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STUDY ON THE SOLIDS AND COD REMOVAL OF SHRIMP PROCESSING WASTEWATER THROUGH A SLOW SAND FILTER IN KHULNA

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ABSTRACT

The shrimp production and processing is an important sector in context of Bangladesh and most of the industries are situated in the Khulna region. There are 145 numbers of fish processing plants in Bangladesh among which 48 are located in Khulna. Among, Shrimp processing industries are major. A survey has been shown 47500L/day/plant effluents are released in the environment which contains much organic loading. These shrimp process indusries are not interested to install wastewater treatment plant in their factory. They seem it requires excess cost for chemicals, land, and personnel etc. In this circumstance, it was the main objective to found out such a treatment method which requires less cost, less chemical or chemical free, and a little amount of land required. The effluent of shrimp process industries are contain BOD_5 of 200-400 mg/L, COD of 400-800 mg/L, DO of 2-4 mg/L, TDS of 1200-2000 mg/L and pH of 7-9 mg/L. To filter the raw wastewater from shrimp processing industry, a slow sand filter was installed in the civil engineering building of KUET. There were five filter beds consist the filter. The filter media were used fine sand & sylhet sand as a fine media and gravel or stone chips as a coarse media. A steady flow was maintained throughout the study. The treated water was collected from the last stage of the filter. The treated water was tested in a laboratory and found remarkable organic solids reduction rate by the filter. From the study it can be said that the slow sand filter can be used for reduction of organic load in the shrimp process industris.

Keywords: *Fish process, Organic waste, Sand filter.*

1. INTRODUCTION

Shrimp process industries play a vital role in Bangladesh in the GDP sector, employment, nutrition, and socio-economic condition. Production and processing of shrimp industries are an important sector in the context of Bangladesh. Most of the shrimp processed industries are situated in the southern region, especially Khulna, Bagerhat, Satkhira district in Bangladesh. The shrimp culture was started in the coastal district of Satkhira in the 1960s. Gradually, shrimp culture expanded to the coastal belts of Khulna, Bagerhat, cox's bazar and Chittagong (Naureen et al., 2006). Its contribution to the national GDP its contribution to the national GDP is mentionable. In 2004-05 this sector was gained us$ 420 million and us$ 526.45 million in 2016-17 fiscal year (BFFEA, 2006).

Most of the shrimp industries in Bangladesh do not follow the environmental compliance for effluent treatment plant (ETP) in their factories and discharge effluent direct to the environment (Debnath & Bari, 2018). Effluent is discharged by these process industries 47500l/day/plant directly in the environment (Billah, 2016). High amount of biodegradable organic loading is carried out by this wastewater. (Debnath & Bari, 2018). One analysis is showing that the wastewater generated from shrimp processed factory varies BOD from 560 mg/l to 1226.6 mg/l, COD ranges from 1666 mg/l to 3666 mg/l (Thomas et al., 2015). Another research has been conducted in Khulna region by Billah (2016), and found COD is approximately 790 ppm, BOD_5 - 490 ppm, Dissolved Oxygen 0.15 – 1.82 ppm, ss-780 ppm, Total Dissolved Solids-1320-2350 ppm, Total Organic Carbon-220 ppm, Oil & Grease 65 ppm, and Salt-11mg/l.

There is conventional treatment method is available nowadays. In Bangladesh, the different types of effluent treatment plants (ETP) are seen such as Physico-chemical, Biological, MBBR, Physico-chemical cum biological, etc. The chemical treatment of wastewater is highly cost in general. On the other hand, biological treatment is difficult to its maintaining. The well-known and trained personnel are required to operate a biological ETP. The shrimp processing factories are not big industries and they do not want to treated wastewater because of its cost, technical reasons and being morally dishonesty. In this circumstance, cost-effective and easy to operate based design is needed. Only physical treatment maybe meets the national standard for solid contents of wastewater discharge**.** The main goal of this study was to determine whether only physical treatments such as slow sand filters, were able to reduce total solids (TSS and TDS) and chemical oxygen demand (COD) in shrimp processing wastewater.

Sand filtration can be the easiest way to reduce solids from wastewater of shrimp industry. There are very common two types of sand filter are used widely in the world. One is Slow Sand Filter (SSF) and another is Rapid Sand Filter (RSF). In the sand filter, water passes through a layer or a combination of layers of sand& gravel. The sand filter removes particles such as organic debris, bacteria, and viruses via mechanical and biological processes (Arndt & Wagner, 2004).

Sand filters have been shown highly effective to reduction of pathogens from wastewater. Schuler et al. (1991) removed from contaminated water 99.9% of experimentally added cysts of Giardia and Cryptosporidium, ranging from 1 to 25 mm, as well as coliform bacteria by using of SSF. Bellamy et al. (1985) accomplished 100% removal of Giardia cysts using sands with effective sizes of 130, 280, and 620 mm. Effective size is defined as the size range at which only 10% of smaller particles remain in a quantity of sand (Wheaton, 1985). Slow sand filter is further effective in removing viruses from water supplies (Hendricks & Bellamy, 1991).

The wastewater used for this study has been collected from a selected shrimp process industry. Typically range of waste loading was measured of COD 383-645 mg/L, TDS 2519-3980 mg/L, pH 7-9 mg/L, SS 60-212 mg/L, TS 3846-4521.

To filter the raw wastewater from the fish processing industry, a gravity-flow slow sand filter has been installed. There were five filter beds consist of the filter. The filter media has been used fine sand & Sylhet sand as a fine media and gravel or stone chips as a coarse media. A steady flow has been maintained throughout the study. The sample collected from the filter was measured in the laboratory. The next section is about the discussion of the methodology and result of the study.

2. METHODOLOGY

To fulfill the purpose, a plan for the entire job was set out. This was an experimental study where studies were done from books and the internet, laboratory tests and software were used to sort the result. First, a shrimp processing industry was selected to collect wastewater samples, after which it was determined a method and arrangement for making a sand filter. Next, some parameters are set for measurement in the laboratory. Only PH, TDS, TSS, and COD were selected for the experiment. Theese four parameters have been choosed cause the purpose was to determine whether the slow sand filter, were able to reduce total solids (TSS and TDS) and chemical oxygen demand (COD) in shrimp processing wastewater. Wastewater was collected from selected industry and it was measured in a laboratory of Khulna University of Engineering and Technology (KUET). The result was recorded and finally presented graphically. The total chart of the study is given in the following chart.

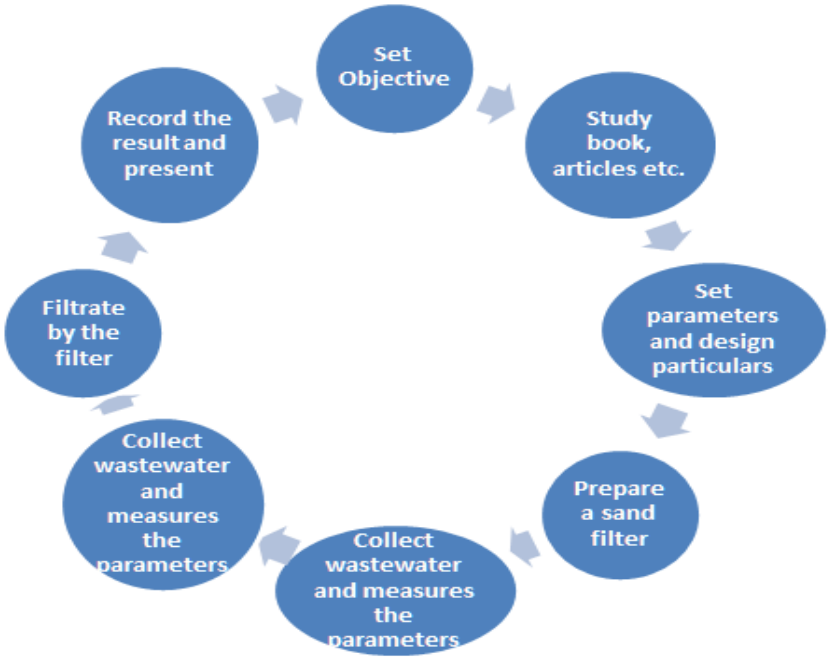


Figure 1: Schematic Diagram of the Methodology

2.1 Experimental Set up

A plastic container (cylinder type) was used with capacity of 30 litres and having diameter of 10 inch and height 12 inch. A water dispenser faucet tap was set 1 inch above from the bottom of the container. A sponge mesh was set due to avoid clogging the water in the top layer of the filter. Also the fine mesh sponge was used on every layer of filter media. The mechanically backwash system was managed like the following Figure 3 (b,c,d). Water was passed through the tap by pressure. Water was up flowed inside the filter media. Backwash water down flowed through the pipe that set in the mid of the cylinder (see the following Figure 3).

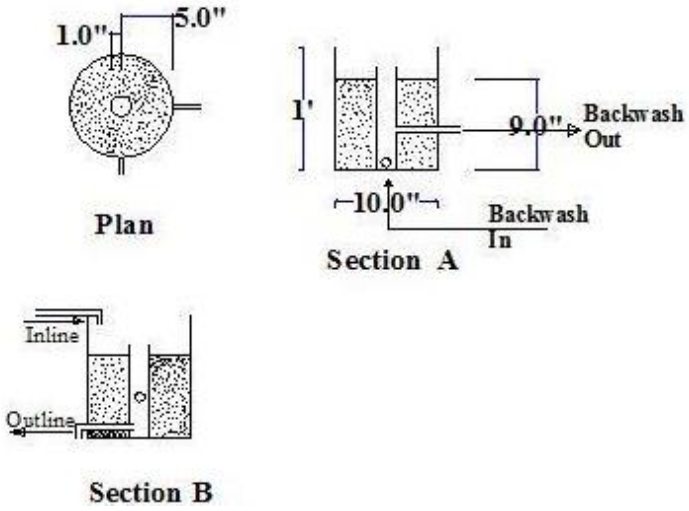


Figure 2: Plan and section of the slow sand filter

2.2 Filter media

Coarse and fine aggregates were used as filter media. Stone chips were used as coarse media whereas coarse and fine sand was used as fine media. Sieve analysis has been performed to maintain uniformity of filter media. Fineness Modulus ratio was not calculated in this study. The # 4, 8, 16, 50 and 100 no sieve was used in this analysis. There are five steps of layers were set in. The layers were decorated in finer to course accordingly. The size, sieve number and layer wise material list is given in the following Table.

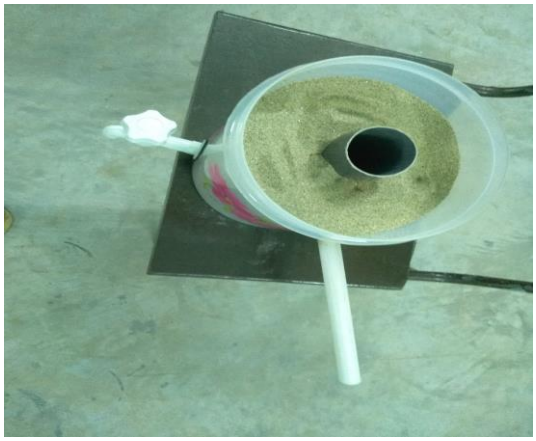
Table 1: Size and sieve detail of the media used

Layer	Material	Size	Sieve No
1st	Coarse aggregate (crash stone)	12.5 (mm)	3/4
2nd	Coarse aggregate (stone chips)	256 (mm)	08
3rd	Coarse sand	600 (µm)	30
4th	Fine sand	106 (µm)	50
5th	Fine sand	121 (µm)	100

(a)

(b)

(c)



(d)

Figure 3: (a) Filter Media used in experiment
(b) Set of the filtration system before filling the filter media
(c) Top view of the filtration system
(d) Set of the filtration system after filling the filter media

2.3 Sample collection

A shrimp processing industry was selected to collect wastewater sample. Next, some parameters are set for testing in the laboratory. Only pH, TDS, TSS, and COD were selected for the experiment. Samples were collected by plastic jar which capacity was 10 liter.

(a)

(b)

Figure 4: (a) Sample collection jar (b) Sample collection from shrimp industries drain Outlet

3. RESULTS AND DISCUSSION

The filter was operated two months. In these two months total eight samples were measured. One sample was measured each week in laboratory. The result was shown the shrimp process wastewater contain mass number of organic solids. From laboratory test the influent wastewater or raw wastewater characteristics were found is given in bellow.

Table 2: Characteristics of Shrimp Process Wastewater

Parameter	Unit	Concentration Range
COD	mg/l	383-645
TSS	mg/l	60-212
TS	mg/l	3846-4521
TDS	mg/l	2519-3980

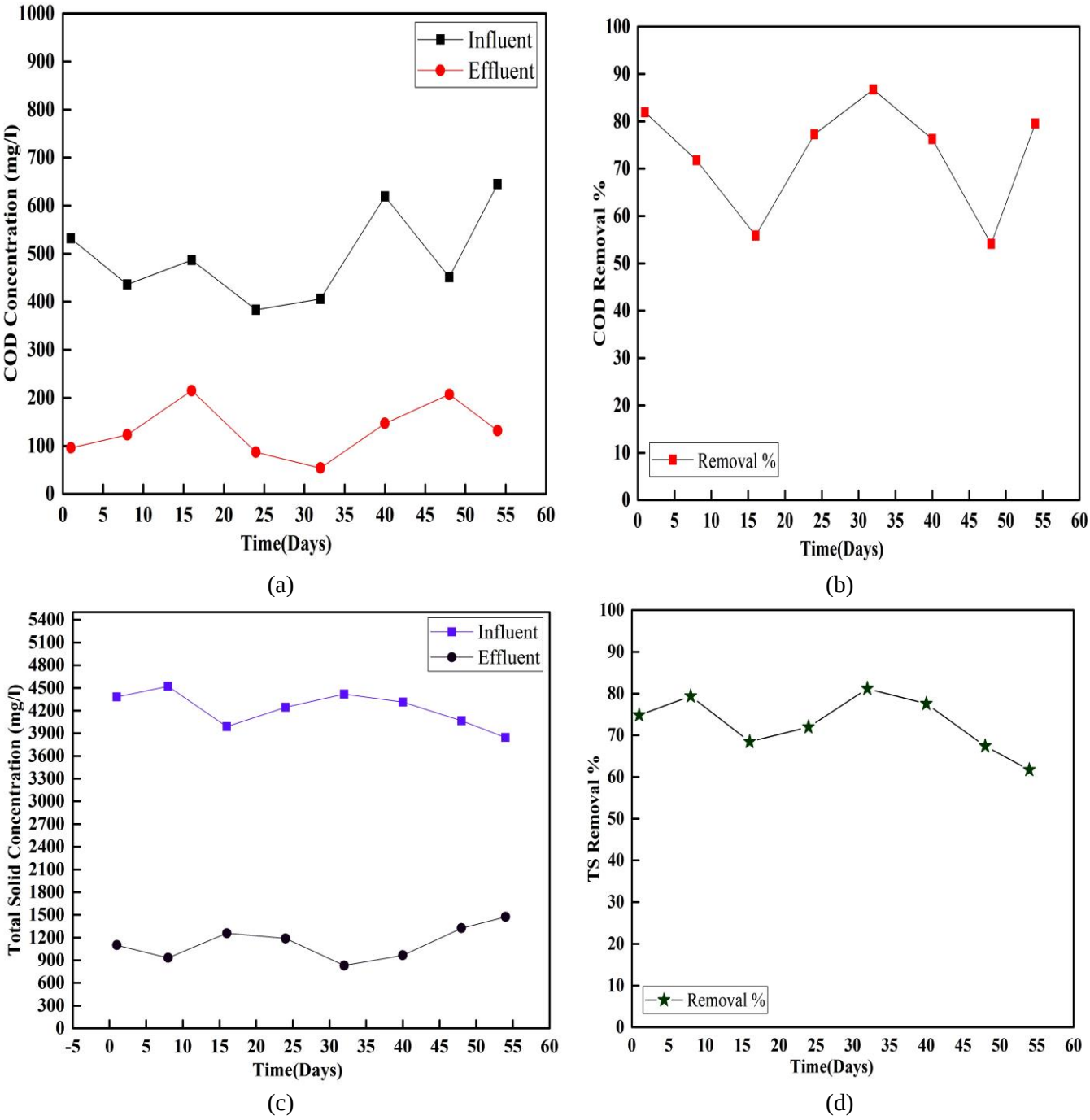


Figure 5: (a) COD Concentration in entire experiment; (b) COD removal percentage in experiment; (c) TS Concentration in entire experiment; (d) TS removal percentage in experiment.

Only the above-mentioned parameters were measure. The Chemical Oxygen Demand was reduced above 70% in the study. In conventional treatment practice, there are many unit processes are combined to treatment wastewater and remove COD. However, based on this study, it is clear that the sand filter can remove COD like those processes. The highest amount of COD of effluent was found near of 200 ppm and lowest one found below of 50 ppm. The national recommendation for discharging effluent should contain equal or less than 200 ppm of COD. The Removal rate and result of COD removal of this study has been given in the Figure 5 (a) and (b) in the above.

Total solid was measured average 4221 mg/L. The removal rate was calculated 86%. The Total Solids of influent was observed almost linear. It was always near to 4000 mg/L (ppm). In this filtration

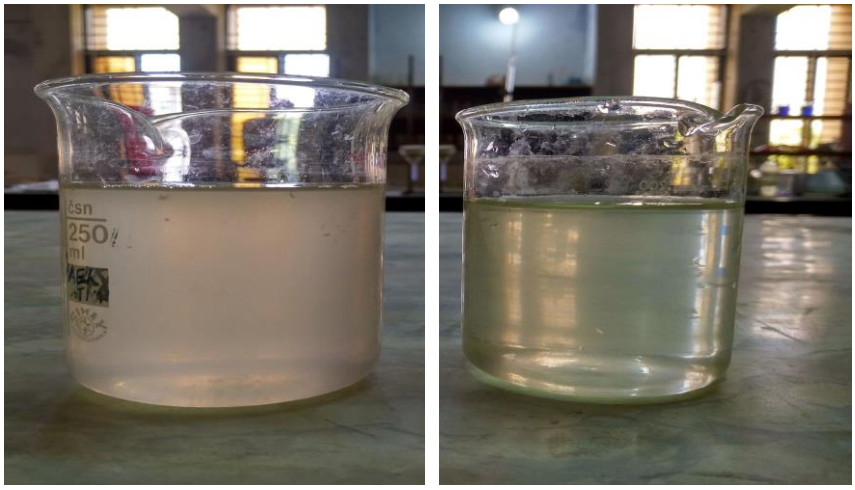
system, influent has been passed through the five filter beds and reduce mass number of solids. The treated wastewater of the filter used in the study contained Total Solids in between 900 to 1200 mg/L. The figure 5 (c) and (d) has been shown the concentration of TS of influent and effluent of the study along with the removal percentage of solids.

The dissolved solids cannot filtrate easily because it is found as the more diluted form in the water. The average amount of dissolved solids was found 3482 mg/L in wastewater of shrimp process industry. After treatment or passing through the filter media, it was found 2145 mg/L in average. The lowest number of dissolved solids of treated wastewater was measured 2450 mg/L whereas highest one was found more than 3900 mg/L. The rate of removal of dissolves solids was 38%. The following figure 6 (a) and (b) is shown more pictorial view of waste concentration of influent and effluent after treatment along with removal rate.

The total solids are divided into major two types of solids like Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). In this study, TSS was found below 50 mg/L. of filtrated wastewater. The solids which is suspended, was settled on the surface of media. The overall removal rate was measured 72. In the figure 6 (c) and (d) is shown the details in graph. The list of parameters considered in the study, concentration in influent and effluent and removal percentage is given in the following table.

Table 3: Efficiency of the slow sand filter system

Parameter	Unit	Influent	Effluent	Removal %
COD	mg/l	494.87	132.62	73
TSS	mg/l	153.25	42.37	72
TS	mg/l	4221.62	1134.50	86
TDS	mg/l	3482.87	2145.62	38



(a) (b)

Figure 7: (a) Influent of the filtration system; (b) Effluent of the filtration system

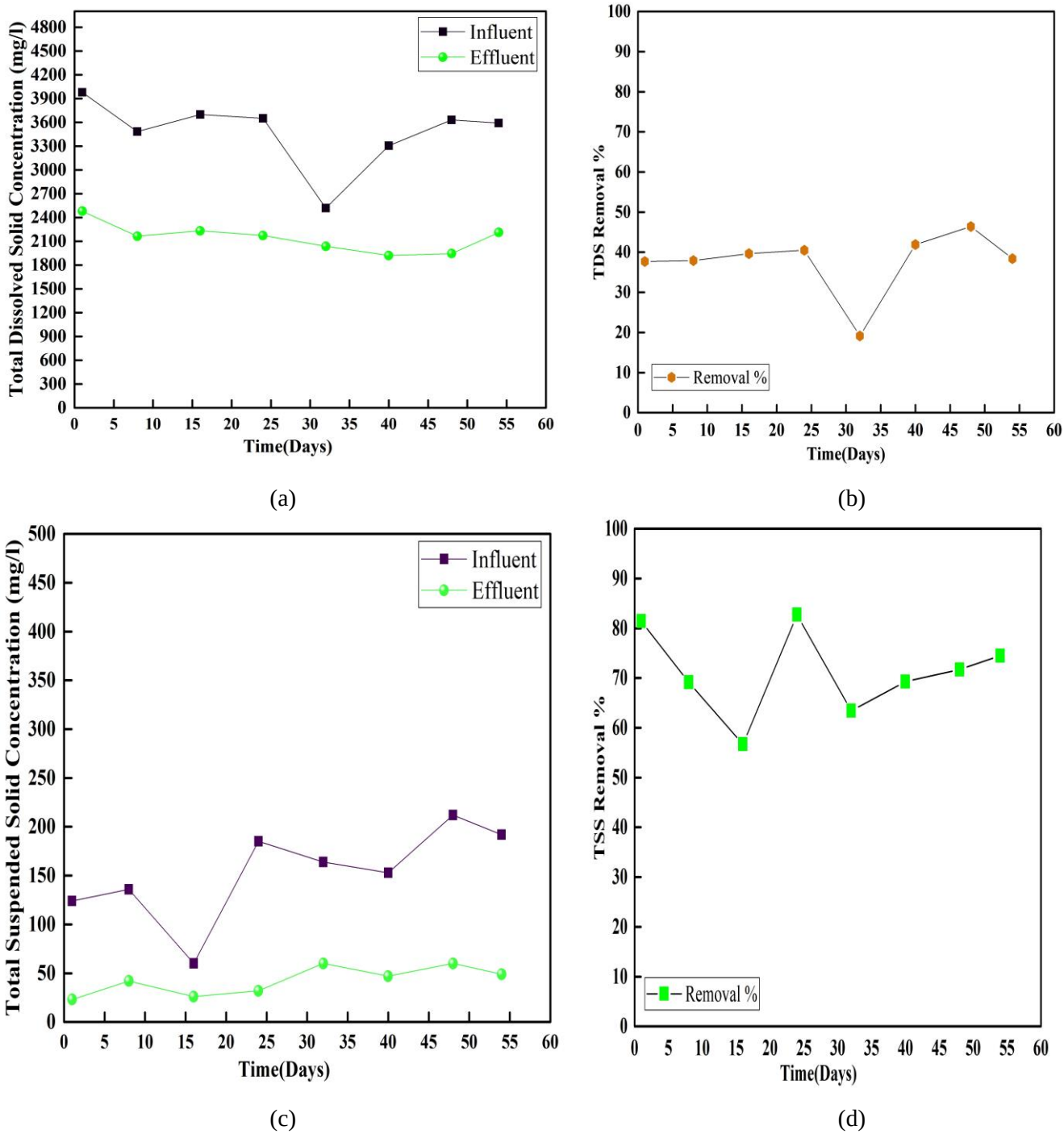


Figure 6: (a) TDS Concentration in entire experiment (b) TDS removal percentage in experiment (c) TSS Concentration in entire experiment (d) TSS removal percentage in experiment

4. CONCLUSION

The slow sand filter has been removed of solids successively 73%, 72%, 86%, & 38% of COD, TS, TSS, & TDS of shrimp process wastewater. The influent was contained 380 to 650 mg/L of COD and 3500 to 4500 mg/L Total solids which removes considerably. Sand filter may be the good alternatives for such a developing country like Bangladesh. SSF can operate followed by screening, grit removal, aeration process etc. In the industries level, where a good amount of wastewater discharge in an hour, the pressure sand filter there may be good options. Where there is slid concentration is medium level in such case only physical treatment may be good alternatives to remove solids from wastewater.

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