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Using the Mobile Water Treatment Systems in Treating Wastewater from Oil Separators

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Abstract

Treating industrial wastewater directly at the place of origin represents the latest tendency in wastewater treatment. It goes without saying that a flexible system is necessary since the process involves operating with low workflows. Mobile wastewater treatment plants based on Juggler technology are designed for the reuse of treated water. A mobile wastewater treatment plant is outfitted with the following systems: filter; physical-chemical treatment; sludge treatment/storage; monitoring automatic continuous cleaning system. The present paper tries to emphasize the advantages of using the new technology of bio-solid particle separation. In addition, the present study reveals the main disadvantage of this technology, namely its limited treatment capacity.

Key words: *wastewater, mobile wastewater treatment plant, oil separators.*

Introduction

The high pollutant content present in oil production wastewater constitutes a major challenge for the treatment process [3, 7]. This represents the reason why discharging considerable amounts of pollutants – usually in the form of oil products suspended on the top of the water – into the effluents has such a significant impact upon the environment [2, 4, 8]. It has been noted that, if there are oil products suspended on top of the water, the diffusion of the atmospheric air can no longer occur, leading to a rapid deterioration of flora and fauna [6, 9, 10]. If the surface waters used as drinkable water sources are contaminated with oil products, they lose their first class water quality classification [11, 13].

The discharge of large wastewater quantities, around 10-20 m^3 wastewater for each tone of crude oil processed by classic refineries and approximately 0.12 and 0.8 m^3 of water for each ton of crude oil processed by modern refineries, has lead to the focusing on pre-treatment processes when dealing with highly oil product contaminated wastewater [1, 5, 12].

The present study tries to offer a solution for the treatment of wastewater from oil separator. The research has focused on determining the actual efficiency of mobile wastewater treatment plants.

Experimental

The used mobile wastewater treatment plant is outfitted with the following components : filters; physical-chemical treatment; sludge treatment/storage; monitoring/ automatic continuous wastewater treatment process management. The treated wastewater has been extracted from three refinery oil separators.

These refineries obtain their water supply from the appropriate water channels and from the equalizing tank outlet channel. The separators' function is the removal of oil production coating and of other immiscible products that are lighter than water, their extraction, as well as suspension sedimentation on the bottom of the tank according to fluid density.

The refineries' total discharged wastewater flow towards the treatment plant is approximately 1000 m^3/h. Because of the low speed and tank dimension geometric ratio, the wastewater's flow through the separators is done using a streamline regime, i.e., along the entire length of the separation chamber.

The amount of wastewater treated by the mobile wastewater treatment plant (MWWT) was 10 m^3/min. Ten experiments have been carried out, all of them on different days and when pollutant contamination was at maximum levels. The analyzed physical-chemical indicators and methods, as well as the equipment used are listed in Table 1.

Table 1. The analyzed physical-chemical indicators, methods, and equipment used

No.	Indicators	Standard methods	Methods
1	pH	SR ISO 10523/1997	pH-meter Mettler Toledo Seven Multi
2	COD (chemical oxygen demand)	Hach 8178	Spectrofotometer DR 2400
3	BOD_5 (biochemical oxygen demand)	Hach 8051	VELP System
4	TSS(total suspended solids)	Hach 8158	Spectrofotometer DR 2400
5	VSS(volatile suspended solids)	Hach 8164	Spectrofotometer DR 2400
6	Extractibles with solvents	SR 7587:1996	Equipment for sample extraction Equipment for solvent distillation

During the biological stage, the discharging of the MWWT's wastewater has been carried out in the refinery's water treatment plant. Sludge disposal from the appropriate tank has been done in the refinery's sludge beds.

Results and Discussion

Throughout the 10 treatments, COD determination upon MWWT entry presented a variation between 2000 mg/l and 3800 mg/l (fig. 1).

Water treatability is shown by the BOD_5/COD ratio. Ratio values are between 0.09 and 0.1. Depending on this ratio, the MWWT's monitoring system chooses the appropriate treatment process. Hence, if the ratio is between the following values 0.05 and 0.1 the first treatment stage is wastewater filtration, followed by the physical-chemical one. The resulting sludge is collected in the appropriate sludge tank. However, if the ratio is between the following values 0.05 only the filtration stage will be carried out.

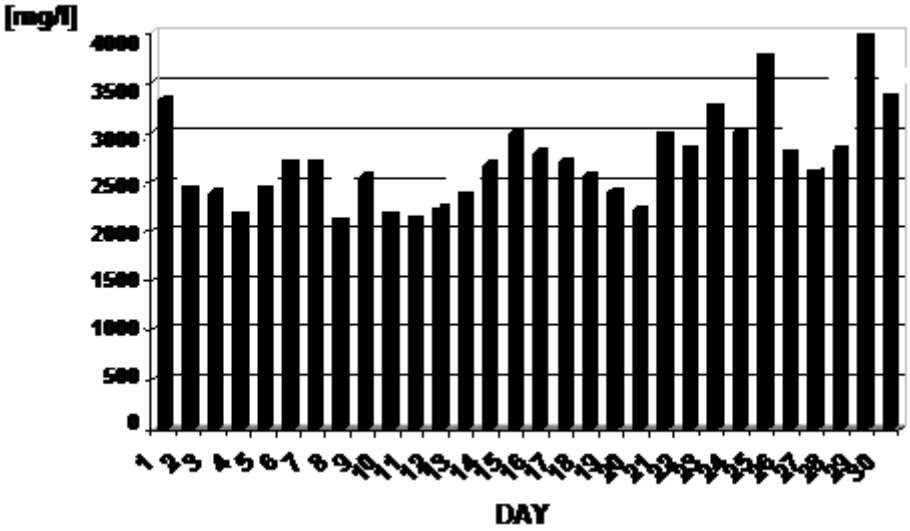

Fig.1. The COD concentration variation during experimental period

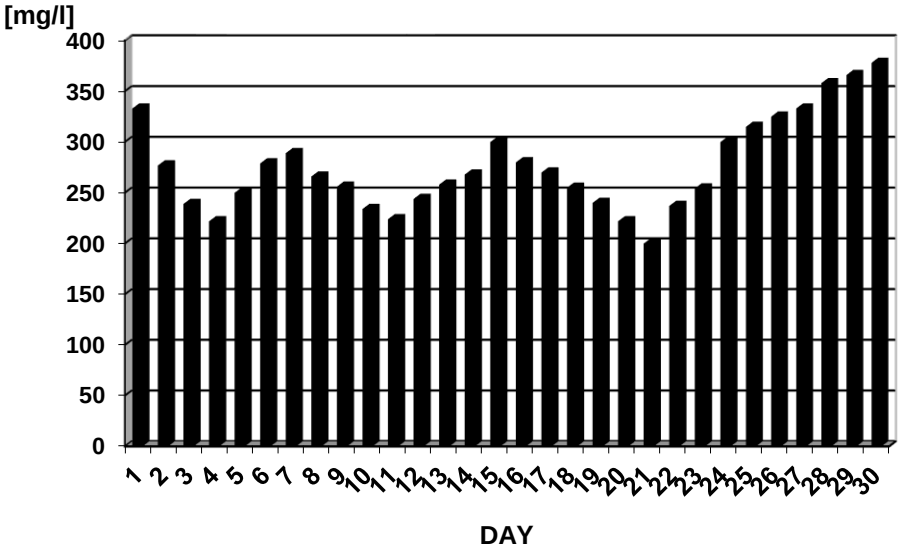

Fig.2. The BOD_5 concentration variation during experimental period

The monitoring of the TSS value upon MWWT entry is carried out in order to determine the correct physical-chemical treatment. Therefore, the correct type of coagulants and flocculants can be chosen. For the present case, when TSS value was between 160 mg/l and 480 mg/l, the MWWT monitoring system chose as the correct treatment method the addition of MOPAC (polyaluminium chloride sulphate - Al(OH)aClb(SO4)c, (a+b+2c)=3, a >1.05) [9].

The VSS value is of the almost importance for the treatment process. High VSS values may lead to bumps in the active sludge aeration process. However, in the present case the recorded values were within the limits 250 mg/l and 310 mg/l, which does not represent a danger for aerobic treatment. The VSS/TSS ratio is very important for the operation of the aeration basin.

The need of effluent pre-treatment is therefore justified by these values which would normally diminish only by approximately 22% after the mechanical-chemical treatment stage in the refinery. The values recorded upon MWWT exit are listed in Table 2. It can be observed that the pH value has settled between 7.3 and 7.6 pH units.

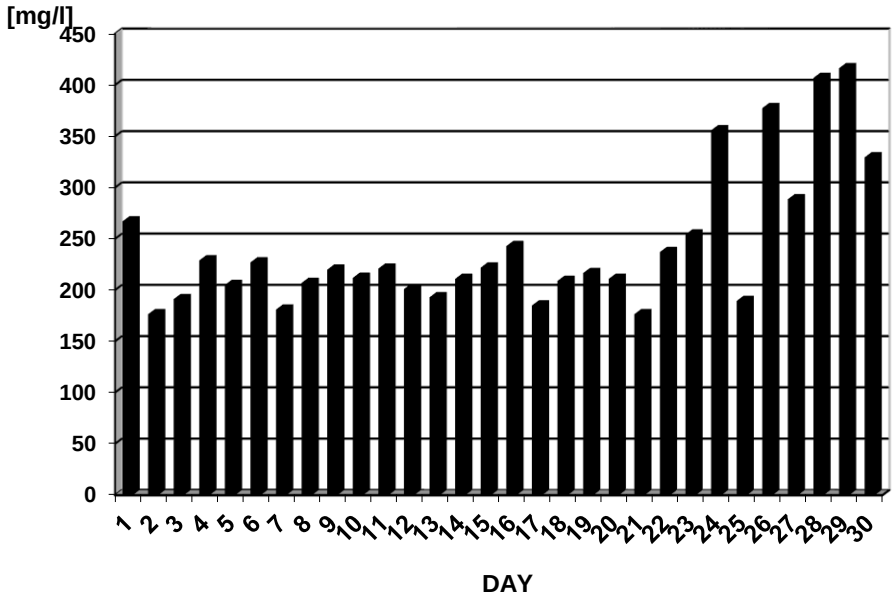

Fig.3. The TSS concentration variation during experimental period

The maximum COD value was 213 mg/l and the maximum BOD_5 value was 25 mg/l. TSS and VSS values were between 51.5 mg/l and 60 mg/l, and 28.4 and 38.9 .

Table 2. The effluent values recorded upon MWWT

	pH	Extractibles with solvents, mg/l	TSS, mg/l	VSS, mg/l	COD mg/l	BOD_5 mg/l
Limits	6.5-8.5	20.0	60.0	-	125	25
1.	7.3	8.9	58.5	30.0	213	24
2.	7.4	7.3	51.5	28.4	201	23
3.	7.5	8.3	54.5	33.6	195	22
4.	7.5	8.6	59.0	28.2	197	23
5.	7.6	9.4	57.0	38.9	168	23
6.	7.5	9.1	54.5	33.4	392	20
7.	7.5	15.7	58.5	31.5	225	23
8.	7.4	15.4	55.5	32.9	123	23
9.	7.5	7.3	58.5	29.8	102	21
10.	7.5	8.4	56.0	33.6	109	24

Mobile wastewater treatment plant effectiveness in relation to the monitored parameters is listed in Table 3.

Table 3. Effectiveness (%) of the BOD_5 (biochemical oxigen demand), COD (chemical oxigen demand), TSS (total suspended solids), VSS(volatile suspended solids) and extractibles with solvent.

Experiment	$BOD_{5,\%}$	COD, %	TSS, %	VSS, %	Extractibles with solvents, %
1	97.9	97.4	99.3	99.1	95.3
2	94.0	93.6	97.5	97.5	91.6
3	93.1	92.8	98.0	97.8	92.1
4	95.4	95.6	98.0	98.1	92.5
5	96.6	96.0	99.1	99.2	94.2
6	96.3	96.0	98.9	98.7	93.9
7	96.3	95.2	98.2	97.7	94.9
8	94.9	94.2	98.3	98.0	90.9
9	92.9	92.9	98.1	97.8	85.0
10	95.3	94.5	98.5	98.3	87.5
Medium value	95.3	94.8	98.4	98.2	91.8

Conclusions

The use of MWWTs in situations of maximum pollutant contamination can be successful as a result of their high effectiveness in reference to the value indicators obtained by the present research: BOD_5 removal effectiveness was 95.3%; COD removal effectiveness was 94.8%; TSS removal effectiveness was 98.4%; VSS removal effectiveness was 98.2 %; extractable solvent effectiveness was 91.8%.

The implementation of such an experiment requires the successful use of mobile wastewater treatment plants in industrial wastewater treatment locations. As the submitted data have shown, in the case of normal loads (maximum COD values, maximum BOD_5 values, maximum VSS/TSS ratio), acceptable discharge values in compliance with NTPA 001/2005 are obtained after proper TSS treatment.

It is worth noting that, apart from the main advantages of this mobile plant, namely its high flexibility and automatic operating, there are also disadvantages, the most significant one being its limited workflow.

References

1. Braden, M. – Demulsification of Oily Waste Waters. *WPCF*. #AC-91-061-005, Alexandria, VA 22314-1994, 1991.
2. Braden, M. – Techniques for Breaking Oil and Grease Emulsions, *Water Environmental Federation Emulsion Workshop*, Dallas, TX, Oct. 6, 1996.
3. Tchobanoglous, G., Burton, F.L., Stensel, H.D., Metcalf & Eddy, Inc. – *Wastewater Engineering:Treatment, Disposal, and Reuse*, McGraw-Hill, New York, 1991.
4. Tchobanoglous, G., Burton, F.L., Stensel, H.D., Metcalf & Eddy, Inc. – *Wastewater Engineering: Treatment, Disposal, and Reuse*. 2nd Ed., McGraw-Hill, 1979.
5. Horan, N. J. – *Biological Wastewater Treatment Systems, Treatment and Operation*, John Wiley &Sons, New York, 1990.
6. Panaitescu, C. Popescu, C. a.o. – Information management for monitoring surface water quality - case study: Ploiesti, Romania, Information management in the modern organizations: trends & solutions, Vols. 1 and 2, *9th International-Business-Information-Management-Association Conference (IBIMA)*, Marrakech, Morocco, 2008, pp. 1100-1103.

7. Panaitescu, C., Onutu, I. – Monitoring the quality of the sludge resulted from domestic wastewater treatment plants and the identification of risk factors, *Environmental Engineering and Management Journal*, **12**, No. 2, 2013, pp. 351-358.
8. Rojanschi, V., Bran, F., Diaconu, G. – *Protecţia si ingineria mediului*, Editura Economica, Bucureşti, 2002.
9. * * * – U.S. EPA and Other Governmental References (suggested by the State of Washington), http://www.epa.gov.
10. * * * – *Directiva nr.76/464/EEC privind deversarea substanţelor periculoase în mediul acvatic* (şi a celor 7 directive conexe).
11. * * * – http://www.ecy.wa.gov/biblio/912.html or http://www.ecy.wa.gov/pubs/912.pdf - *Pollution Prevention Planning Guidance Manual*.
12. * * * – http://www.p2pays.org/ref/02/01881.pdf, http://www.p2pays.org/ref/02/01882.pdf - *Study of Selected Petroleum Refining Residuals – Industry Study* – Parts I and II.
13. * * * – M.O. nr. 187, partea I, 20.03.2002, *H.G. nr. 188/28.02.2002, pentru aprobarea unor norme privind condiţiile de descărcare în mediul acvatic a apelor uzate-modificată şi completată cu H.G: 352/2005* (M.O. nr. 398, partea I, 11.05.2005).

Utilizarea sistemelor mobile de epurare a apelor în tratarea apelor de la separatoarele de produse petroliere

Rezumat

Tratarea apelor uzate industriale direct, din locul de proveniență a acestora, reprezintă ultima tendință în tratarea apelor reziduale. Este de la sine înțeles că această operare este necesara pentru un sistem flexibil deoarece procesul implică fluxuri de lucru mici. Stația de epurare a apelor uzate mobilă este echipată cu următoarele componente: filtru; tratament fizico-chimic; tratamentul nămolului/ depozitare; sistem de monitorizare automat de curățare continuă. Lucrarea de față încearcă să scoată în evidență avantajele utilizării noii tehnologii de separare a particulelor bio-solide. În plus, prezentul studiu relevă principalul dezavantaj ale acestei tehnologii, și anume capacitatea de tratare limitată.