

## SOURCES OF POPs FROM INDIVIDUAL DISCHARGES IN THE CITY OF VENICE

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### Introduction

The unique urban structure of Venice, the ancient city island in the middle of the homonymous lagoon, has always discouraged, both for technical and economical reasons, the construction of a modern sewerage system for the collection and the treatment of the urban discharges, which therefore continue to flow into the waters of the surrounding lagoon. In recent years, most of the tourist structures of the city, like hotels and restaurants, have been forced by the Municipality of Venice and the MagistratoalleAcque, the Venice water authority, to adopt individual treatment systems to reduce the pollution load in the Venice lagoon. Individual treatments were installed also in many domestic discharges, but a large amount of them still continue flowing into the lagoon without any kind of treatment. In the present paper, the efficiency of the different type of individual treatment systems adopted by hotels of the city of Venice has been evaluated not only in terms of abatement of macro-parameters, such as suspended solids and COD, but also in terms of efficiency in reducing the POPs load.

### Materials and Methods

Samples from the discharges of 12 different hotels with similar range of comfort (from 4 to 5 stars) but different type of wastewater treatments were monthly collected in the period from March 2004 to February 2005. Hotels were further selected according to the type of individual treatment system: three hotels (A, B, C) were equipped with septic tanks, five hotels (D, E, F, G, H) with SBR (Sequence Batch Reactors) plants and four hotels (I, L, M, N) with MBR (Membrane Biological Reactors) plants. All the samples were collected at the outlet of the treatment plants, before the discharge in the lagoon and analysed for suspended solids, COD (Chemical Oxygen Demand), PCDD/Fs and DLPCBs. For the analysis of POPs, the samples were spiked with a series of 15 <sup>13</sup>C<sub>12</sub>-labeled 2,3,7,8 PCDD/F (EDF8999), 12 <sup>13</sup>C<sub>12</sub>-labeled PCB (EC4937) internal standards, and then extracted with dichloromethane and cleaned up. The HRGC/HRMS analyses were conducted using a HP 6890N gas chromatograph coupled to a MicromassAutospecUltimaNT mass spectrometer operating in EI mode at 35 eV and with a resolution of 10.000 (5% valley). The recovery always ranged between 55% and 105%. Reproducibility were 15% for lower value or better. The laboratory blank, repeated twice, where lower than 8% respect to the minimum concentration found<sup>1</sup>.

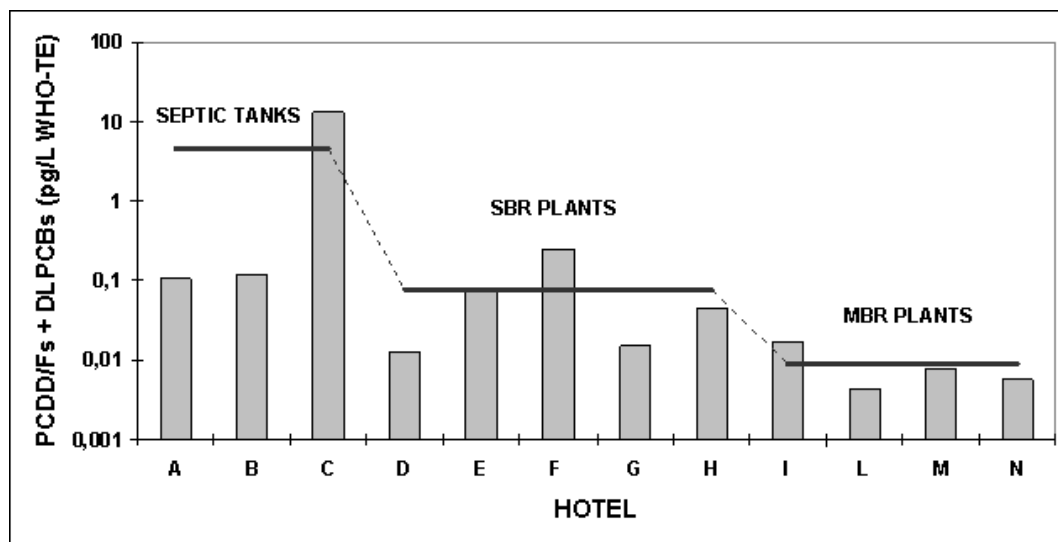
### Results and Discussion

The cumulative results of the analyses performed on the different samples are reported in Table 1. The results are expressed as the average of all the 12 measurements performed on each hotel during the entire study ("Mean value" in Table 1). The average value for each group of hotels characterised by the same type of treatment plant has also been calculated ("Av." in Table 1). The results of Table 1 clearly indicate different performances in the abatement of the various contaminants. The less effective treatments has been revealed, by far, those based on septic tanks, followed by SBR plants and MBR plants, which revealed the most effective in the abatement of all parameter considered, including POPs.

**Table 1. Results of the analyses on wastewater samples of hotels in Venice subjected to different discharge treatments.**

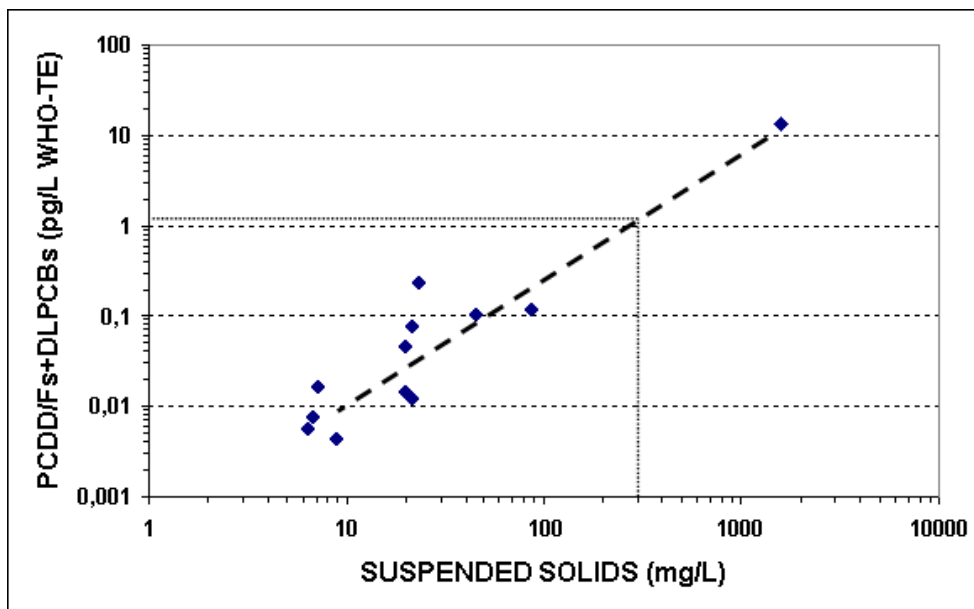
HOTEL	TYPE OF TREATMENT	PARAMETER									
		Suspended Solids (mg/L)		COD (mgO <sub>2</sub> /L)		PCDD/Fs (pg/L WHO-TE)		DLPCBs (pg/L WHO-TE)		PCDD/Fs + DLPCBs (pg/L WHO-TE)	
		Mean value	Av.	Mean value	Av.	Mean value	Av.	Mean value	Av.	Mean value	Av.
A	Septic Tanks	46	579	264	594	0.0273	4.010	0.0770	0.490	0.1044	4.500
B		87		414		0.0742		0.0429		0.1170	
C		1605		1103		11.9298		1.3509		13.2808	
D	SBR	22	21	62	131	0.0008	0.0246	0.0116	0.0534	0.0124	0.0781
E		22		62		0.0520		0.0268		0.0787	
F		23		155		0.0383		0.2004		0.2386	
G		20		238		0.0029		0.0118		0.0148	
H	20	138	0.0292	0.0167	0.0458						
I	MBR	7	7	38	42	0.0117	0.0032	0.0053	0.0054	0.0170	0.0087
L		9		32		0.0000		0.0044		0.0044	
M		7		52		0.0001		0.0076		0.0076	
N		6		46		0.0012		0.0045		0.0057	

The mean values of the POPs concentration (PCDD/Fs and DLPCBs) measured in the different hotel discharges are showed in Fig. 1. It is quite evident the improvement of the treatments based on MBR plants, which can reduce one order of magnitude the POPs concentration with respect to SBR plants (average value of 0.0087 pg/L for MBR compared to 0.0781 pg/L for SBR) and more than two order of magnitude in comparison with septic tanks (average value of 4.500 pg/L for septic tanks).



**Figure 1 – Comparison of POPs concentration in wastewater samples of hotels in Venice subjected to different discharge treatments.**

The relationship between suspended solids and the sum of PCDD/Fs and DLPCBs in the discharges of the Venice hotels is shown in Fig. 2.



**Figure 2 – Relationship between suspended solids and POPs (sum of PCDD/Fs and DLPCBs) in wastewater samples of different hotels in Venice.**

The relationship of the double log scale plot of Fig. 2 indicates that the concentration of POPs increases more than linearly with the suspended solids concentration and confirms that POPs are strongly adsorbed to suspended solids in the urban discharges. Previous studies indicated that the mean concentration of suspended solids in the effluents of septic tanks of the Venice hotels was about 300 mg/L and that the total load of suspended solids released by the urban discharges of the city of Venice (hotels and other domestic discharges) could be about 2,900 T/year, with the optimistic assumption that all the discharges were subjected to a preliminary septic tank treatment before discharging into the lagoon<sup>2</sup>. According to those data and the results of the present study, the corresponding load of POPs produced by the urban discharges, expressed as the sum of PCDD/Fs and DLPCBs, should be about 10 mg/year WHO-TE. Considering that the estimated efficiency of septic tanks for the removal of suspended solids from domestic discharges is in the range 30-70%, untreated discharges could have a mean concentration of suspended solids in the range of 400–500 mg/L which corresponds, according to Fig. 2, to a concentration of POPs of about 2 pg/L WHO-TE. Therefore, in the worst assumption of lacking of any type of treatments, the total load of POPs produced by the domestic discharges of the city of Venice could be estimated in the range of 20-30 mg/year WHO-TE, from about 10 to 15% of the total load of POPs calculated from the discharges of the neighbour industrial Porto Marghera area<sup>3</sup>. The results of the present study have also revealed the existence of urban discharges, like that of hotel C, which, due to their characteristics, cannot be considered domestic and could further increase the load of POPs to the lagoon. The extremely efficient removal of suspended solids by MBR plants, through the filtration of the activated aerate mixture by ultrafiltration membranes, can drastically reduce the release of POPs from hotels and other domestic discharges and can help to reduce the contamination by POPs of the Venice lagoon. The combined incineration of the separated sludges in modern thermal plants, preventing the “de novo” POPs formation, could provide a real possibility to operate a net decrease of POPs in the environment.

### Acknowledgements

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### References

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