Environment & Ecology 29 (3A) : 1274—1278, 2011
 ISSN 0970-0420

Characterization of Biodiesel Spentwash and Amelioration through Chemical Coagulation Treatment for Irrigation

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Abstract

A study was carried out to characterize the biodiesel spentwash by measuring the selected physico-chemical characteristics and to ameliorate the spentwash by using some chemicals as coagulating agents and subsequently to utilize the spentwash for irrigation. Biodiesel spentwash, appears dark yellow to cream colored liquid, emits pungent odor and is highly alkaline in nature. Spentwash exhibits all the characters of polluted water. Among the different coagulants used as coagulating agents, potash alum was found to be most effective in removal of contaminants from the biodiesel spentwash. This treatment makes the spentwash pollutants free to the extent of it being used for irrigation.

Key words : Biodiesel spentwash, Biodiesel production unit, Coagulation, Physico-chemical properties, Amelioration.

Water polliution by industrial effluents has been one of the vital issues of environmental problems in both developed and developing nations. The effluents from almost all industries are directly or indirectly discharged into canals and rivers. Due to continuous disposal of wastewater into water bodies, the surface water quality is getting gradually deteriorated because of the mixing of various chemical pollutants of the effluent with water. The natural water resource is limited and this must support ever growing population, requirements of irrigation and industries. Majority of the industry use good quality water and discharge almost the entire quantity as effluents. Diminishing water supplies make it necessary to conserve, recycle and reuse this effluent water. Biodiesel is produced through a process of transesterification using methanol and NaOH as catalyst. At the end of the process biodiesel is purified by washing with water which helps in removing the catalysts, soaps and other soluble contaminants. For production of one liter of biodiesel 2 to 3 liters of water is required i.e., around three parts of water is used for washing a part of biodiesel (1). Water flushed out from the biodiesel production unit, known as biodiesel spentwash which is dark creamish yellow in color, with pungent odor, having high pH, fairly high in total suspended solids (TSS), high total dissolved salts (TDS), high BOD and COD, highly alkaline (high content of NAOH), calcium and magnesium salts, residues of potassium, nitrogen, phosphorus, glycerin, methyl esters, ions of copper and iron and other toxic substances. The spentwash released from the production unit will also be contaminated with methanol and is toxic to nature (2). The spentwash should never be disposed of into drains or into water bodies, doing so can result in methanol and other toxicants contaminating the water bodies and soil which could be reason for major pollution problem. Adequate treatments are necessary to prevent the contamination due to the toxic substances present in biodiesel spentwash and to reuse it for irrigation and other purposes. Biodiesel production activities are in full swing and in coming years, management of large quantities of spentwash will be an issue. Hence, adequate treatment methods are to be developed. Several approaches have been attempted the most promising method appears to be chemical coagulation, which removes the pollutants from the spentwash most effectively and is effective in improving the quality of the spentwash.

Methods

Collection of Spent Wash

The biodiesel spentwash samples derived from karanj (*Pongamia pinnata)* biodiesel production, were collected in dry plastic bottles which are rinsed with

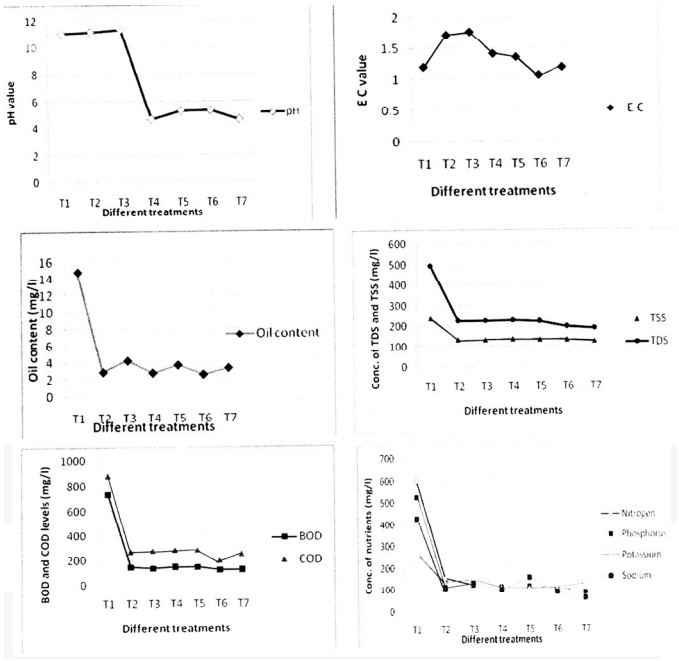

Figure 1. Effect of different coagulants on properties of biodiesel spentwash.

distilled water and then in spentwash, from the Biodiesel Production Unit (BPU), University of Agricultural Sciences, GKVK, Bengaluru, in November and December 2009. The combined sample of spentwash was collected at the main drain pipe which is connected from washing tank to outside discharge unit.

Characterization of Biodiesel Spent Wash

The physico-chemical and biological properties of biodiesel spentwash samples were analyzed according to standard procedures described in Manivaskam (3).

Coagulation of Biodiesel Spent Wash

To reduce the color, odor, pH, EC, suspended solids, BOD and COD and other pollutants of the biodiesel spentwash, different chemical compounds were tried as coagulating agents. The coagulants used included potash alum, ferric chloride and calcium hydroxide in two different concentrations.

One liter of well mixed biodiesel spentwash was taken in beakers and coagulants were added simultaneously to all the beakers. The suspension was stirred thoroughly to ensure dispersion of the coagulant in spentwash and allowed to settle for two hours. The supernatant of the settled samples were used for testing the characteristics of biodiesel spentwash.

Experimental Details

The coagulation experiment consisted of seven different treatments as detailed below.

Treatment designated	Treatments (mg/l)
T_1	Raw biodiesel spentwash (control)
T_2	Calcium hydroxide at 75
T_3	Calcium hydroxide at 125
T_4	Ferric chloride at 100
T_5	Ferric chloride at 200
T_6	Potash alum at 50
T_7	Potash alum at 100

Statistical Analysis

Fisher's method of analysis of variance was employed for the analysis and interpretation of the data

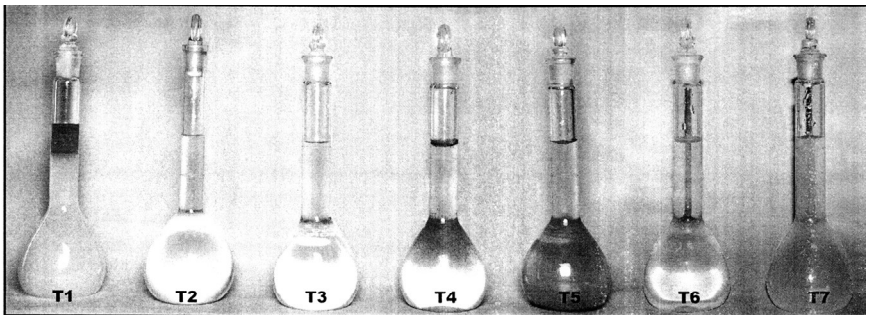

Figure 2. Effect of coagulants on biodiesel spentwash. T_1 : Raw biodiesel spentwash, T_2 : Calcium hydroxide at 75 mg/l, T_3 : Calcium hydroxide at 125 mg/l, T_4 : Ferric chloride at 100 mg/l, T_5 : Ferric chloride at 200 mg/l, T_6 : Potash alum at 50 mg/l, T_7 : Potash alum at 100 mg/l.

as given by Gomez and Gomez (4). The level of significance used in *F* test was $P = 0.05$ and the CD values were calculated.

Results and Discussion

The karanj biodiesel spentwash samples collected from the Biodiesel Production Unit, UAS, GKVK, Bengaluru, having the characters of polluted water and the results are described in Table 1. The results showed that biodiesel spentwash is dark yellow creamish yellow in color with brownish residues in it and having pungent odor which is slightly irritating. The biodiesel spentwash is alkaline in nature, having high EC. This might be due to use of NaOH as catalyst in the transesterification process, where biodiesel was produced from seed oil. Spentwash posses the characters of polluted water by having high amount of oil, oxygen demanding waste and total suspended matter. The spentwash also consist of fairly high amount of plant nutrients. This might be due to the use of different chemicals during biodiesel production and also use of seed oil as a chief raw material in production process.

Table 1. Physico-chemical and biological characteristics of karanj biodiesel spentwash.

Parameters	Values (BSW)	ISI limits
Color	Dark yellow with brownish residues and turbid	Clear
Odor	Pungent	Odorless
pH	11.07	5.5—9.00
EC (dS/m)	1.20	< 1.00
Oil content (mg/l)	14750.00	10
TSS (mg/l)	240.00	100.00
TDS (mg/l)	493.50	2100.00
BOD (mg/l)	727.93	30.00
COD (mg/l)	878.70	250.00
Nitrogen (mg/l)	648.00	100.00
Potassium (mg/l)	123.00	-
Phosphorus (mg/l)	274.66	-
Sodium (mg/l)	126.33	-
Total bacteria (CFU/ml)	18.00	-
E-Coli (CFU/ml)	Nil	Nil

The microbiological analysis showed that the spentwash recorded low populations of bacteria and *E. coli* was completely absent. This might be due to boiling of water and oil to higher temperatures and also due to use of concentrated acids in the production process. Similar results were also reported by Suehera et al. (2) that the biodiesel spentwash was highly alkaline and posses many characters of polluted water and it is not fit for agriculture without treatment. Chemical precipitation of biodiesel spentwash was useful to remove particulate and colloidal materials which determine the quality of spentwash.

Addition of coagulants improved the quality of biodiesel spentwash. The results are presented in Table 2. The addition of coagulants improved the quality of biodiesel spentwash by reducing the pollutants present in it. Similar results were reported by Nemerow (5) and Karanjkar (6).

Among different types coagulants used, potash alum followed by ferric chloride and calcium hydroxide were better coagulants in removal of color and odor, reduction of pH and EC and removal of sus-

Table 2. Effect of addition of coagulating agents on the physico-chemical characteristics of the biodiesel spentwash. *Significant at 5%, T_1 : Raw biodiesel spentwash, T_2 : Calcium hydroxide at 75 mg/l, T_3 : Calcium hydroxide at 125 mg/l, T_4 : Ferric chloride at 100 mg/l, T_5 : Ferric chloride at 200 mg/l, T_6 : Potash alum at 50 mg/l, T_7 : Potash alum at 100 mg/l.

			Parameters				
Treatments	Color	Odor	pH	EC (dS/m)	Oil content (mg/l)	TSS (mg/l)	TDS (mg/l)
T_1	Dark yellowish, turbid	Pungent	11.07	1.20	14750.00	240.03	494.03
T_2	Very light yellow, clear	Slightly pungent	11.18	1.72	2755.00	135.46	225.96
T_3	Light yellow, turbid	Slightly pungent	11.35	1.76	2150.00	134.43	224.93
T_4	Light brownish, turbid	Odorless	4.61	1.41	2560.00	137.26	227.16
T_5	Brownish, turbid	Odorless	4.28	1.36	1883.33	134.86	223.03
T_6	Light, slightly turbid	Odorless	5.28	1.06	1072.00	133.83	197.46
T_7	Light, slightly turbid	Odorless	5.24	1.19	932.33	125.93	187.50
F value	-	-	*	*	*	*	*
CV (%)	-	-	1.04	2.68	7.57	2.19	0.65
SE ±	-	-	0.05	0.02	0.21	1.88	0.96
CD at 5%	-	-	0.14	0.06	0.64	5.70	2.90

Table 2. Continued.

	Parameters					
Treatments	BOD (mg/l)	COD (mg/l)	N (mg/l)	P (mg/l)	K (mg/l)	Na (mg/l)
T_1	731.26	881.66	598.33	274.66	163.33	126.66
T_2	144.06	265.50	152.66	132.66	136.33	106.33
T_3	134.00	273.60	121.00	121.00	147.83	128.00
T_4	145.53	280.40	112.33	112.33	109.66	96.00
T_5	142.53	278.63	113.00	113.33	106.53	153.33
T_6	120.66	198.11	101.83	99.00	97.98	85.66
T_7	122.43	245.96	85.00	85.00	95.66	57.20
F value	*	*	*	*	*	*
CV (%)	3.59	3.39	1.96	4.62	10.52	3.83
SE ±	4.56	6.78	2.08	4.52	8.65	3.33
CD at 5%	13.83	20.58	6.30	13.71	26.25	10.10

pended salts, BOD, COD and other nutrients from the spentwash. Potash alum and ferric chloride addition to biodiesel spentwash formed insoluble alluminium hydroxide and ferric hydroxide respectively. They in turn must have facilitated the precipitation of colloids and increased the sedimentation rate of other particulate matter in the spentwash. Thus it reduces the total suspended matter present in the spentwash and also enhances the sedimentation rate of organic matter present in the spentwash. Similar results were reported by Upadyaya and Singh (7).

Conclusion

The study infers that the untreated effluent (raw spentwash) was unsuitable for irrigation and other purposes, as it contained high amounts of toxic substances. On the other hand the treated spentwash free from color, odor and other toxic substances and can be used in agriculture for certain selected crops. Therefore the chemical precipitation method can be considered as one of the efficient method for reducing the toxic substances from the biodiesel spentwash and can be used for treating the biodiesel spentwash.

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