

Fast Settling of the Sludge's Petroleum Refinery Wastewater by Friendly Environmental Chemical Compounds

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Abstract. The oily sludge is produced by various steps of petroleum process. This sludge are contain of the crude oil and other hydrocarbons such as heavy hydrocarbons, heavy metals, insoluble Organic compounds, inorganic particles and water. These sludge's have a lot of pollutions such as phenolic derivatives, heavy metals and hazardous organic compounds and for this reason they called "Hazardous Waste". In addition to the Phenol, the oily sludge are contain of several metals such as Cd, Cu, Zn, Mn, Ni, Pb. According to the recent data, the Indian petroleum refineries produce about 28000 ton of sludge per year that this amount of sludge is one of the most important problems for them and they have had serious environmental problems for disposal treatments. Dewatering and concentration of the sludge's are very difficult that is related to their colloid properties and for that the settling of the sludge's are difficult and need to a long time for it.

Keywords: Oily Sludge, Chemical Compound, Wastewater, Refinery, petroleum

1. Introduction

Petroleum is among of the stable compound in the nature that can't be decomposed by the bacteria and for this reason can be destroyer effects on the environment. When the large amount of oil mix with water especially in the API wastewater pound, the oil influence to the redundancy particles and form the adhesive layer and settled as a rigid layer at floor of the pound. After some time this layer become very rigid and it is necessary to remove it from the API wastewater pound.

Generally all kinds of the settled suspense particles at floor of the pound named sludge. Sludge is a muddy-brown dense liquid with unpleasing odor which has Organic compounds and pathogens¹. API wastewater pound sludge has some oil and so this sludge is oily sludge. In the petroleum refinery process produce a large amount of oily sludge which can be act as a source of the environmental polluter, therefore their tank storage are very important. The oily sludge is includes 60-90% water, 40-60% oil and 5-40% inorganic compounds²⁻⁵.

Most of the refineries have API wastewater pound before the second step of refinery with active sludge which produce large scale of oily sludge with 60-90% water⁶. Because of existence of oil emulsion at this sludge, separation of water of it, dewatering, is very difficult. API wastewater pound separate free oil from water and outlet water has about 70-140 ppm oil as free, emulsion and soluble oil. This water leads to the nature and environment as directly or after one another refinery steps with low changes on the component. Dewatering of sludge cause of reduces the sludge volume and odor, recycle and ease of transfer the sludge⁷⁻⁸.

Generally the petroleum sludge is sort to two groups: oily sludge and biological sludge⁹. Oily type has 3-8% solid material and 70% Organic compound and biological type has 0.5-2% solid material and 90% Organic compound¹⁰. There are some problems for removing of sludge in the API pound:

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- There are several splatters in the API pound and if the distance of them and floor to be too long, the sweeping process of sludge can't occur completely and the sludge settle sum and preventive of move of the splatters because of their rigidity and gummy properties.
- A little of this sludge because of removing of their gases come on the water and with the separated free oil lead to the oil storage tanks and science these kinds of oil consume as stove fuel then can be effect on the environment pollution.

There are several ways for reduction of volume or removing of the industrial sludge which are thickening, dewatering, drying and burning of the sludge.

Consequence of wastewater refining two products are produced, water and biosolid. Biosolid is solid phase of sludge which is produce during the refining process. Solid phase containing of heavy hydrocarbons, organometals, trace elements and some nitrogen compounds.

According to the EPA, U.S. Environmental Protection Agency, oil sludge is in the list of the dangerous wastewaters and containing of various kinds of pollution such as phenols, trace elements and etc. The amount of produced the oily sludge in the different refineries are high qualities for example Indian refineries produced about 28000 ton sludge annually¹¹. The trace elements in oily sludge are include 17-25 mg/kg Ni, 27-80 mg/kg Cr, 7-80 mg/kg Zn, 19-24 mg/kg Mn, 0.8-2 mg/kg Cd, 32-120 mg/kg Cu and 0.001-0.12 mg/kg Pb¹².

Oily sludge is a suspension of oil and water keep company with sediments and sands; recycle of this sludge is expensive¹³. Thickening method is used more for biological sludge and because of the using of some expensive instruments this method has high charged. Dewatering method is mostly occurred with using of physical ways and mechanical instruments that need to the large space, of course, some of them are expensive too.

Generally reasons that illustrated for having not economical advantages for mechanical reduce of sludge volume are that the maximum amount of concentration sludge increasing in thickening step is about 10% and in dewatering step is about 30% and also because of the colloid particles, thickening and dewatering of oily sludge is difficult.

Using of the especial chemical compounds as settlers of the colloid particles is a useful method for separating of sludge from the oil/water emulsion¹⁴. In this process chemical dewatering is occurred and with increasing of yields and collection of the sludge particles the better results is obtained. Coagulation of solid phase and removing of water is accomplished by using of the chemical method. According to the reports using of the chemical method is more economic compare with other physical method alone¹⁴.

The sludge particles usually have negative charge and for this reason these particles can't attract each other and form bigger particles, these chemical compounds change this charge and act as a bridge between the sludge particles and in results sedimentation is occurred.

Chemical dewatering accomplish in four steps:

- Adding of chemical compounds to the oil/water suspension.
- Surface absorption of materials on the sludge particle surfaces.
- Aggregation of particles.
- Sedimentation of sludge.

In adding of the chemical compounds to the oil/water liquid it is necessary that the collected colloid particles must not break during the mixing process and also the relaxation time to form of the aggregated particles should be short time. These materials make instability in the electrostatic forces and transmit the particles to each other. These compounds called Coagulant.

Usually some inorganic salts, soils and polymers with high molecular weight, normally about $16-18 \times 10^7$, are used as coagulants that these polymers can be with or without branches. Each of these coagulants act in the especial pH e.g. suitable range of pH for Alum, Lime and Sodium Aluminate consecutively are 3.4, 12 and 11¹¹.

Of course, each of these coagulants have advantages and disadvantages for example Lime is a good coagulant but make alkaline liquid and adding of the Calcium in the water cause this compound rise the

water hardness. Alum is an inorganic salt with some elements such as Al, K and S which is a routine coagulant but this can't be effective in the alkaline pH.

Some heavy polymers are introduced as coagulants such as Imidazole-Pyrimidine derivatives, Poly Aluminum Chloride that they are whether inactive in the alkaline pH or harmful for environment¹⁴.

In this study we decided to introduce a new coagulant which not only act in the every pH but also be a friendly environmental compound. We improved an especial derivative of Starch (SBG) and obtained a highlight results that there is not in the other kinds of coagulants.

There is an important note that in this study we used from a serious of the routine coagulants in the industries. This new coagulant is very economic and can be used several times with high yields.

2. Experimental method

We provide 0.5, 1, 2 and 3 % (w/v) aqueous solution of the coagulant and mixed 10 ml of these solutions with 500 ml of the oil/water suspension of API wastewater pound, Petroleum Refinery Company, for 45 minute. We could find a minimum effective concentration (MEC) for each coagulant and every test repeated for five times. For each coagulant we obtained its diagram.

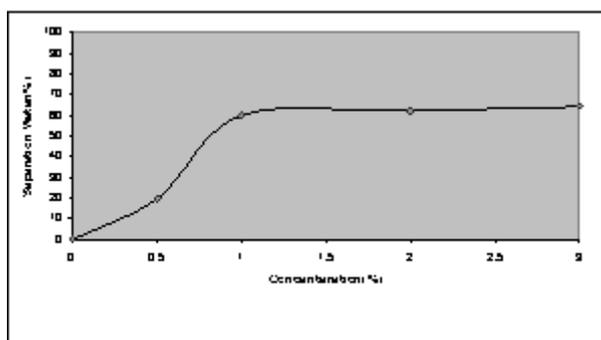


Fig.DW₁: Rate of Separation Water by Lime

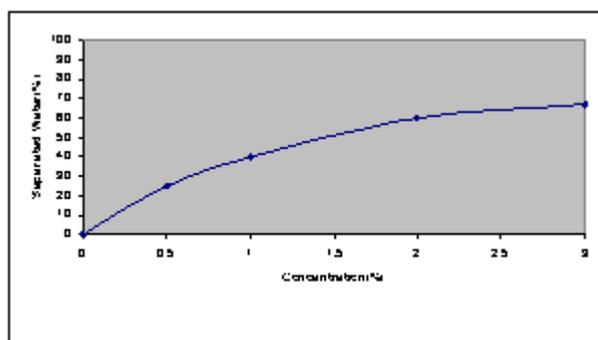


Fig.DW₂: Rate of Separation Water by Alum

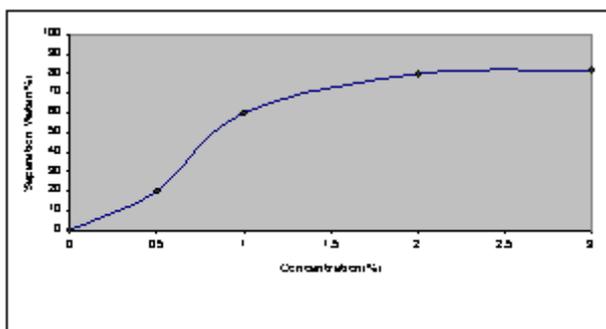


Fig.DW₃: Rate of Separation Water by Bentonite

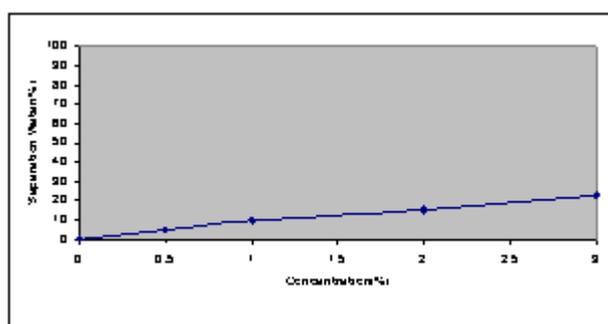


Fig.DW₄: Rate of Separation Water by Polymer

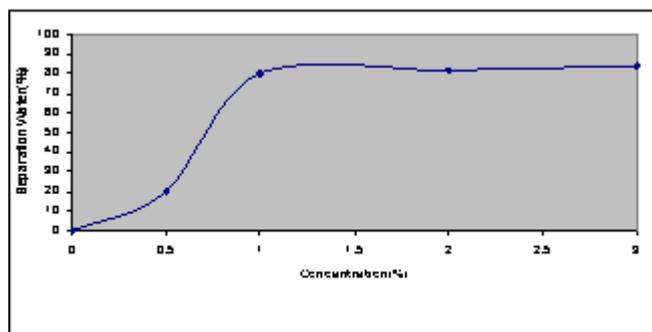


Fig.DW₅: Rate of Separation Water by SBG

3. Experimental method

According to the results, the minimum effective concentration (MEC) for separation and sedimentation of oily sludge by Lime was about 1% and the amount of separated water (SW) was about 60%; for Bentonite the MEC was about 3% and the SW was about 40%; for Imidazolic Polymer (IP) the MEC was about 2% and the SW was about 70%; for Alum the MEC was about 3% and the SW was about 20% and for SBG the MEC was about less than 1% and the SW was about 80%.

Transparency of separated water in each case was different; Lime and SBG had clear water on the surface of the precipitates and the other waters were dirty and not clear.

The effective time for precipitation of the oily sludge for Lime was about 25-30 minutes, for Bentonite was about 40-45 minutes, for Polymer IP was about 25-30 minutes, for Alum was about 30-35 minutes and for SBG was about 3-5 minutes.

According to these results SBG coagulant is a highlight compound which is used in very low amount, less than 1%, with maximum yield that is act in a very short time and it is important that this compound can be used for several times and therefore this coagulant is an economical compound.

4. Conclusion

According to the obtained results using of this new chemical compound, SBG, as a good coagulant reagent is more useful compare to the other sludge settling. This compound act very faster than the others and also is economic and environmental friendly.

5. Acknowledgements

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6. References

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