

SLUDGE UTILIZATION AND REDUCTION EXPERIENCES IN THE PULP AND PAPER INDUSTRY

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ABSTRACT

This paper presents pilot-scale experiences on utilization of primary sludges from an integrated pulp and paper mill in the manufacturing of hardboard. The results have shown that the primary sludge added in 1/4 ratio yields the best result considering quality and operating aspects for the hardboard production. Lab-scale anaerobic treatability studies were carried out by an upflow anaerobic sludge blanket reactor (UASBR) with a volume of 10.35 l using settled effluents from the related industry as the feed. Anaerobic treatability study results have shown that such an application prior to existing activated sludge system may provide 70 percent reduction in energy requirement for aeration and about 65 percent net reduction in excess biological sludge production.

KEYWORDS

Pulp and paper mill effluents, sludge treatment, activated sludge systems, anaerobic treatment, bioenergy recovery, hardboard production.

INTRODUCTION

Mill Description: The investigated industry, SEKA Izmit pulp and paper mill, which was installed in Kocaeli province on the Izmit bay of the Sea of Marmara, is an integrated industrial complex. SEKA Izmit pulp and paper mill was the first pulp and paper factory in Turkiye and it has been modified several times. Fig 1 shows the process mass balance in SEKA Izmit pulp and paper mill.

MATERIALS AND METHODS

Experiments on the sludge samples were carried out on grab samples but BOD, COD, suspended solids and toxicity measurements were made on twenty-four hour composite samples. Wastewater samples were analyzed for suspended solids (SS), COD, BOD₅, pH, alkalinity, temperature, N, P and toxicity using APHA standard methods (APHA, 1985). Biogas flowrates were measured by wet-type gas meter. CO₂ content of the biogas was determined by Orshat apparatus. Quality control tests of hardboard samples, which were produced by using several proportions of primary sludges, were carried out in accordance with Turkish Standards for pulp and paper industry.

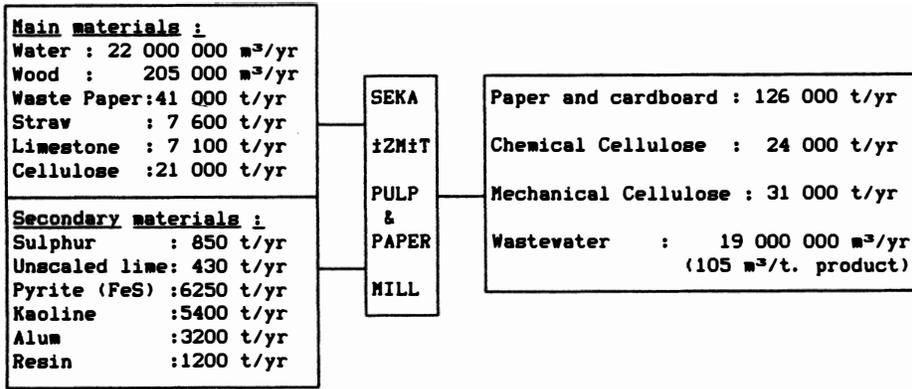


Fig. 1. Process Mass Balance for SEKA Izmit mill.

RESULTS AND DISCUSSION

Evaluation of Full-Scale Treatment Plant Performances : SEKA Izmit pulp and paper mill has a full-scale activated sludge wastewater treatment plant. This treatment plant was started up at the beginning of December 1990. The treatment system has been carefully operated since that time. Table 1 shows the flow, pH temperature, SS, BOD₅, COD and sludge volume index (SVI) values measured in May 1991 as an example. BOD₅ and sludge mass balances have been presented considering average design flow, BOD₅ and SS values in Fig.2.

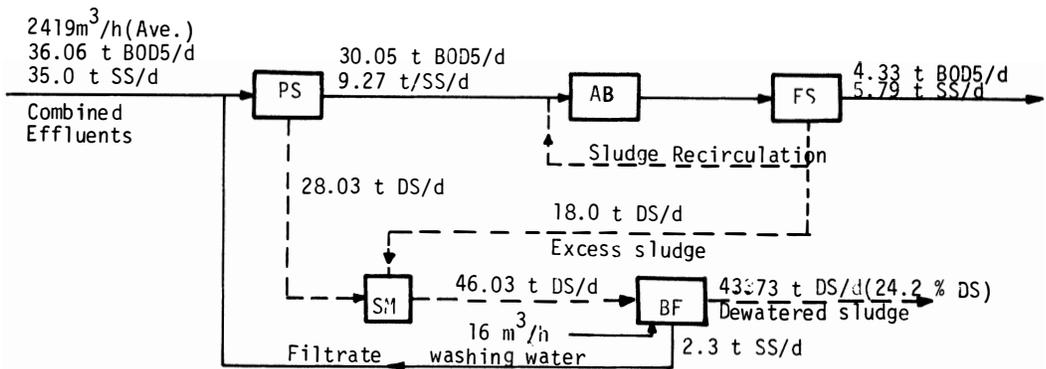


Fig.2. BOD₅ and Sludge Mass Balances for SEKA Izmit Wastewater Treatment Plant

The average mixed liquid suspended solids concentration (MLSS) in the aeration tank is about 6000 mg/l and the amount of the primary and excess biological sludges with an average dried solids content of 25 percent from the belt filters is about 100 t per day on wet weight basis.

Table 1 Average Performance Data for SEKA Izmit Wastewater Treatment Plant in May 1991 (No of samples = 19)

Parameter	Sampling Location			
	Primary Sed.		Aeration Tank	Secondary Sed.
	Influent	Effluent		Effluent
Flow (m ³ /h)	1650	-	-	-
pH	6.7	6.5	6.4	6.5
Temp. (°C)	24	24	24.4	24
SS (mg/l)	570	190	5960	88
BOD ₅ (mg/l)	410	-	-	57
COD (mg/l)	2295	-	-	1510
SVI (ml/g)	-	-	65	-

Hardboard Production : Utilization of the primary sludge for the production of hardboard was one of the main purposes of this study. For this purpose, the primary sludge was sent to the SEKA Bolu hardboard and Formica manufacturing factory to be added in different ratios to the raw materials in hardboard production. Hardboard is produced with "wet process" in SEKA Bolu Hardboard and Formica factory. The primary sludge used in hardboard production had a DS content of 27.5 % after belt filtration. The full scale results have shown that primary sludge added in 1/4 ratio yielded the best result considering quality and operating aspects in the hardboard factory (Eroglu et al, 1991). The utilization of the waste primary sludge (28 t DS/day) in hardboard manufacturing will result in decrease of the amounts of sludge to be processed and area requirement for the sludge disposal. Such an application will also provide considerable cost savings and source recovery. The savings on wood are 5850 t/year (350.000 \$ /year) and on electricity are about 1.4 MWh/year (100.000 \$/year).

Anaerobic Pre-Treatment As An Alternative For Sludge Reduction : The average excess biological sludge produced in the treatment plant for the SEKA Izmit pulp and paper mill is about 20.6 m³/d with 1.3 percent DS content at design loading conditions. This corresponds to about 75 t dewatered sludge per day with a DS content of 24.2 % at the design capacity. The scarcity of the land for dewatered sludge disposal has forced the SEKA to investigate and implement new alternatives for reduction of the huge amounts of excess biological sludges in the near future. These include anaerobic sludge digestion, incineration, aerobic stabilization and application of anaerobic pre-treatment following primary sedimentation. In this study, the effects of anaerobic pre-treatment on excess biological sludge production and energy requirement for the activated sludge aeration have been investigated. Table 2 summarizes steady-state averages of major operating parameters obtained at two different hydraulic retention times (HRT) of 24 and 18 h respectively. Considering these values it can be concluded that UASBR treatment of settled primary effluent from the SEKA Izmit mill provides a COD removal of about 55 percent at 18h of retention. Such a reduction in COD corresponds to about 70-75 percent removal of easily biodegradable portion of the feed (i.e BOD₅). Biogas production yields of about 0.25 m³ per kg COD removed can be achieved by anaerobic treatment and this corresponds to about 0.20 m³ methane per kg COD removed. Seventy percent reduction of BOD load in the activated sludge system will result in 70 percent reduction of the energy requirement for aeration and in the excess sludge production from the treatment plant. Thus, application of anaerobic pre-treatment before the existing activated sludge system in the SEKA Izmit mill would provide 70 percent reduction in energy requirement for aeration and the amount of excess biological sludge would decrease from 18 t DS/day to 6.4 t DS/d. This excess biological sludge of 6.4 t DS per day includes about 3.1 t DS per day of anaerobic sludge from the anaerobic pretreatment plant. The mass balance for BOD and SS in the case of

anaerobic pretreatment for the SEKA Izmit pulp and paper mill are shown in Fig.3. The energy equivalent of the biogas from the anaerobic digester will be about 2300 kWh per day for average design loadings.

Table 2 Steady-State Operating Results From The UASBR Treatment of SEKA Izmit Mill Effluents

Parameter	HTR = 24 h		HTR = 18 h	
	Influent	Effluent	Influent	Effluent
pH	6.9-7.5	7.3-7.9	6.9-7.5	7.3-7.9
Temperature (°C)		33 + 2		33 + 2
Alkalinity (mg/l)	750	1200	800	1100
CODT (mg/l)	2350	1140	2185	1000
Gas flowrate (l/d)		3.1		4.0
CO ₂ (%)		~20		~20

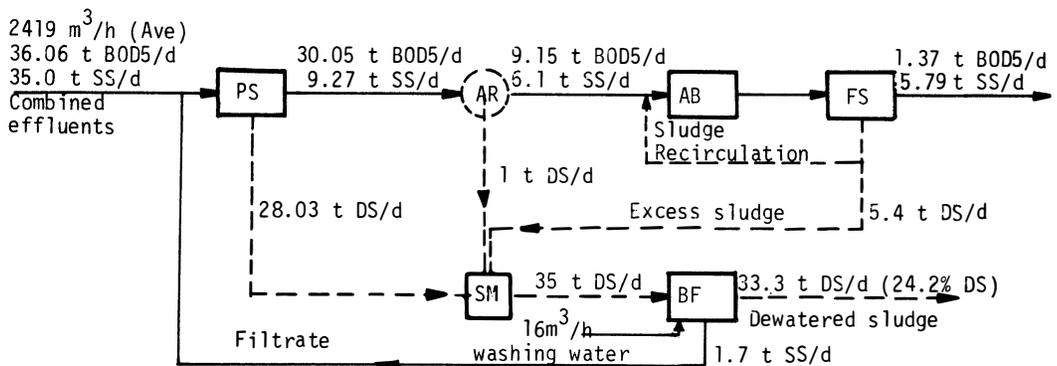


Fig. 3. BOD₅ and Sludge Mass Balances in the Case of Anaerobic Pre-Treatment For The SEKA Izmit Mill.

CONCLUSION

The utilization of sludges from the primary sedimentation tanks in hardboard manufacturing decreases the amount of sludge to be processed. Such an application will also provide considerable cost savings and source recovery. Primary sludge added as 1/4 ratio yields the best result considering quality and operating aspects for the production of hardboard. Anaerobic pre-treatment prior to the existing activated sludge system in the SEKA Izmit pulp and paper mill may provide 70 percent reduction in energy requirement for aeration and about 65 percent reduction in excess biological sludges from the treatment plant. In addition to these, it is also possible to recover bioenergy which is equivalent to about 2300 kWh per day by adding anaerobic pretreatment into the system.

REFERENCES

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