J. Appl. Environ. Biol. Sci., 4(11S)126-133, 2015

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Municipal Wastewater Treatment Using Algae, Activated Sludge and Ultra Filtration System For Facilitate Achieving Drinking Water

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Received: October 29, 2014
Accepted: December 31, 2014

ABSTRACT

Three scenarios of culture including Activated Sludge, Algae and Symbiosis of Algae and Activated Sludge with equal concentration was cultivated to treat domestic wastewater . the influence of this scenarios and changing Trans Membrane pressure (TMP) on the treatment efficiency of a small scale membrane bio reactor with a two hundred nanometer pore size (UF) membrane were investigated. Changing TMP has negligible effect on the total dissolved solids (TDS) and Nephelometeric Turbidity Unit (NTU) removal. Comparatively, different scenarios has tangible effects on chemical oxygen demand (COD) and TDS removal. The highest COD, TDS and NTU removal efficiencies were observed with the Symbiosis scenario and with 0.5 bar TMP (98.95%, 90.99% and 99.63% respectively) within 30 days. The highest TSS removal efficiency was observed with the Activated Sludge scenario with 0.5 bar TMP (97.52%) within 30 days.
KEYWORDS: Symbiosis, Algae, Activated Sludge, Spirulina, Ultra filtration,

1- INTRODUCTION

Algal–bacterial culture introduced itself as a municipal and industrial wastewater treatment method in hot weather countries [1; 7]. With illuminated conditions, Bacteria consume O_2 to mineralize Organic carbon. The O_2 which is produced by algae activity. This relationship has a good effect on economic parameters with aeration [2]. Algae consume CO_2, The CO_2 which is produced by bacteria activity, Results in reducing greenhouse gases [3; 4; 5; 9]. Moreover, increasing parameters like: pH, temperature and O_2 concentration are some examples for Algae activity side effects. These side effects can eliminate viruses and pathogens [4; 5]. Products such as fertilizer, drugs and biodiesel are some achievable examples that can be produced by harvesting the algae biomass at the end of treatment process [6]. In this study, the influence of spirulina algae and aerobic activated sludge and the changing TMP of ultra filtration system on the municipal wastewater treatment were investigated.

2-MATERIALS AND METHODS

A polycarbonate aerator tank photobioreactor with capacity of 36l (Diameter: 25.5cm, Depth: 72cm) was used to perform wastewater treatment Tests. The temperature was approximately 23^{o}C. The algae inoculum was obtained from the culture pond of the Faculty of Agriculture of Ferdowsi University of Mashhad. The collected algae inoculum (as shown in Fig-1) was mainly spirulina algae. The aerobic activated sludge which was prepared from the Parkandabad municipal wastewater treatment plant (1hour settling and discarding the supernatant) was used as bacteria inoculum. Both of the initial algae inoculum TSS and initial activated sludge inoculum TSS was 9.6 g/l. For the first scenario (the activated sludge), reactor filled with 1000 ml activated sludge inoculum. For the second scenario (the algae), reactor filled with 1000 ml algae inoculum. And for third scenario (the symbiosis), reactor filled with 500 ml algae inoculum and 500 ml activated sludge inoculum. For all scenarios the rest of reactor filled with 35 l pretreated wastewater (after pre-screening, grit removal and primary settling process) was added into the bioreactor to investigate the COD, TDS and turbidity removal efficiencies. The specification of the pretreated wastewater was chemical oxygen demand (COD): 432.0 ± 2.1 (mg O2/l), Total Dissolved Solids (TDS): 538 ± 13.6 (mg/l), total suspended solids (TSS): 243 ± 1(mg/l), nephelometeric turbidity unit (NTU): 316.

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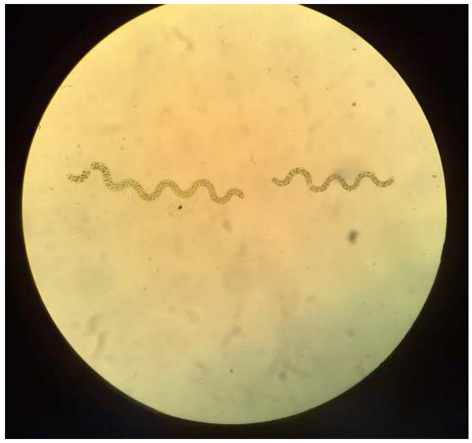

Fig-1: Picture of Spirulina algae under microscope magnification number: 40x10

3- RESULTS AND DISCUSSION

3-1- the influence of three scenarios with different TMP on carbon source removal

The abilities of the Membrane Bio Reactor with three scenarios (Activated sludge, Algae, Symbiosis) to reduce COD were measured. The trend of COD reduction was similar in four TMP, It can be concluded that there was no solid correlation between COD removal and changing TMP (Fig-2). A maximum carbon reduction was achieved within 30 days in Symbiosis scenario, during which the COD concentration reduced from 432 mg O_2/l to 4.5, 4.5, 4.6 and 4.9 mg O_2/l with TMP of 0.5, 1, 1.5 and 2 bar respectively, the higher the TMP of filtration system and the longer it stays high, the weaker removal COD efficiencies. The corresponding COD removal efficiencies were 98.95%, 98.95%, 98.93% and 98.86%, respectively. Moreover, COD removal investigation in two other scenarios (only Algae and only Activated sludge) was also performed. regards to 30 day operation, It was evident from the results that the COD reduction capability with only Algae in 0.5 bar TMP (90.80%) and only Activated Sludge in 0.5 bar TMP (95.34%) were much lower than Symbiosis (Fig-3). For Algae scenario, the absence of sludge to boost the organic degradation may result in low removal efficiency. For Activated Sludge scenario, low COD removal could be due to the absence of enough oxygen supply from algae.

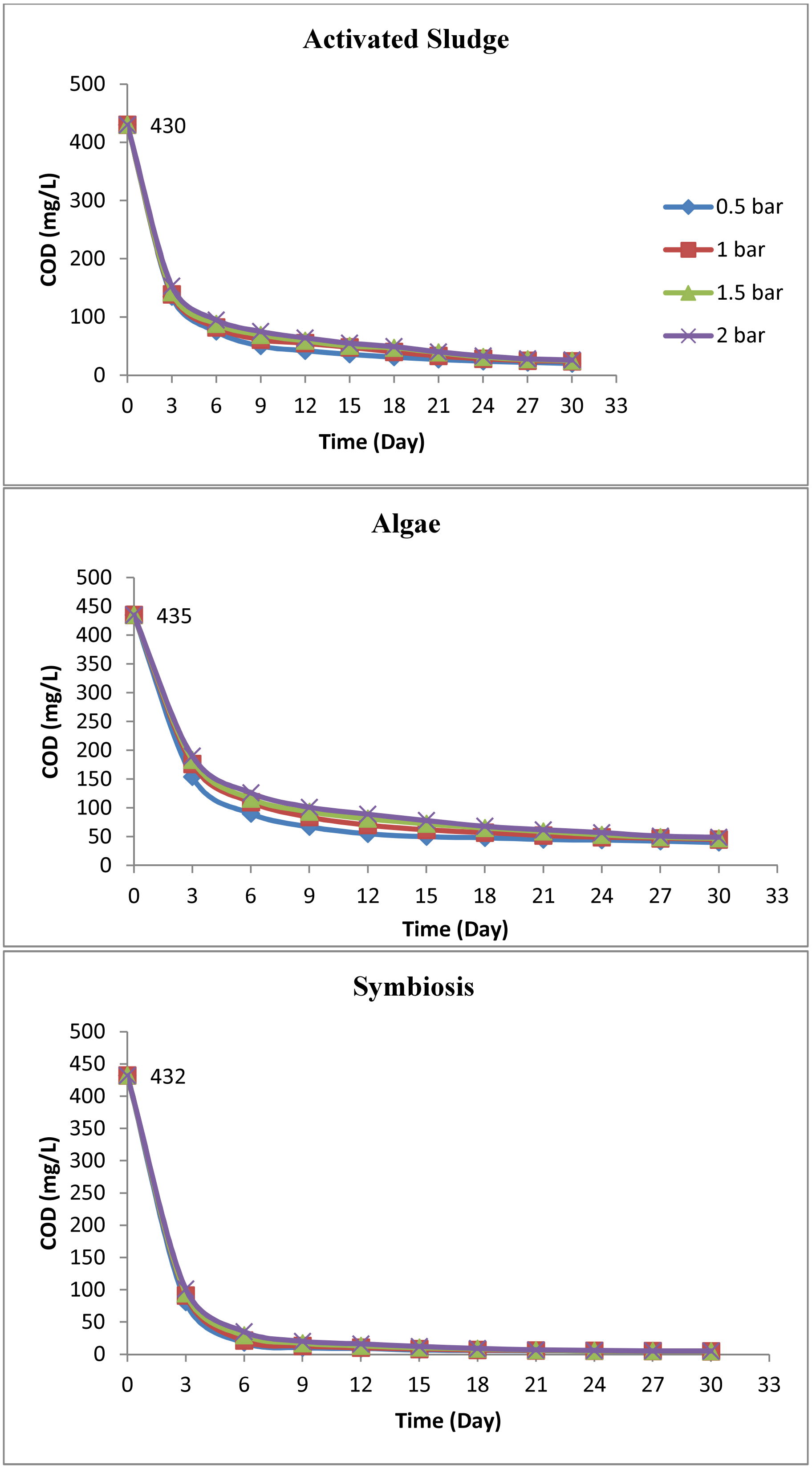

Fig-2: amount of COD with three scenarios in different TMP

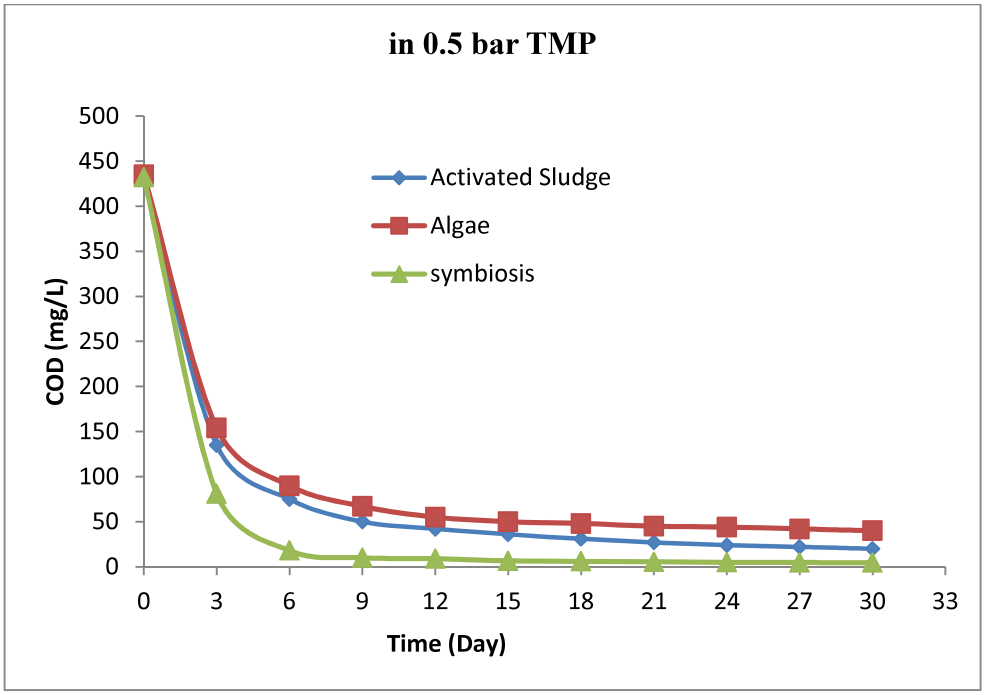

Fig-3: The COD concentration in 0.5 bar TMP with different scenarios

3-2- the influence of three scenarios with different TMP on TDS reduction

The TDS reduction in these scenarios with different TMP was also investigated. As shown in Fig-4, due to incapacitated Ultrafiltration membrane pore size for discriminating dissolved particles from water, there was no difference in results with changing the TMP. Antithesis, there was a huge difference between TDS reduction in three scenarios (Fig-5). Amount of inlet TDS for Activated Sludge, Algae and Symbiosis were 538, 545, 524 mg/l respectively. Outlet TDS concentration within 30 days were 312.2, 60.5, 47.2 mg/l respectively. TDS removal efficiencies for Activated Sludge, Algae and Symbiosis were 41.97%, 88.89% and 90.99% respectively. There was no enough oxygen from algae to supply Activated Sludge scenario and resulting in poor TDS removal.

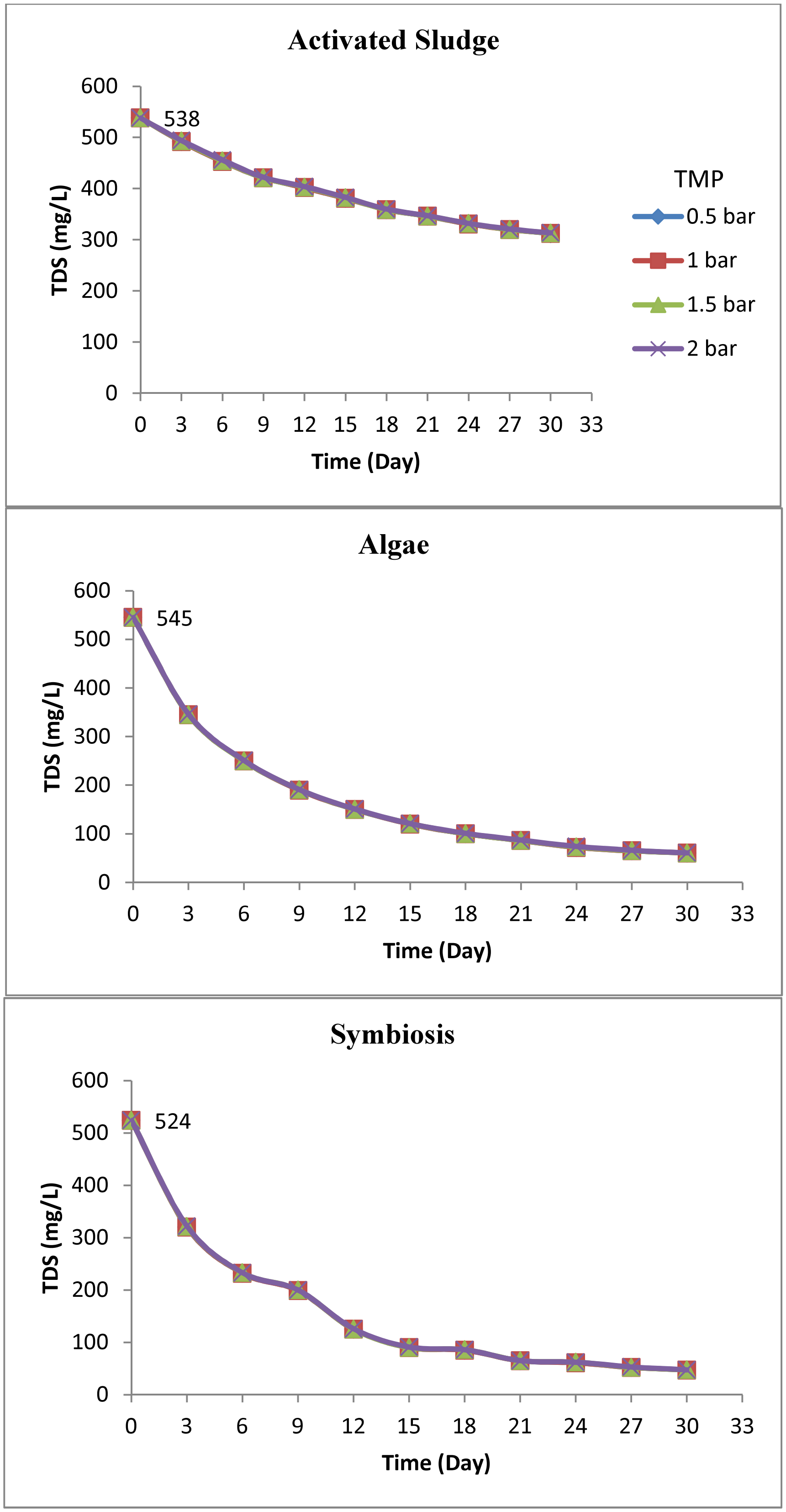

Fig-4: the TDS concentration with different TMP on three scenarios

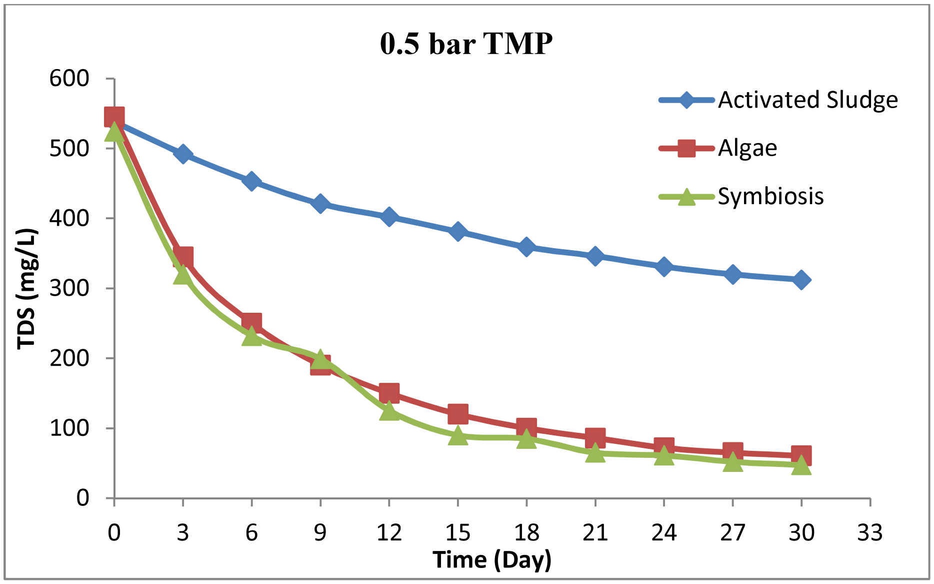

Fig-5: the TDS concentration in 0.5 bar TMP with different scenarios

3-3- the influence of three scenarios with different TMP on TSS and NTU reduction

Finally, the results of TSS and NTU reduction in three scenarios with different TMP were scrutinized. Due to Ultrafiltration system ability for removing large and suspended particles from water, with all TMP and all scenarios, TSS and NTU removed almost completely. The higher the TMP of filtration system and the longer it stays high, the weaker TSS and NTU removal efficiencies. Noticeably, the Activated Sludge scenario showed the best TSS reduction (from 243 mg/l to 3, 7, 8 and 9 mg/l for 0.5, 1, 1.5 and 2 bar TMP respectively) and the other results for algae and symbiosis scenarios were weaker than Activated Sludge (Fig-6). The TSS removal efficiencies in 0.5 bar TMP for Activated Sludge, Algae and Symbiosis were 98.76%, 95.88% and 97.53% respectively. In addition the NTU removal in three scenarios and different TMP were also investigated. The results of NTU reduction for three scenarios were the same (Fig-7). On the other hand, results of NTU reduction were effected by changing the TMP. A maximal NTU removal was attained within 30 days in Activated sludge scenario, during which the NTU content decreased from 316 to 1.08, 1.09, 1.10 and 1.11 with TMP of 0.5, 1, 1.5 and 2 bar respectively. Difference between these results was negligible, yet the higher the TMP of filtration system and the longer it stays high, the higher NTU in results.

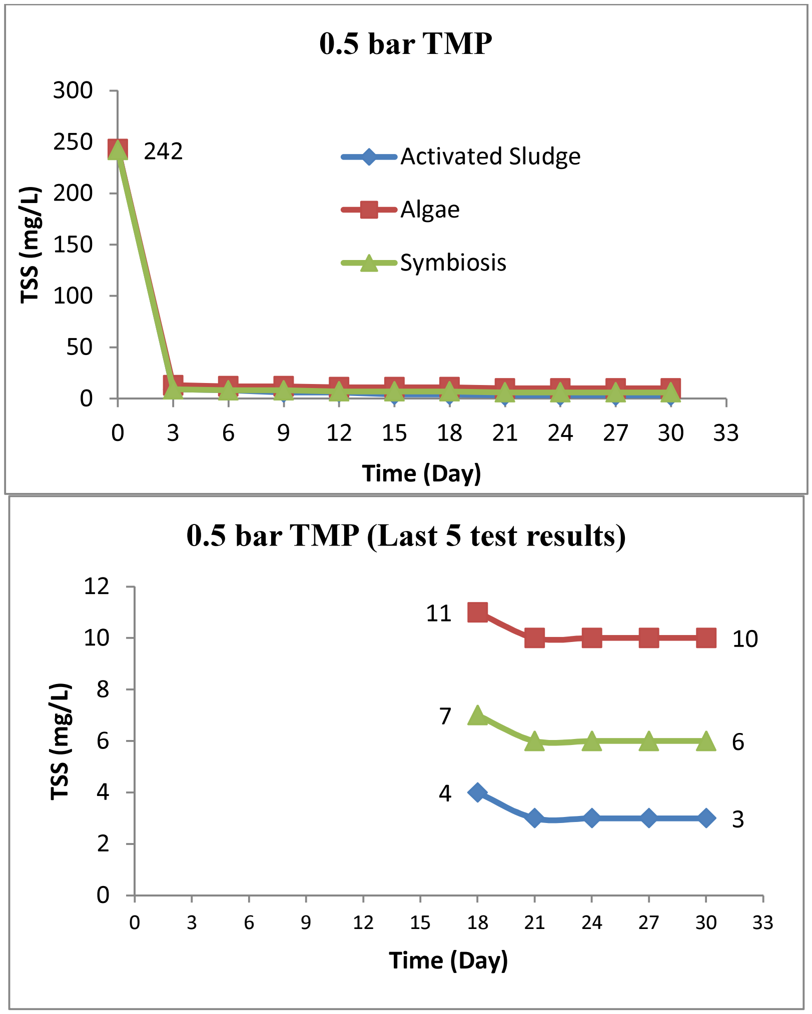

Fig-6: the TSS concentration in 0.5 TMP with different scenarios

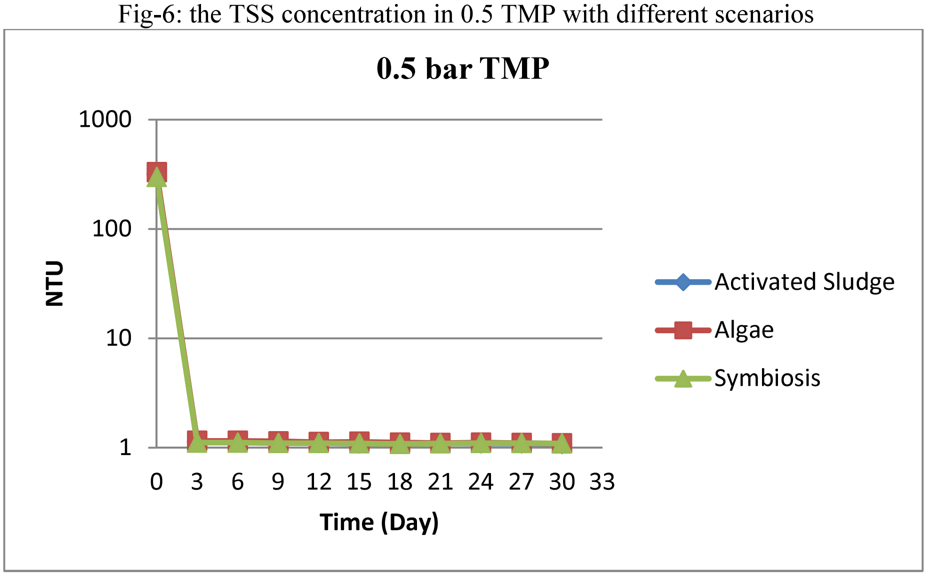

Fig-7: the NTU reduction in 0.5 bar TMP with different scenarios

4- Conclusion

The wastewater treatment was enhanced through the synergistic cooperation between algae and activated sludge. More than 98% of COD and 90% of TDS were removed with symbiosis scenario. More than 98% of TSS and 99% of NTU were removed with 0.5 bar TMP of filtration system. According to operation pressure calculation with TDS results of this project for further Reverse Osmosis treatment (RO) and drinking water achievement, the operation pressure was around 0.2 bar, this pressure was 10 times lower than the require pressure for treating the inlet wastewater with RO system [8].

Acknowledgements

The authors wish to thank Amirreza Tabatabaie, Amin Maher and Dr. Susan Khosroyar for their advice, information support and for their kind assistance and also thank Islamic Azad University of Quchan for their support.

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