Airplane Wastewater: characterization and a pre-treatment step

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Abstract

The characterization of airplane wastewater from Portela Airport, Lisbon Portugal, allow to conclude that it presents a high concentration of SST, COD, a low biodegradability, COD/BOD_5, between 0,17 and 0,42, and high concentrations of Cl^- and NH_4^+.
The SST, mainly from paper, has to be removed before any treatment. The application of decantation, centrifugation and coagulation /flocculation with 0,2 M of coagulant $Al_2(SO_4)_3$ allow SST removals of 68%, 88% and 92%, respectively.
The decantation is the operation that has a lower percentage removal of COD, 34%, against 39% for coagulation /flocculation with 0.02 M $Al_2(SO_4)_3$ and 40% for centrifugation. The resulting effluent, from these operations, have a low biodegradability than the initial wastewater.

Keywords: airplane Wastewater; treatment; solid removal.

I. Introduction

Portela Airport, located just inside the city of Lisbon, Portugal, generates a daily average effluent volume of 50 m^3 from the boxes of aircrafts.
This water comes from the use of aircraft toilet by passengers,. Before each flight, a blue color product that has in its composition a quaternary ammonium germicide and ethylene glycol as antifreeze is added to each box to prevent microorganism growth. Consequently, these waters are a murky, blue-green, liquid if added of germicide product or a brownish color liquid, if not. Once passengers are accustomed to use large quantities of paper, this generates large quantities of TSS in the effluent. The composition of human urine, largely determines the physical and chemical characteristics of the effluent; a liter of human urine contains approximately 25 g of urea, 9 g sodium chloride, ammonia, uric acid and other substances (Julião, M ., 2007).

Normally the effluents from aircraft are mixed with the waste water generated in the buildings of airports and its treatability by biological processes becomes possible (Adeola, S. et al., 2006, Liu, Z. and such., 2007, Gabrieli, R ., 1997).

2. Methodology

Sample collection: Airplane Wastewater was collected from the Portela Airport in Lisbon (Portugal), during the months of March to June 2007, a total of one composite sample (24 hours) per month and immediately frozen to avoid biological activity. The characterization methods were according to Standard Methods (APHA, 2003).

Precipitation experiments. Jar-Tests were conducted in 1-L glass recipients by using a wastewater volume of 800 mL. The pH meter was immersed in the samples and the basic precipitant with lime, or coagulation was added to raw Aiplain Wastewater, under rapid agitation until the desired pH. When pH of precipitation was obtained the agitation was stopped. After sludge sedimentation, the samples were collected and analyzed to determine the main contaminant indicators.

3. Results and discussion

3.1. Characterization

The average daily flow rate of Portela Airport also varies throughout the year, with a maximum in July (46, 1 m^3/day) and a low of 41.6 m^3/day in December. For the other hand the fluctuations in flow during the day are very striking.

Table 1 summarizes the main characterization of the Airplain Wastewater used in this study (average values are shown).

Table 1: Airplane Wastewater characterization from Lisbon Airport

Parameter	Mean value (5)
pH	8,3 ± 1,4
Condutivity	11,8 ± 2,9
Potencial Redox	-301 ± 289,4
SST	2523 ± 2082
COD	10520 ± 7990
BOD_5	4450 ± 1789
$N\text{-}NH_4^+$	1725 ± 351
N_t	1899 ± 244
Orthophosphate	14
$N\text{-}NO_3$	<1
$N\text{-}NO_2$	<1
Oils and fats	170 ± 82
Total Hardness	128 ± 59 (4)
Ca^{2+}	0,2 ± 0,4(4)
Na^+	772 ± 162(4)
Cl^-	1257 ± 249(3)

Units in mg/L, except conductivity in mS/cm and Redox Potential in mV

The physical-chemical characteristics of the effluent from the aircraft's Portela airport showed that it is a neutral/basic effluent, pH vary in the range of 8, 9-9, 7. Presents high concentrations of suspended matter (SST in the range of 444 - 4605) due mainly for the presence of toilet paper. The organic load of this effluent, in form of COD, vary in the range of 2, 5 – 1, 89 g/L. This effluent presents a mean biodegradability index (BOD_5/COD ≈ 0, 42). Due to the presence of human urine this effluent presents large concentration of chloride (range 1008-2763 mg/L) and ammonia. Consequently, these physicochemical characteristics are the responsible for this difficult treatability. Therefore, given that, its discharge into the receiving waters would require the use of very expensive technologies, like reverse osmosis or ionic exchange.

3.2. Treatments

Confronting the physicochemical characteristics of this effluent with the environmental regulations for the discharge in the receiving waters it can be conclude that it necessary the removal of more than 99% of the principal parameters like COD, BOD5, SST, N and P. So, the solution more economical is the discharge in the municipal sewage. For this discharge it is needed the TSS removal at 78% and 40% of oils and fats.

3.2.1. Raw airplane wastewater

Nevertheless, in order to download it to the municipal sewage, the airplane wastewater must undergo a pre-treatment that may involve coagulation / flocculation or centrifugation (Carvalho, 2006, Rivas *et al*., 2003, Matcalf and Eddy, 2003, Rivas *et al.,* 2004, Rivas *et al.,* 2005).

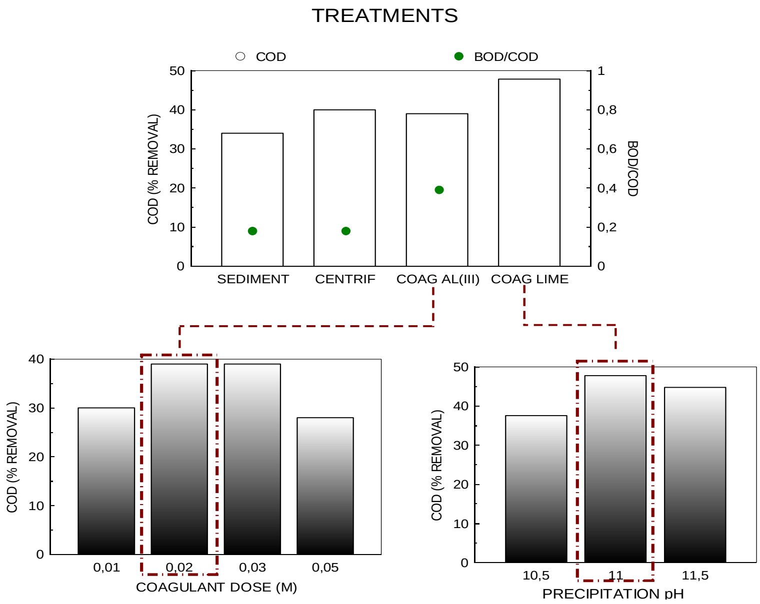

Figure 1. *Influence of the pre-treatments in COD removal. Experimental conditions: pH_o=8, 3; COD_o =10, 4 g/L.*

The figure 1 summarizes the results obtained with the application of four physicochemical treatments: sedimentation, centrifugation, coagulation with aluminum sulfate, and coagulation with lime at basic pH

As we can see, the lime precipitation allow a maximum COD removal of 47, 8% at pH=11 in opposition to single sedimentation, 34%. Of the three different pH values studied, pH 11 shows the best COD removal. The previous experiments show that $FeCl_3$ was not efficient at natural pH or adjusted. On the contrary, the coagulation with $Al_2(SO_4)_3$ show good COD and SST removals. The sedimentation occurs immediately after the addition of coagulant, but flocculation was not observed.

The table 2 summarizes the removals of different parameters with this operations and processes.

Table 2: Airplane Wastewater characterization from Lisbon Airport

	SST (%)	COD (%)	BOD 5 (%)	N-NH_4^+ (%)	N_t (%)	P_t (%)	Oils and Grases (%)
Sedimentation	68	34	71	4	9	13	71
Centrifugation	88	40	71	3	4	0	40
Coagulation with 0,02M $Al_2(SO_4)_3$	92	39	54	16	-	94	-
Coagulation with lime	-	47	-	-	-	-	-

As we can see, all steps treatments (sedimentation, centrifugation, coagulation with aluminium sulphate, and coagulation with lime) allow the effluent discharge in the municipal sewage.

3.3.2. Pre-treated Airplain wastewater

The previous treatments proved to be effective to obtain an effluent able to be discharged into municipal sewage.

Nonetheless, additional centrifugation and sedimentation treatments were applied to supernatant of to obtain the additional removal of organic matter and color.

The optimized doses of coagulant (0, 02 M of $Al_2(SO_4)_3$ and powdered activated carbon (CAP) in the range of 2, 5-15 g/L, were used. The results are summarized in the figure 2.

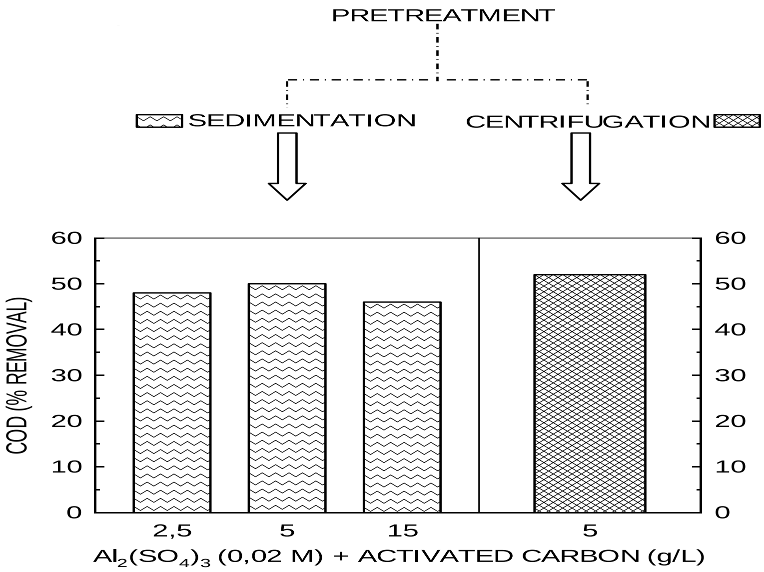

Figure 2. *Influence of the application of Coagulation + CAP in COD removal of supernatant of Sedimentation and coagulation. Experimental conditions: pH_o=7, 0; COD_o =6, 9 g/L.*

As we can observe, the CAP shows the best results to the concentration of 5 mg/L, for both processes. With this additional step of coagulation or centrifugation), with coagulant and CAP, we achieved additional COD removals near 50%. However these post- treatments are insufficient to obtain the discharging characteristics.

4. Conclusions

This study showed that the most economical solution to airplane Wastewater of Airport of Portela would be to discharge it into municipal sewage. Laboratory results showed that the centrifugation is a good solution to remove the required amount of solids and oils and greases, because it produces sludge free of chemical reagents and thus apt for agricultural use.

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