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Treatment of an Industrial Aqueous Discharge by Solar Photolysis in a Compound Parabolic Collector Photo Reactor

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ABSTRACT

Despite the treatment applied at the refinery, the water leaving the wastewater treatment plant (WWTP) still contains pollution that can be dangerous for flora and fauna. Therefore, additional non-conventional, effective and cost-effective treatment methods must be combined with conventional treatment methods. Furthermore, solar photolysis, based solely on solar radiation, is a very economical method of mineralization and disinfection that respects the concept of sustainability, since it uses available UV radiation without the addition of chemical reagents. Moreover, for a treatment time of 4 hours, measurements of pollution parameters such as COD,TSS, turbidity, TOC, CN and heavy metals (Zn^{2+}, Cu^{2+}, Pb, Fe^{2+}) led to very interesting reductions, demonstrating efficiency of solar photolysis in the remediation of complex substances. Similarly, reductions of 84.81%, 70.23%, 85.03% and 82.08% were obtained for COD, BOD, TSS and turbidity respectively. In addition, heavy metals were eliminated with percentages of 100%, 33.67% and 83.33% respectively for Zn^{2+}, Fe^{2+} and Pb.

Keywords: photolysis, Compound Parabolic Collector, petroleum refinery wastewater, heavy metals.

1 Introduction

The development of industrial activities generates large amount of wastewater, these industries include petroleum industry that consume large amount of water. Petroleum refinery wastewater (PRWW) is treated by conventional methods at the wastewater treatment plant (WWTP) implanted at the refinery and still contains amounts of pollution; therefore, its reuse becomes dangerous for both human health and the environment. The present study aims to improve the efficiency of treatment operations by using non-conventional, effective and less costly treatment methods in addition to the existing treatment methods to enable this effluent to be reused safely and to allow a better water management [1-2-3]. Solar photolysis appears to be a promising solution [4]. Photo reactors are widely used for petroleum refinery wastewater treatment, especially compound parabolic reactor (CPC), which received considerable interest in the treatment of PRWW [5].

2 Experimental

We carried out a series of outdoor closed loop experiments in the compound parabolic collector (CPC): figure 1 without any addition of reagents. Wastewater samples were all collected at the same sampling point on different days with different compositions: Table I and with initial pH values ranging from 6.8 to 8.6. The treatment time was fixed at 4 hours with measurements of pollution parameters every 2 hours.

3 Results and Discussion

Reductions of 84.81%, 70.23%, 85.03% and 82.08% were obtained for COD, BOD, TSS and turbidity respectively. In addition, Heavy metals were eliminated with percentages of 100%, 33.67% and 83.33% respectively for Zn^{2+}, Fe^{2+} and Pb. Higher COD removal was achieved for the effluent that contains highest initial COD with no initial presence of the Cu^{2+}. The decrease observed in COD values suggests that this process is effective in oxidizing all the oxidizable matter present in the effluent.

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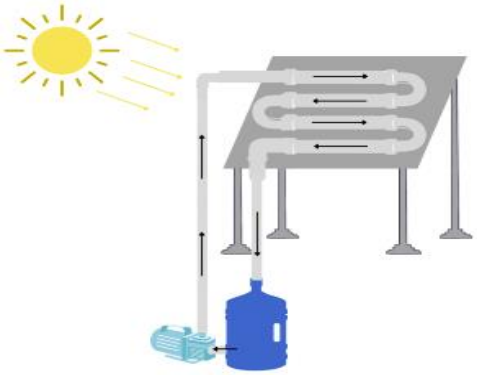

Figure1: Compound Parabolic Collector (CPC)

Table1: *Chemical characterization of the effluent before and after treatment.*

Parameter	Unit	Initial value range	Reduction Pourcentage %							
			Test 1		Test 2		Test 3		Test 4	
			2h	4h	2h	4h	2h	4h	2h	4h
COD	mg/L	75.4 – 422	53.84	64.45	80.66	84.81	-	-	25.68	30.73
BOD	mg/L	53.3 – 146	15.57	15.57	59.25	70.23	34.52	-	-	-
TOC	mg/L	85.6 – 87.2	-	-	-	-	43.45	45.79	42.66	45.41
TSS	mg/L	33 – 409	42.85	51.94	73.22	85.03	54.52	60.39	69.69	78.78
Turbidity	NTU	10.6 – 89	20.2	25.68	76.98	82.08	32.58	57.07	33.86	43.77
Zn^{2+}	mg/L	0.98 – 1.7	17.64	44.7	100	100	36.73	74.48	80	100
Fe^{2+}	mg/L	0.55 – 29	13.09	19.64	5.61	33.67	80.96	81.65	52.72	65.45
CN	mg/L	0.03 – 0.41	51.29	59.91	20	33.33	9.09	18.18	16.18	18.11
Cu^{2+}	mg/L	0 – 0.82	54.54	63.63	-	-	30.48	68.29	74.5	91.5
Pb	µg/L	0 – 5	-	-	66.66	83.33	94	98	-	-

4 Conclusions

This study demonstrated the applicability and effectiveness of solar photolysis for the treatment of petroleum refinery wastewater, enabling this treatment method to be recommended in the industrial context of refineries to improve the management of aqueous discharges and promote a sustainable approach to the environment.

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