CARRIER FLOTATION BY CHAR SLIME - WASHING OF ŞIRNAK ASPHALTITE SLIMES

ÇAR ŞLAMI İLE TAŞIYICI FLOTASYON-ŞIRNAK ASFALTİT ŞLAMININ YIKANMASI

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ABSTRACT

Şırnak asphaltite slime below 200 micron size is processed. The clean coal products of the column flotation are received with mid-products and shale settlements in the modified column cell in the baffled form. The use of hydrocyclone, agglomerate thickener and wash decantation has been a suitable potential method after the driven and internal loop column flotation. With this method, ultrafine sized oily sludges with high efficiency and low solid rate coal washing are provided. It also enabled highly efficient wastewater treatment as a result of separating the oil with czar foam. Therefore, the method applied in this study can be designed as an optimum wastewater treatment technology for the treatment of oily wastewater in the oil and drilling industry. The aeration process in internal loop column flotation with air jet is widely used in lake water treatment and fresh water treatment. In this study, internal loop carrier column flotation, hydrocyclone overflows and agglomeration process are optimized for coal washing and environmental wastewater treatment. The ash and sulfur contents decreased to a level of 48% ash reduction and a 34% sulphur reduction.

Keywords: slime flotation, column flotation, carrier flotation, modified flotation, coagulation, asphaltite slime, biochar, active carbon

1. INTRODUCTION

The flotation process of oily coal sludges in foam by column flotation provides the physical and chemical properties of the sludge, the type of coal, the cleaning of coal sludges and water purification in microwave conditions in the process of cleaning toxic sludge with froth flotation using activated carbon and collector oil. In this way, the cleaning of coal by flotation reduce ash (Akdemir & Sönmez 2003, Anonymous a,b,c, 2015) and the conventional flotation system is used for cleaning coal and also for oily sludges in the integrated plant designed (Aplan 1977, Chandra&Sharma, 1976). The designed modified coagulation and flotation unit provide that sufficient cleaning and solve the problems such as water and soil pollution and environmental waste loss, including energy production, were minimized. If the integrated mobile system is economically sustainable, it is aimed that the operating cost was low and the management was slightly economical and portable in conformity with Şırnak City Province, and an issue in Southeastern Anatolian region due to the fact of less population.

Biochar is produced by heating biomass in the total or partial absence of oxygen. Pyrolysis is the most common technology employed to produce active sites over asphaltite, and also occurs in the early stick to agglomerate oil contact. High ash asphaltite coal mining in Şırnak Asphaltite fields has approached the urbanization area. The dispersed nature of this mining requires environmental water treatment and mine waste management. Aqueous waste toxic leachates of mining, oily pulps need to be washed in coal column flotation units and oily waste sludges need to be treated with activated carbon

1.1. Coal Slime and Waste

Evaluation of natural resources, in parallel with the energy needs of our country will provide economic benefits by reducing fuel imports. Basically, energy production is made from imported natural gas and has a 46% share of health. After the energy use of coal imported natural gas is located in the second row and is provided by burning coal in thermal power plants with a share of 26% (TTK, 2009). Depending on the future energy demand, the ratio is expected to increase. A total of 83 million tons per annum of lignite and coal in boilers and industrial furnaces production was evaluated as the need for heating and energy. The cleaning of coal ash minerals is needed and the flotation comprise micron size particles sticking coal in froth (Feurstenau,1976, Aplan,1986). In this study, the opening of the quarry closed in Sirnak region and the high-calorie but ash and sulfur content can be produced by washing it is considered to be the economic contribution of higher asphaltites. Şırnak asphaltites the washability studies made by developing potential flowsheets were compared accordingly wash washing plant investment and operating costs. The result of the feasibility study has identified suitable premises.

Asphaltites of Southeastern Anatolia is located in the Şırnak and Hakkari ‘s provinces in Turkey 120 million tons of proven reserves of Şırnak and Hakkari possible asphaltite of 0.2-1% moisture, 37-65% ash, sulfur burning 6,3-7.5% total sulfur 5.5-5.7%, 60-65% volatile matter and 2800-5600 kcal / kg has a lower temperature (TKİ,2013). Şırnak asphaltites beds are distributed or block-shaped space rock in the vein location. Avgamasya asphaltite production is lump size over 500mm carried by trucks into the stock yards. Avgamasya and Karatepe seams are separated in the reserve forms as compared with the width of 15-25 and 10-20 m inclined form. The lump asphaltite piles are diverted to screening and crushing plants in order to obtain size classification. Coal slimes are obtained in the screening as dust wetting in the yard. There is also a side rock in the deposits. The side rock occurs as limestone bed rock, shale, marl clay, marl and porous limestone is located. Şırnak asphaltites coal is soft with shale ash and macro sized calcite, micron sized pyrite occurs widely dissociated in coal and shale of asphaltite.

1.2. Washing with the Coal Flotation

The fine size coal is agitated in high volume tank cell ın the flotation method. In the column cell used in column flotation (Jameson, 2001), the washing of the coal was successful by giving the counter-current air to the pulp feed depth (Matis, 1995). Thus, an effective pulp mixture is provided. Various applications, such as slurry agitation separators and drum type washers are also used in the preparation of high ash coals (Miettinen et al., 2010). In microwave assisted column flotation, oily hydrocarbon micelles are easily transported to the foam zone on the surface of activated carbon, charcoal, coal, and coal particles, which are agglomerated coal-bound (Feurstenau, 2001). Flotation have different industrial applications (Aplan 1977), and widely used in wastewater treatment using aeration and foam. The column cell is providing a high rate of bubble-oily coal contact and is separated from the column load in the coal flotation tank by countercurrent flow of coal pulp. (Wills & Napier-Munn, 2006, Klimpel & Hansen, 1987, Rubio 1996).

1.3. Modified Agglo-Flotation Cell

The slime coal grains are attached to the hydrophobic oil by hydrophobic contact at the long collector oil. The agglomeration of coal slime with suitable amount of oil comes into contact with the water-air bubble interface (Yoon, 1993, Yoon, 2000). The coagulated froth system was collected by the modified flotation cell with pneumatic air jet injection in to the pulp to increase the recovery of small and superfine particles (Schubert, 2008). With the help of air jet pipes in this modified baffled cell, the pneumatic system and effective bubble pulp agitation is provided (Rubio, 1996). The smaller sized bubbles produced by the air jet. In this application, the principle of air and modified conventional froth flotation of slime agglomeration and flotation is managed as illustrated in Figure 1 in this study.

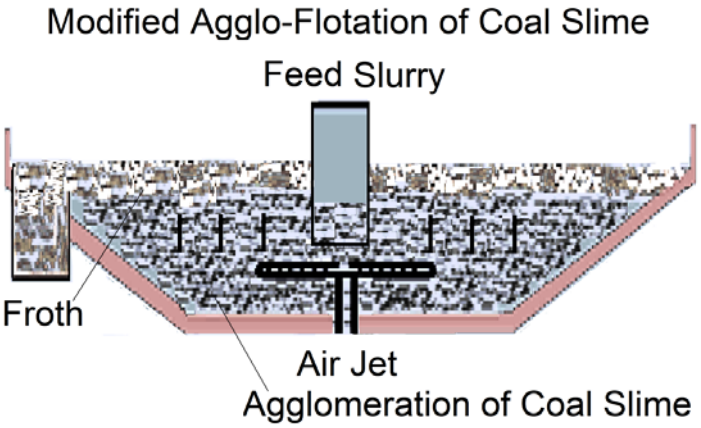

Figure 1 Schematic of the agglomeration - asphaltite flotation system with froth phase and air bubbling.

2. WASHING WITH THE AGGLOMERATION - FLOTATION OF ŞIRNAK ASPHALTITE

At the agglomeration time, the physicochemical contact is sufficient in oil collector used for finer size below 100 micron and ultrafine size near micron sized coal particles. The slime size affect the particle removal from wastewaters using low agitation (Anonymous a, b, c, 2015). The flotation in column cell at high dense slurry medium reduces efficiency for coal flotation. Even in waste water treatment, less efficient flotation is resulted from less density sludge. While among the chemical processes, horizontal flow oil - slime flotation through the use of coagulation by collectors were widely employed (Figure 2) (Fuerstenau, 1976, Gupta et al 2010). Aluminum and iron ions causing flocculation as destroying coal flotation in generated oil coagulation of oily sludge as described (Oats et al, 2010).

Agglo-flotation of the coal slime particles need high contact time with more hydrophobic particle surface. The modified column cell of this baffling matter placed in column cell as illustrated in Figure 2 raised the contact time of particle-bubble attachment. For smaller slime particles active carbon fine is needed with small bubbles during long froth receive and long duration periods in the modified column cell using baffles (Valderrama et al, 2011, Yiannatos et al.,1988).

It was observed that electrolytic generated micro bubbles reduced floatability in electro flotation and less contact periods caused loss in quartz flotation at laboratory with a grade 39.1% (Nunes, 2011, Klimpel et al.1987 a, b, Ketkar et al., 1991).

2.1. Column Flotation of Coal

The hydrophobic surface properties of coal change with the alternating ash mineral types placed as micron sized in the coal (Falatsu&Dobby, 1992). The ash content of coal greatly affects the hydrophobic contact angle of coal particles even with high bituminous coal types (Ata, 2012, Ata&Jameson, 2005, Chander&Sharma, 1976, Chander et al., 1987).

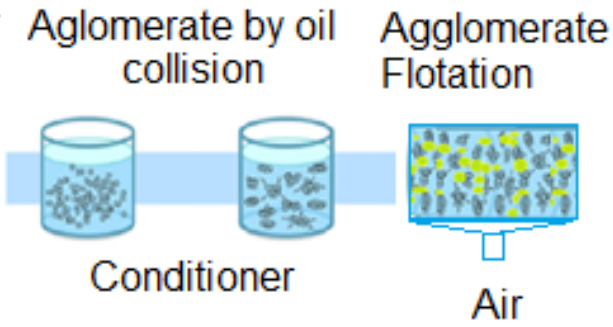

Figure 2 Schematic of the agglomeration - horizontal column flotation system with froth phase and air bubbling.

The ash composition and dissociation manner reduce the coal recoveries in the column flotation of coal (Lu et al.,2007, Ma and Pickles, 2003). In the column flotation the bulk bubble volume in the cell and bubble volume density are critical for the air–particle collision and receiving the coal bubble mixture. There is another fact for bubbling occurrence at sufficient rate due to pulp mixing in the cell or cycling slurries in the cell. The main influence of the ash of minerals results to an increase in the ash content of froth with the encapsulation of ash particles by coal particles. Washing water amount affect that collected ash mineral particles with froth zone. The froth form should be stabilized in the column flotation of coal (Warren 1985, Xie&Ou,1999a, b, Xie et al.,2012).

3.MATERIALS AND METHODS

3.1. Agglo- Column Flotation Experiments

The influence of pH in flotation cell is controlled by addition in a 1 M HCl and NaCl solution Column cell used in agglo- flotation tests were carried out in a 3,5liter volume 70 cm long and 9 cm wide tank cell, with an 200 micron mesh stainless sparkler as shown in Figure 2. Fuel oil was used as collector and MIBC was used as surfactant for the frothing in the column flotation cell.

According to the feed rate in flotation tests used, 70 -100 mg L^{-1} of fuel oil and 50-75 g L^{-1} MIBC frother in the conditioner sequentially added and pH is regulated at 7,5. In each test, feed rate of slime is at constant solid/ liquid ratio of 20%. Flotation time is kept as 10 minutes during fed into the agglo- column flotation cell. After 20 minutes the froth collection of the slime and froth with low fuel oil addition was determined by collected froth weight. The two stage cleaning process is successfully practiced for asphaltite agglo-flotation as shown in Figure 3.

4. RESULTS and DISCUSSION

4.1. Coal Slime Characterization

It is also advantageous to treat the waste pulp sludge by rotary drum filtration and cyclic column flotation. It has been determined that the waste sludge contains 2.5-8% oil in the tests carried out using the pulp of oily spills in various industrial repair shop areas in Şırnak province. It has been determined that these sludge can be evaluated in coal washing, as well as carrier charcoal, Şırnak asphaltite and lignite can be washed by carrier flotation. However, it has been determined that a high quality final clean coal product and wastewater treatment is not sufficient.

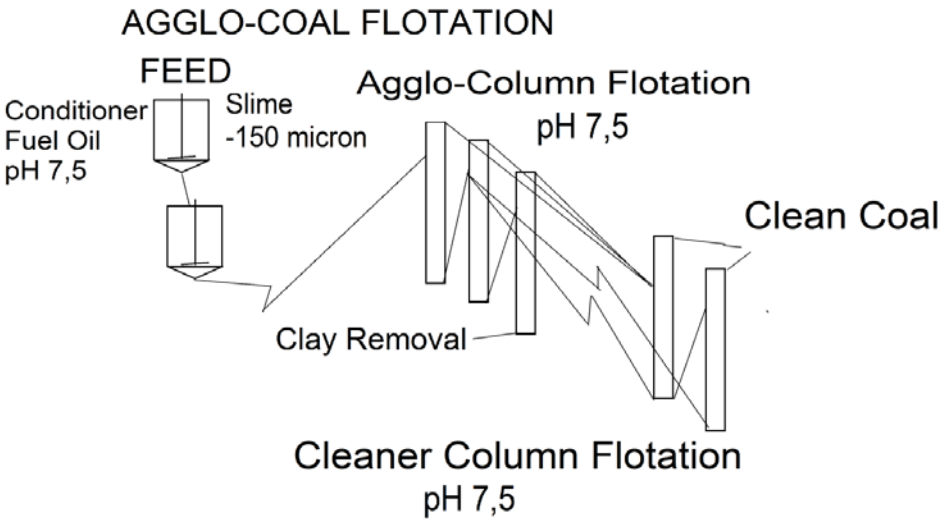

Figure 3 Schematic of the agglo - column flotation system with two froth phase and harsh pneumatic effect

the particle size analysis result a distribution curve as shown below in the Figure 4. The under screen values with extrapolation of Gaussian particle size distribution shows 27% of fines in the coal slime. The asphaltite slime have diameters below 25 μm, 80% of the asphaltite sample in the column had diameters below 75 μm . The chemical analysis is given in Table 1 for asphaltite's shale samples. The short analysis of asphaltite slime sample is given in Table 2.

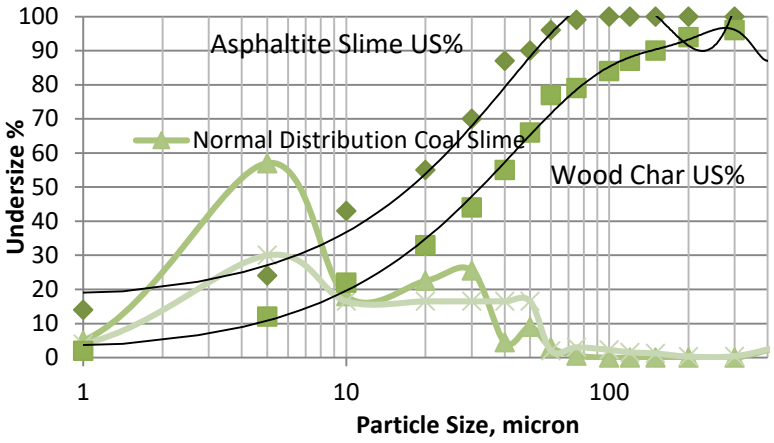

Figure 4. The size distribution of Asphaltite Slime and normal sixe distribution obtained from at pH 7,5.

4.2. Effect of collector oil on the coal agglo-flotation

The No 2 fuel oil is used in the experiments of agglo- flotation of Şırnak asphaltite. The oil collector type is suitable for agglomeration of coal slimes in the conditioner time of 5 minutes prior to column flotation unit cell.

The results of lower oil capture with oak coal dust were realized at 10% by weight. Oak charcoal, however, is lower in density than about 1.1 -1.2 activated carbon. Oil adsorption rate is higher than activated carbon. Oak charcoal dust can also take micro slime grains into the pore along with the oil. Thus, it allowed good absorption of the oil in the internal loop column flotation. In these tests, the ash of the coal in the feed decreased from 42% to 22.4%, and the oil yield in clean coal reached

77.2%. If the internal loop column flotation of Avgamasya asphaltite coal slime is to be used only for oil separation, longer duration flotation should be preferred

The certain 2/1 air rate/slurry in the column cell managed sufficient froth coal recoveries in the flotation period of 10 minutes as illustrated in Figure 5. The lack of collector oil, column froth coal recoveries stayed below 22% achieved in 20 minutes flotation time. The agglo- flotation is efficient by use of coagulated char - coal particles collided to bubbles, but higher entrainment happened in the column flotation cell. Collided coagulated char coal slime particles are separated by baffling flow forces when the particles enter the baffling flow distribution in pulp circulation in the column with remaining in longer in the slurry phase of column. Froth carried higher collided ash minerals suspended in the inter-bubble coagulants to be recovered by entrainment as illustrated in Figure 5.

Table 1. Şırnak asphaltite ash matter, ash clay and marly shale composition

%Component	ŞırnakMarl	ŞırnakŞhale
SiO_2	24.4	48.3
Al_2O_3	12.1	24.1
Fe_2O_3	7.4	7.5
CaO	27.8	9.4
MgO	4.8	3.2
K_2O	3.2	2.1
Na_2O	1.1	0.3
loss	21.3	3.0
SO_3	0.1	0.3

Table 2. The proximate analysis of Şırnak Asphaltite Slime

Coal	C%	H%	Ash%	S%	Moisture,%	Heat Value,kcal/kg
ŞırnakAsphltite Slime	15	3,1	41,1	6,5	0,6	3710

The oak wood char is used as carrier in the tests as active carbon fine. The char carrier raised the coal recoveries over 25% with a flotation time of 20 minutes. A higher asphaltite recovery in the froth was in the range of 64-76 % at 40 gr/ton of fuel oil use as seen in Figure 6..

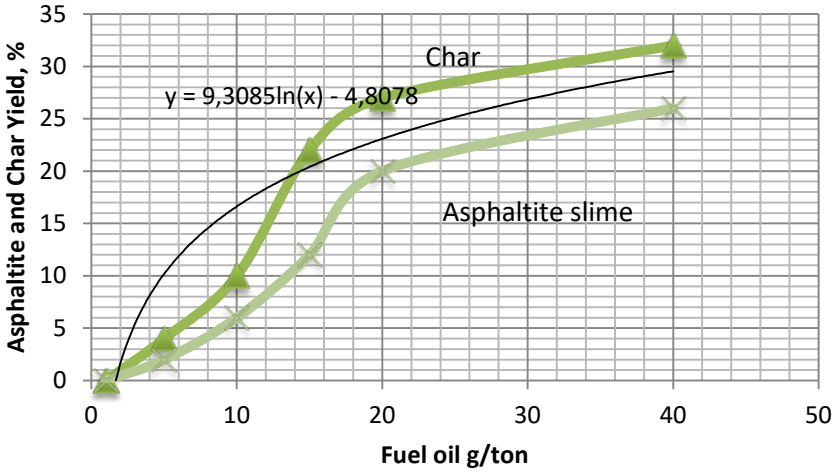

Figure 5. The coal yield of agglomerate asphaltite flotation as a function of the fuel oil concentration added a 1M HCl solution at pH 7,5 .

4.3. Effect of flotation time on the agglo-column flotation

20 minutes flotation time for agglo-column flotation f Şırnak asphaltite slime recovery by active carbon fine is sufficient. The feed ash content of 42,2 % decreased to 27,6% at flotation period of 5 minutes . However, the longer flotation periods raised the ash to the 33,2 % in the froth.

The distinctive method in this study was to take an efficient foam product as a clean coal product and to condition the coal slimes for 10 minutes with microwave irradiation, unlike wastewater treatment. The test results of Avgamasya asphaltite slimes with oak charcoal powder on column flotation with carrier inner loop are shown in Figure 6.

The coal recovery by carrier flotation is high at alkali pH, reduced from 73% to 42% when the pH is increased from 7 to 10. Alkali pH at 10 can cause hydrolysis reactions happening on the coal surface. There is a contribution ash slime covering to coagulates with resulting high entrainment.

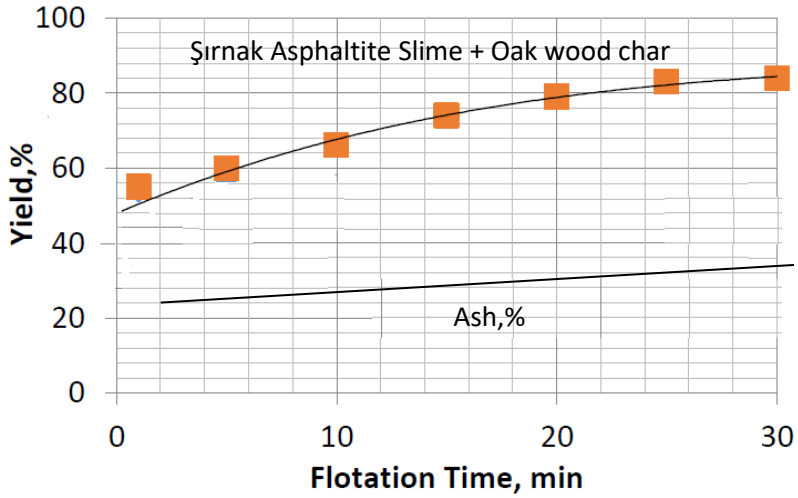

Figure 6. The asphaltite recovery in the agglo-column flotation with carrier char, in the presence of 40 mg /l fuel oil at pH 7,5.

4.4 Column Flotatio Circuit for Agglo- coal washing

The modified column units usig both cleaning and scrapping as shown in Figure 3. (Anonymous a, b, c, 2015). Şırnak asphaltites slimes with char coal fine mixing will also improve calorific vajue of asphaltite slime. Marketing price will rise in the washing units. The optimal agglo- floatation, column flotation circuit is shown in Figure 7.

A high-performance column flotation unit for the slime washing is prompted with receiving 26% ash containing asphaltite as high success (Tosun b, c, 2015). Flotation circuit diagram is seen below for the optimal coal recoveries by cycling slime slurries with scrapping in design.

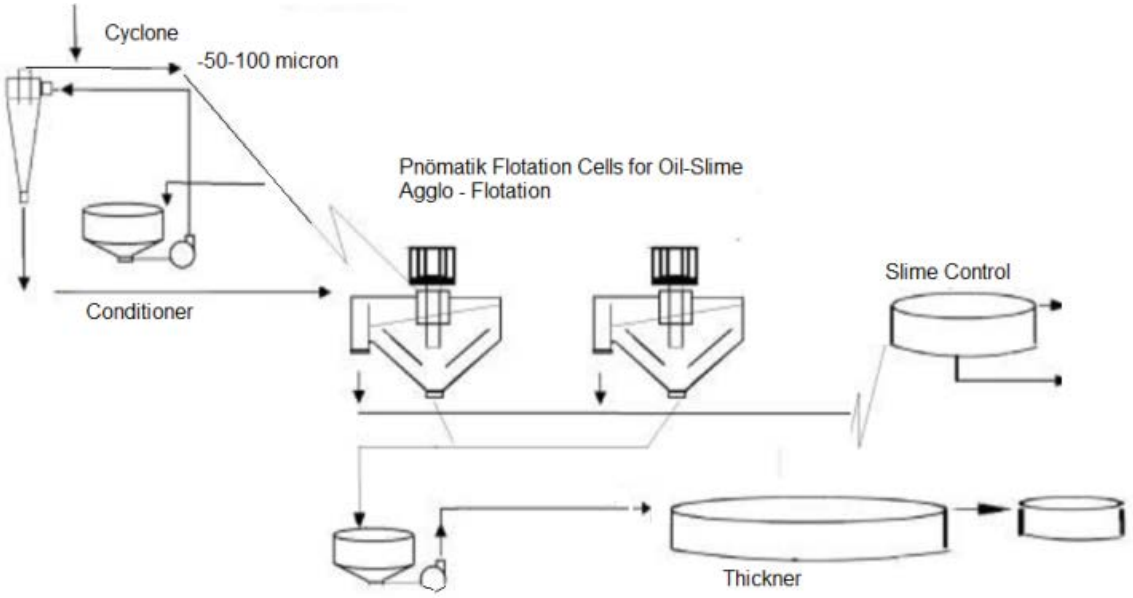

Figure 7. The proposed plant design for asphaltite cleaning with the agglo slime flotation.

6. CONCLUSIONS

The results demonstrated that coal recovery with fuel oil was efficient such as 45% and 62% asphaltite yield at lower ash content of 28% and pneumatic flotation can be used to recover asphaltite slime from the sludge. Slime particle sizes ranging from 30 to 76μm were obtained with 40 mg/L of fuel oil addition and 20 min conditioning was sufficient for pneumatic flotation. A recovery of 76% of fine slime and active carbon agglomerates was managed in the low collector dosage used in the agglo- column flotation. However the collector addition increased the recovery over 80% combustible matters. The addition of fuel oil more over 40 gr/ton on for agglo- flotation improved slight less coal recovery and increased ash content to 30% with two stage cleaning flotation and fuel oil addition at total 70 gr/ton addition at pH 7,5 and 33 % at 70 gr/t fuel oil addition.

The asphaltite reserves and current coal mining in Şırnak, were 83% of total Turkey's asphaltite reserves. This type of washing of asphaltite slime improve the coal recoveries in the washed clean coal as shown with the proposed plant design which will recover 100 thousand ton clean coal and 40 thousand ton waste removed almost half of ash and sulfur contents of asphaltite in a year. the slime evaluation will manage high profits in terms of reduced costs as well as transport and high benefits on the base of environmental protection.

Column flotation with agglomeration effect and aeration effect was used to recover the froths temporarily. The fuel oil and surfactant adsorption was evaluated through aglo flotation measurements.

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