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APPLICATION OF JET PUMP TO NEUTRALIZATION OF STRONGLY ALKALINE WASTEWATER WITH OFF-GASES

1. INTRODUCTION

Various food processing plants, e. g. mineral water bottling plants have sections in which bottles are washed. The bottles are first placed in the solution of NaOH (6–8 g/dm^3) and then washed in hot and cold water.

Basic bath is changed usually once in 24 hours. Because of high content of NaOH in such an effluent its neutralization with mineral acids cannot be simply done because it could result in exceeding the permissible standards of anion concentrations (Cl^-, SO_3^{-2}, NO_4^- etc.). Discharge of wastewater neutralized with mineral acids would be possible after its manifold dilution with municipal water; this procedure, however, would lead to an undue excessive consumption of the latter. Promising results in neutralization of pickling effluents from aluminium industry by combustion gases [1, 2] have prompted the authors to apply this method to the neutralization of strongly alkaline wastewaters.

Considering the concentration of soda lye two kinds of wastewater can be distinguished: 1) washing wastes which contain low concentrations of sodium lye, sporadically exceeding admissible limit of reaction (pH = 9), and 2) wastewaters from the exchange of concentrated bath which contains large amounts of sodium lye. For these reason these wastes were separated.

The washings after pH correction with automatically metered sulphuric acid, is discharged to sewage system, while the latter wastes are neutralized with off-gases extracted from the stack by means of a jet pump.

Laboratory investigations allowed to formulate technological parameters for the design of an experimental neutralization system. The jet pump was chosen according to the data given by KRAWCZYK [3].

2. EXPERIMENTAL PART

2.1. INSTALLATION

As stated above, only highly concentrated effluents discharged periodically (daily): from upper tanks (2×2 m^3 = 4 m^3) and twice a week from the lower tank of the washing stand (containing 6 m^3 of effluent) are subject to the saturation processes (fig. 1). When the work in washing stand is completed the effluents from both upper tanks *1* and *2* are conveyed by pipeline or pumped with pumps *5* — depending on local

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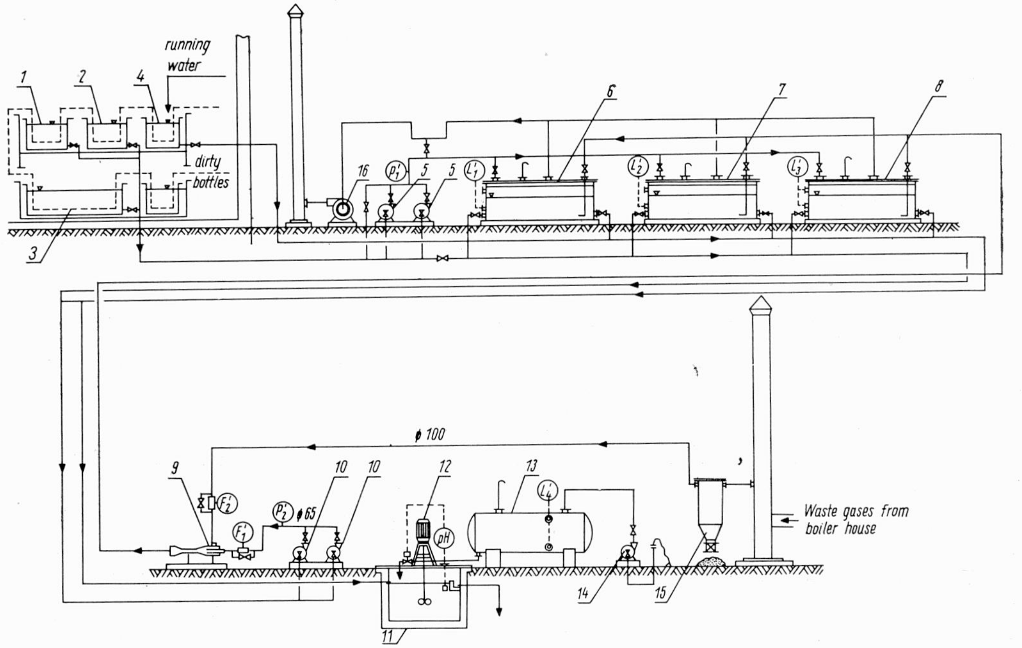

An experimental train of neutralization of strongly alkaline wastewater by means of off-gases (description in text)

Schemat instalacji do oczyszczania ścieków alkalicznych za pomocą gazów spalinowych

1, 2 — basen górny myjni, *3* — basen dolny myjni, *4* — basen do płukania butelek wodą bieżącą, *5* — pompa, *6* — zbiornik magazynowy, *7, 8* — saturator ścieków, *9* — strumienica, *10* — pompa do wymuszonej cyrkulacji ścieków, *11* — studzienka, *12* — mieszadło łopatkowe, *13* — zbiornik stężonego H_2SO_4, *14* — pompa do kwasu siarkowego, *15* — odpylacz, *16* — wentylator

conditions — to one of saturators *7* or *8*. The storage tank for effluents from lower tank *3*, can be used if necessary as a saturator, having the same equipment as the saturators *7* or *8*. The tanks *7* and *8* contain 4 m^3 of effuents from the two upper tanks. The effluents from the lower tank are pumped by the pump *5* into the tank *6*, and then 2 m^3 of this effluent are pumped with the same pump into tank *7* or *8*. After 3 days tank *6* is emptied and ready to accept the next 6 m^3 batch of effluent from the lower tank. The preparation of wastewaters for saturation in one of saturators consists in pumping of the whole contents of the two upper tanks *1* and *2*, and 2 m^3 ot wastewater coming from the lower tank *3*, and pumped into saturator from tank *6*. Pump *5* can be also used for pumping the effluents from the lower tank to the storage tank *6* by means of a special system of valves and pipelines, shown in the layout in fig. 1. Before the saturation is initiated the saturator contains 6 m^3 of wastewater, with an average concentration of 4 g/dm^3 NaOH. Raw wastewater pumped to one of the saturators *7* or *8* is subject to the saturation process. Saturators are tanks with flat rectangular bottom, their covers are equipped with connector pipes providing liquid supply and gas drainage. Jet pump is employed for saturation; waste gases from the chimney are first drawn by the liquid jet flowing with a high speed, and then thoroughly mixed with it. Pump *10* draws wastewaters from the saturator *7* or *8* and through the jet pump forces it back to the saturator. From experimental data obtained in one industrial plant it follows that for 6 m^3 of wastewater prepared for saturation 463 m^3 of gases must be used to obtain the pH value lower than 9. This means that the liquid must be pumped 78 times, provided that the ratio of drawn gas to the volume of liquid is 1:1. After saturation the wastewater is drained to the sewer, and then to municipal sewage treatment plant. The wastewater is gradually released from the saturator in order to empty it within 16 hrs. In this way wastewater thus mixing it with washings from the final washing of bottles (the latter flow-rate amounts to 9 m^3/h). Washwaters together with the slow-flowing wastes after saturation by common pipe line, flow into a sink tank *11*, where — in case when the pH exceeds *9* — they may undergo additional neutralization with concentrated sulphuric acid. In the sink tank the wastewaters are intensely stirred with a paddle mixer *12*. The pH of wastewater drained to the sewage system is measured by pH-meter probe which automatically controls the acid and feed from the supply tank *13*.During normal operation of the treatment plant and failure-free run of the washing stand the pH correction will not be necessary. The pH adjustment equipment protects the sewer system against discharges of alkaline wastewaters.

Tank *13* is a stock tank of concentrated H_2SO_4, fed from vehicles by pump *14*. Gases for saturation are supplied with pipe line from the lateral branch of chimney of the local boiler house. Before entering the jet pump they are purified from larger impurities in a special gas cleaning plant *15*.

Unused gases are sucked by exhauster (suction fan) *16* and thrown out through chimney to the atmosphere. If treatment plant is situated in short distance from the boiler house then combustion gases (furnace gases) sucked by the exhaust fan can be let to the boiler house chimney by connecting it with waste-pipe of the exhauster.

2.2. COMPOSITION OF WASTEWATERS

The compositions of separate kinds of strongly alkaline wastewater and of washwater are presented in tables 1 and 2, respectively.

Table 1

Composition of highly alkaline wastewaters

Wastes from the bottom basins	COD mg O_2/dm^3	SO_4^{--} mg SO_4^{--}/ /dm^3	Cl^- mg Cl/dm^3	TSS	NaOH content g/dm^3
(6 m^3); Wastes discharged twice a week	96	8	24	418	3.2
(2 m^3); Wastes discharged daily basin I	101	9	38	285	6.6
basin II	88	8	15	232	2.1

2.3. SATURATION OF WASTEWATER BY WASTE GASES

Saturator is batch fed with 6 m^3 of wastewater (the average concentration of NaOH amounting to 4 g/dm^3),

Feed: combustion gases — 465 m^3/24 hrs.

Effluents: wastewaters after saturation — 5.85 m^3/24 hrs;

gases after saturation — 450.0 m^3/24 hrs;

steam from saturator — ca 150 kg/24 hrs.

Wastewater from the saturator contain on the average 7.15 $NaHCO_3/dm^3$. Neutralization process of the separate kinds of sewage is presented in table 3.

Table 2

Washwaters composition — discharge 9 m³/day

Day	Permanganate demand	Sulphates	Chlorides	Suspended solids	pH
11. 04. 75	15.0	22.0	21	154.0	8.2
19. 06. 75	12.8	29.0	21.0	232.0	8.0
14. 07. 75	9.0	19.0	23.0	159.0	8.2
13. 11. 75	6.0	[illegible]1.0	27.0	98.0	7.9

Table 3

Course of neutralization with off-gases

Wastewater	pH	V gas/V wastes	pH	V gas/V wastes
The upper tank I containing 6.6 g NaOH/dm³	11.40	11.1	10.00	71.1
	11.35	27.5	9.75	82.2
	11.35	34.4	9.45	101.3
	11.20	45.3	9.15	120.0
	10.40	61.1	8.90	158.8
The upper tank II containing 2.1 g NaOH/dm³	10.2	10.3	9.0	26.4
	10.0	14.1	8.8	32.0
	9.6	17.8	8.5	38.1
	9.2	21.3		
The bottom tank containing 3.2 g NaOH/dm³	11.4	11.1	8.6	42.6
	10.3	19.1	8.5	53.5
	9.5	30.9	8.5	64.4
	9.1	37.8		

The composition of neutralized, strongly alkaline averaged sewage is presented below:

$NaHCO_3$	7.15 g/dm³,
pH	8.7,
COD	30–40 mg O_2/dm³,
Sulphates	72 mg SO_4^{-2}/dm³,
Chlorides	32 mg Cl/dm³,
Total suspended solids (TSS)	236 mg/dm³.

During the 16 hour metering of the washwaters the pH ranged from 7.5 to 8.6, COD from 8 to 12 mg O_2/dm³, the contents of sulphates, chlorides and $NaHCO_3$ ranged within 25–35 mg/dm³, 20–25 mg/dm³, and 250–295 mg/dm³, respectively.

2.4. FINAL AVERAGING AND pH CORRECTION

Feed:

- wastewaters after saturation 5.85 m³/24 hrs.
- washwater from final washing of bottles 144.0 m³/24 hrs.

Effluents

— averaged to the sewer wastewaters 149.85 m^3/24 hrs.

The averaged wastes contain 250–295 mg of $NaHCO_3/dm^3$.

In the above balance the process of final neutralization with concentraced H_2SO_4 is not given quantitatively since the pH need not be corrected if the washing stand and the wastewater treatment plant are operating without break downs.

3. CONCLUSIONS

Results of investigations presented in the paper confirm the applicability of the presented method. The main advantage of such neutralization is the simplicity of the system applied and, consequently, a higher probability of trouble-free operation without break dwon. Combustion gases introduced to wastewater by a fet pump neednot be dedusted, as it is the casse when a blow fan is employed.

The inconvenience of this method lies in relatively small quantity of off-gases drawn during one et cycle, which calls for multiple forced recycle of the liquid in order to assure adequate saturation.

REFERENCES

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[4] Patent application No. 186 312.