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SOLIDIFICATION – SLUDGE PROCESSING TECHNOLOGY IN A PETROCHEMICAL PLANT

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ABSTRACT:

This paper presents the technological process of solidification for the treatment of hazardous waste in Petrochemicals. The treatment is based on the technological process of physical and chemical reactions of waste mixtures with additives on the basis of calcium and obtaining a reaction product as a solid inert powder (solidificate). The technological process is carried out in terms of exothermic molecular encapsulation.

KEY WORDS: sludge, solidification, petrochemical

OBRADA MULJA SOLIDIFIKACIJOM U FABRICI PETROHEMIJE

REZIME

Ovaj rad daje prikaz tehnološkog procesa solidifikacije za tretman opasnog otpada u industriji Petrohemije. Tretman se zasniva na tehnološkom procesu fizičkih i hemijskih reakcija smeša otpada sa aditivima na bazi kalcijuma i dobijanje produkta u vidu čvrstog inertnog praha (solidifikat). Sam tehnološki proces se odvija kao egzotermna molekulska enkapsulacija.

Ključne reči : mulj, solidifikacija, petrohemijska industrija

INTRODUCTION

Several methods of biological sludge processing are in application (inorganic and flotation sludge according to their characteristics can be treated only by dehydration):

- conventional aerobic sludge stabilization and dehydration
- exothermic aerobic sludge stabilization and dehydration
- anaerobic sludge treatment in two-stage digesters with a mesophilic enzymatic reaction in the primary digester and sludge dehydration
- anaerobic sludge treatment in two-stage digesters and dehydration
- anaerobic treatment of sludge in the contactor digester with the mesophilic enzymatic reaction of sludge and then dehydration of the sludge
- dehydration of unprocessed - raw sludge and stabilization, solidification or incineration.

Conventional aerobic sludge stabilization and dehydration
This procedure requires large investments (large pool for sludge), and the power consumption is very high.

Exothermic aerobic sludge stabilization and dehydration
This procedure is often used. As the operating temperatures of the stabilization process are higher (autoignition of the sludge), retention time is less and relatively small pools for sludge are needed, and the power consumption is a significantly lower. Until now, this procedure was used for municipal sludge.

Anaerobic sludge treatment
The Anaerobic method is good and acceptable, but is not applicable in HIP-Petrochemicals due to the presence of heavy metals in biological sludge that can act as inhibitors.

Dehydration of unprocessed - raw biological sludge, stabilization, solidification or incineration.
Sludge dehydration is theoretically possible in the following ways:

- with belt filter presses
- with chamber filter presses
- with vacuum filters
- with centrifuges of the decanter

DESCRIPTION OF TECHNOLOGICAL PROCESS OF WATER TREATMENT PLANTS IN PETROCHEMICAL PLANTS

Factory for water treatment in HIP-Petrochemicals is designed to accept and process wastewater from manufacturing plants of petrochemical complex and Oil Refinery. The wastewater passes through pretreatment processes contained within manufacturing plants that have the role of removing the dominant characteristic pollutants. The role of pretreatment at each facility consists in the fact that specific pollution is removed entirely or to a degree that allows adequate quality treatment in the primary and secondary phase in the plant for water treatment. Pretreatment is of great importance because certain flows are toxic, others contain high mineral oil or additives of inorganic substances whose presence negatively affects the biochemical purification procedure. Special treatment for caustic flow consisting of the oxidation of sulfide to sulfate, and the transformation of organic sulfides (mercaptans) to sulfonates, was built in the water treatment plant itself. Oxidation with hydrogen peroxide with previous separation of gasoline into oil inside the separator, excludes the possibility of separation of hydrogen sulfide in the pH fields below 7.

After the pretreatment, which is done in manufacturing plants, with the exception of caustic flow, the wastewater is directed to the primary treatment, in a joint plant. Since the wastewater comes to the primary treatment in separate flows the treatment is carried out in two main technological lines, as follows:

1. The line for the primary treatment of wastewater with inorganic characteristics; and
2. Line for exemplary treatment of wastewater with organic characteristics.

The line for the primary treatment of wastewater with inorganic characteristics consists of sedimentation in which the deposition is done with the use of coagulants to enhance the effect of deposition followed by the clarified water that goes into the receiver pool and then in the stabilization pool. Primary treatment of wastewater that carries organic pollution consists of the process of removing suspended solids, oil and grease (dissolved air flotation and filtration on the anthracite filters

under pressure). After primary treatment of waste waters with organic pollution, wastewater is routed to secondary processing, in the plant for biological treatment. The plant for biological treatment is based on the principle of two-stage biological oxidation where the first stage of the biological treatment is performed on the biological filter and the second stage with activate sludge. After biological treatment water is discharged into the secondary sedimentation tanks, and then in the stabilization pool before discharging into the recipient. In the secondary sedimentation tanks the separated sludge is returned to the process of the activate sludge, and the excess of the biological sludge is sent to the sludge processing.

The amount of wastewater, with the organic pollution that comes from the Oil Refinery is 9600 m^3/day. To the plant comes the sanitary flow of the Petrochemicals at a rate of 600 m^3/day, and the total amount of water from the Petrochemicals is 4100 m^3/day (Table 4).

Table 1.Total amounts of the waste water

No	The origin of the waste water	Amount (m^3/day)
1.	Organic flow of "Petrochemicals"	2000
2.	Inorganic flow of "Petrochemicals"	1500
3.	Sanitary flow of "Petrochemicals"	600
T O T A L "Petrochemicals":		4100
4.	Organic flow of the Oil Refinery	9600
TOTAL flow		13700

SLUDGE TREATMENT TECHNOLOGIES - SOLIDIFICATION

In the processing of process and sanitary wastewater four types of sludge are distinguished (biological, sanitary, inorganic and flotation sludge). In the following procedure the dehydration is carried out on sludge on the centrifugal decanters. Final treatment and stabilization of sludge is performed with CaO (quicklime) or $Ca(OH)_2$ (slaked lime). Capacity of the plant for the wastewater treatment is up to 1000 m^3/h.

$$CaO_{(s)} + Oil_{(l)} \longrightarrow \underline{CaOOil}_{(s)}$$

$$Ca(OH)_{2(aq)} + Oil_{(l)} \longrightarrow \underline{CaOOil}_{(s)} + H_2O_{n\ (l)}$$

The main technological process of the sludge treatment is its dehydration. The first stage of dehydration of the sludge is thickening sludge. Table 1 presents the projected amount of sludge that comes for the thickening.

Table 2. View of the amount of sludge for thickening

Ordinal number	Sludge types	SM (%)	Amount	
			(m^3/d)	(kg/d)
1.	Biological sludge	1,5	336	5040
2.	Sanitary sludge	2	20	400
3.	Inorganic sludge	1,5	160	2400
4.	Flotation sludge	8	40	3200
Total			556	11040

Biological, sanitary and inorganic sludge are with the appropriate discharge system, transported to the sludge thickener. In order to improve the thickening effects, speeding up the process and stopping the anaerobic process, at the entrance of the thickener, the powder lime is dosed. Table 2 shows the dehydration characteristics of the thickened sludge:

Table 3. Dehydration features of the thickened sludge – project data

Ordinal number	Sludge type	SM (%)	Amount	
			(m^3/d)	(kg/d)
1.	Biological sludge	5	100	5000
2.	Sanitary sludge	2	20	1000
3.	Inorganic sludge	5	36	1800
Total			156	7800

Thickener is a cylindrical system with conical bottom. The pump station of the thickened sludge, through a suitable propellant system, switches thickened sludge to the centrifuge. The sludge of the line 1 is dosed by means of the mono-pump directly in the centrifuge, while at the same time the polyelectrolyte – flocculant is dosed

The tank (thickener) of the flotation sludge accepts the flotation sludge and has a function of retention. The pump station of the thickened sludge, transports the flotation sludge to the centrifuge 2 while the centrifuge 1 still works. In the object of dehydration the three centrifuges are installed. Under the centrifuge the conveyor belt is found, for the transportation of the dehydrated sludge. After dehydration the sludge is stabilized with lime (under the belt conveyor the mixer of dehydrated sludge with lime is integrated). Two centrifuges are two-phased, and centrifuge for the flotation sludge is three-phased. The final sludge dehydration is done in the centrifuges. Table 3 shows the projected amounts of dehydrated sludge:

Table 4. Amounts of dehydrated sludge

Ordinal number	Sludge type	SM (%)	Amount	
			(m^3/d)	(kg/d)
1.	L i n e 1	28	25	7000
2.	L i n e 2	28	12	3360
Total			37	10360

Lime powder is stored in the respective silos. Sludge dehydration ends the whole purification process of the waste waters of the Petrochemicals and NIS Oil Refinery.

Sludge treatment possible is from 3 m^3/day, during the five working days, dehydrated and stabilized sludge with the plant capacity around 11 000 m^3/day of waste waters. Average monthly capacity is 60 m^3 of which the 12 m^3 is the flotation sludge.

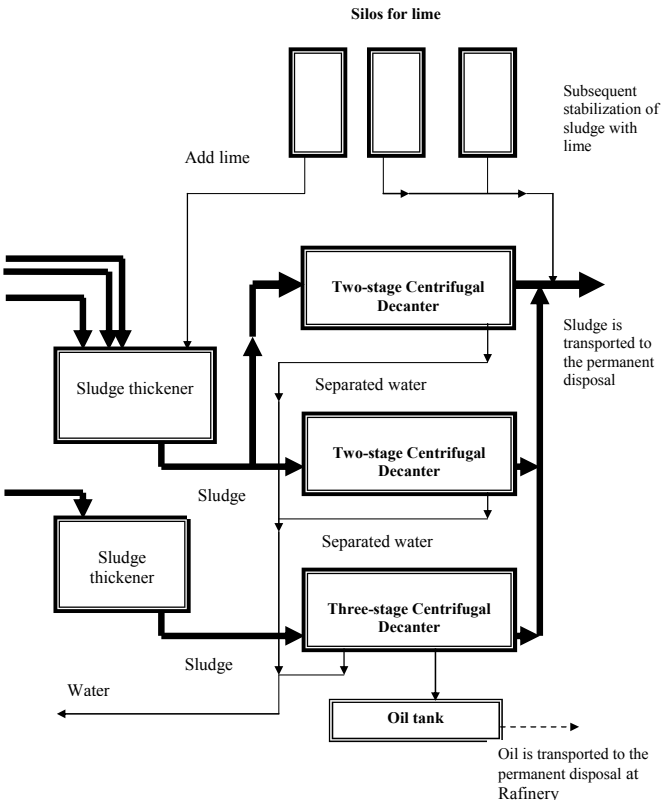

Figure 1. Plant for sludge dehydration

CONCLUSION

The problem of separated sludge in the chemical industry is very complex and requires a comprehensive understanding. Technology (solidification) used in HIP-Petrochemicals in the plant for sludge dehydration is excellent and based on many years of experience we can say that with the process we can obtain solidificate that can be disposed in the open area. In this the dehydrated sludge has no negative and detrimental impact on the environment (due to the laboratory proven stability) and hydrophobicity, except it requires a warehouse. There is a possibility that the solidificate can be used for building materials. Because of the enhanced features, of the newly obtained solidificate it can be pointed out and concluded that an environmental and economic problem can be solved with a significant financial effect and marked component of environmental protection and sustainable use of waste.

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