries along with reduced ash percent of cleans over diesel oil as collector in floatation of coal sample. Soap-light diesel oil emulsion nullified the use of frother in coal flotation.soap-light diesel oil emulsion recovered 80.4% of the cleans by weight along with 14.82% ash of cleans by nullifying the use of frother in flotation experiments whereas diesel oil recovered 37.4% of the cleans by weight along with 12.21% of cleans ash. Conclusively soap-light diesel oil emulsion enhanced the efficiency of flotation.

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