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Role of aquatic plants in treatment of industrial effluents

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Abstract
In the present study, appropriate mathematical models have been developed on the basis of the governing equation derived out of the initial and boundary conditions of the problems. Further, using the models, simulation of water has been done in and around the coal washery complexes situated at the bank of Damodar river stretch. The river water is being utilized for various purposes such as drinking, bathing, agriculture and industrial use. Most of the Industries are responsible for polluting the environment, particularly the nearby river systems by continuous discharge of the industrial effluents. Such Industries are always located on or nearby the bank of rivers. Therefore, it is very much warranted that a study on the dispersion characteristics of pollutant species along multi wastewater-outfall river system has to be considered in order to develop an indigenous and effective algorithm for water quality prediction, which would lead for designing suitable predictive system for better river quality management using appropriate mathematical models for simulating the water quality along the river stretches.

Keywords: aquatic plants, industrial effluents

Introduction
Environmental Pollution is a rising danger an immense disquiet in today's context pertaining to its effect on the ecosystem. The worldwide rise in population and industrialization during the last few decades have resulted in ecological disturb and degradation of the natural property. One of the most vital natural resources which have been the worst victim of population explosion and increasing industrialization is water. In recent years, considerable attention has been paid industrial wastes discharged to land and surface water. Industrial effluents often contain various several organic and inorganic compounds. Huge amount of waste water generated from human resolution and industrial sectors accompany the disposal system either as municipal waste water of industrial wastewater. This wastewater is enriched with varied pollutants and harmful both to human being and the aquatic flora and fauna and its successive accumulation in the soil has adverse effect on soil productivity. Over 5 million chemical substances produced by industries have been recognized and about 12000 of these are marketed which amount to around half of the total production.
Due to discharge of contaminated effluents and its long-term consequences of can cause cancer, delayed nervous damage, deformity in urban children, mutagenic charges, neurological disorders etc. Various acid manufacturing industries discharge acidic effluent, which not only make the land infertile but make the water of the river acidic also. The high acidity causes stomach diseases and skin ailments in human beings. Alkaline effluents cause infertility of the soil and destroy flora and fauna of the vicinity. Contaminated water by pesticides, such as DDT, aldrin, dieldrin, heptachlor etc. are harmful for aquatic life and human beings as well. Discharge of cyanide-contained wastewater to water mass may lead to death of fish and other aquatic life. Then use of water containing fluoride can causes mental disorders and stomach ailments and can also reduce agricultural production.

The washeries discharge the effluent in to the river system 300-500 m3 in a day. About 6–10 tons of good quality coal are lost in the form of fine particle. Seven coal washeries and other allied industries like coke oven plant, power plants are situated along the stretch between Mahuda Coal Washery and the confluence Point of Gobi River and Damodar. The tributaries carry the effluents of nearby coal washeries, surrounding mines and allied industries and finally blend with Damodar River. The selected river stretch for the present study has been reported as a highly polluted zone.

Free floating aquatic plants draw the carbon dioxide and oxygen that the need from the air, but they depend upon the dissolved constituents of the water for all of their nutrients. Under anaerobic conditions, many of these plants transport oxygen to their roots for metabolic purposes. Excess oxygen is then available to the surrounding media (Reddy *et al*.1989). When the roots of the plant are within the water column they act as a living substrate for attached growth of aerobic bacteria which then use the excess oxygen to degrade dissolved organic compounds in the water.

Materials and Methods

Sample collection point

a) Sudamdih coal washeri (sample A)

b) Bokaro steel plant waste water (sample B)

Fig 1: Sudamdih coal washeri

Fig 2: Bokaro steel waste water

Characterization-12 parameters analysis ofeffluent.

Table 1: Sudamdih coal washeri (sample A)

S. No	Parameters	Unit	Result
1	P^H	A/B	5.2
2	Temp	C^o	40
3	Color	O.D	0.208
4	DO (Dissolved Oxygen)	mg/L	4.4
5	COD (Chemical oxygen demand)	mg/L	88
6	TDS (Total dissolved solid)	mg/L	200
7	TS (Total solid)	mg/L	310
8	TSS (Total suspended solid)	mg/L	110
9	Oil and Grease	mg/L	0.066482
10	Hardness	mg/L	332
11	Calcium Hardness	mg/L	159.6
12	Magnesium Hardness	mg/L	172.4

Table 2: Bokaro steel plant waste water (sample B)

S. No	Parameters	Unit	Result
1	P^H	A/B	3.4
2	Temp	C^o	38
3	Color	O.D	0.059
4	DO (Dissolved Oxygen)	mg/L	6.2
5	COD (Chemical oxygen demand)	mg/L	107.186
6	TDS (Total dissolved solid)	mg/L	789
7	TS (Total solid)	mg/L	1250
8	TSS (Total suspended solid)	mg/L	461
9	Oil and Grease	mg/L	0.010538
10	Hardness	mg/L	204
11	Calcium Hardness	mg/L	142.9
12	Magnesium Hardness	mg/L	61.1

Plants selection for treatment-a) *Eichhornia* species

b) Duckweed (*lemna minor*)

c) *Anabaena Azolla*

Prepare setups for treatment

1) Setup A -Coal washeri effluent, Plantoriginal/duplicate set

2) Setup B- Steel waste water, Plant original/ duplicate set

3) Setup C- Control plant / water set

Fig 3: Prepare all setups

Results and Discussion

Procedure: **-Setup A**-(Original/duplicate set)

Table 1: a) *Lemna* (Coal Effluent)

Parameters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
pH (A/B)	5.2	5.2	6.5	6.1	1.0	7.1	N-S	7.4
Color (O.D)	0.208	0.208	0.161	0.192	0.112	0.145	N-S	0.061
TDS (mg/l)	200	200	183	151	152	141	N-S	136
TS (mg/l)	310	310	291	235	259	220	N-S	212
TSS (mg/l)	110	110	108	84	107	79	N-S	76
Oil /grease(mg/l)	0.066482	0.066482	0.058794	0.014532	0.025281	0.01065	N-S	0.004914

Table1: b) *Eichhornia* (Coal Effluent)

Parameters	‘ 0’day		After10 days		After20 days		After30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
pH (A/B)	5.2	5.2	6.8	5.8	7.2	6.9	7.3	7.5
Color(O.D)	0.208	0.208	0.191	0.107	0.126	0.029	0.059	0.013
TDS (mg/l)	200	200	145	135	141	132	122	129
TS (mg/l)	310	310	253	242	245	235	219	216
TSS (mg/l)	110	110	108	107	104	103	97	87
Oil/grease (mg/l)	0.066482	0.066482	0.02912	0.025312	0.02510	0.021342	0.02289	0.020462

Table 1: c) *Azolla* (Coal Effluent)

Parameters	‘ 0’day		After 10 days		After20 days		After30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
pH (A/B)	5.2	5.2	6.8	6.2	7.8	7.9	N-S	N-S
Color(O.D)	0.208	0.208	0.102	0.095	0.072	0.017	N-S	N-S
TDS (mg/l)	200	200	169	170	156	162	N-S	N-S
TS (mg/l)	310	310	263	256	246	245	N-S	N-S
TSS (mg/l)	110	110	94	86	90	83	N-S	N-S
Oil/grease (mg/l)	0.066482	0.066482	0.0024	0.058102	0.00156	0.034111	N-S	N-S

Table 2: a) *Eichhornia* (plant)

Characters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
Root(no.incount)	23	13	23	13	25	11	25	11
Leaf(no.incount)	7	8	7	8	8	5	8	5
Pigment(mg/gm)	4.38	4.93	5.21	4.73	8.85	4.45	12.1	4. 32
Starch (mg/ml)	1.546	0. 72	1.121	0. 51	0.7151	0. 23	0.424	0. 007
Protein(mg/ml)	3.3	3.3	3.0	2.5	2.5	2.2	1.9	1.9
Mortality rate (%)	0	0	9	3	9.4	3	9.4	9
Biomass (%)	0	0	0	0	1	1	1	1

Table 2: b) *Lemna* (plant)

Characters	‘0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
Root(no.incount)	8	10	6	10	6	8	N-S	8
Leaf(no.incount)	4	4	3	4	3	3	N-S	3
Pigment(mg/gm)	10.41	10.41	6.52	9. 94	1.86	9. 25	N-S	7.88
Starch (mg/ml)	0.81	1.02	0.17	0.81	0.12	0.45	N-S	0.32
Protein(mg/ml)	3.9	4.0	2.6	3.4	1.8	2.8	N-S	1.3
Mortality rate (%)	0	0	9	9	9.4	9.7	N-S	9.7
Biomass (%)	0	0	1	1	1	1	N-S	1

Table 2: c) *Azolla* (plant)

Characters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	Duplicate
Root (no.incount)	5	11	5	11	N-S	N-S	N-S	N-S
Leaf (no.in count)	3	5	3	5	N-S	N-S	N-S	N-S
Pigment (mg/gm)	8.68	8.68	2.6	6.93	N-S	N-S	N-S	N-S
Starch (mg/ml)	0.086	0. 21	0.21	0.08	N-S	N-S	N-S	N-S
Protein(mg/ml)	2.9	2.6	2.3	2.1	N-S	N-S	N-S	N-S
Mortality rate (%)	0	0	9.1	9	N-S	N-S	N-S	N-S
Biomass (%)	0	0	1	1	N-S	N-S	N-S	N-S

Setup B- steel water (Original/duplicate set)

Table 5: *a) Eichhornia* (steel Effluent)

Parameters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	Duplicate
pH (A/B)	3.4	3.4	6.8	5.9	7.1	6.0	N-S	7.6
Color(O.D)	0.059	0.059	0.043	0.053	0.030	0.040	N-S	0.017
TDS (mg/l)	789	789	519	669	512	625	N-S	510
TS (mg/l)	1250	1250	900	982	889	859	N-S	316
TSS (mg/l)	461	461	381	313	377	234	N-S	194
Oil/grease (mg/l)	0.010538	0.010538	0.000438	0.010224	0.000256	0.009023	N-S	0.002394

Table 5: b) *Lemna* (steel Effluent)

Parameters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	Duplicate
pH (A/B)	3.4	3.4	6.9	5.6	7.3	6.9	7.5	7.3
Color(O.D)	0.059	0.059	0.052	0.054	0.044	0.037	0.012	0.021
TDS (mg/l)	789	789	722	725	699	648	745	579
TS (mg/l)	1250	1250	1140	451	1101	396	1110	389
TSS (mg/l)	461	461	418	274	402	252	365	190
Oil /grease (mg/l)	0.010538	0.010538	0.010406	0.010448	0.002451	0.010423	0.00046	0.001552

Table 5: c) *Azolla* (steel Effluent)

Parameters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	Duplicate
pH (A/B)	3.4	3.4	6.0	5.4	7.4	6.9	N-S	N-S
Color(O.D)	0.059	0.059	0.036	0.040	0.040	0.028	N-S	N-S
TDS (mg/l)	789	789	689	730	730	669	N-S	N-S
TS (mg/l)	1250	1250	855	936	936	814	N-S	N-S
TSS (mg/l)	461	461	166	206	206	145	N-S	N-S
Oil/grease (mg/l)	0.010538	0.010538	0.00121	0.00268	0.00268	0.00128	N-S	N-S

Table 6: a) *Eichhornia* (plant)

Characters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
Root (no. in count)	26	16	26	16	N-S	10	N-S	10
Leaf (no. in count)	6	4	5	4	N-S	3	N-S	3
Pigment (mg/gm)	4.38	10.4	1.1	8.29	N-S	6.55	N-S	4.38
Starch (mg/ml)	1.29	1.15	0.23	0.97	N-S	0.29	N-S	0.23
Protein	3.3	3.3	2.0	2.9	N-S	2.5	N-S	1.0
Mortality rate	0	0	9.1	6.1	N-S	9	N-S	9.1
Biomass	0	0	1	1	N-S	1	N-S	1

Table 6: b) *Lemna* (plant)

Characters	‘ 0’day		After 10 days		After 20 days		After 30 days	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
Root(no. in count)	12	10	12	10	8	8	8	8
Leaf (no. in count)	4	4	4	4	3	3	3	3
Pigment (mg/gm)	10.41	10.41	9.25	9.8	6.49	6.29	4.42	2.13
Starch (mg/ml)	0.81	1.29	0.68	0.81	0.49	0.33	0.20	0.13
Protein	3.9	3.9	3.0	3.2	2.4	2.5	1.4	1.2
Mortality rate	0	0	9	5.1	9.1	8.1	9.1	9.1
Biomass	0	0	1	1	1	1	1	1

Table 6: c) *Azolla* (plant)

Characters	‘ 0’day		After 10 days		After 20 days		After 30	
	original	duplicate	original	duplicate	original	duplicate	original	duplicate
Root(no. in count)	10	3	5	5	N-S	N-S	N-S	N-S
Leaf(no. in count)	3	5	3	3	N-S	N-S	N-S	N-S
Pigment (mg/gm)	8.68	8.68	2.69	5.25	N-S	N-S	N-S	N-S
Starch (mg/ml)	0.32	0.08	0.08	0.02	N-S	N-S	N-S	N-S
Protein	2.6	3.3	1.0	2.6	N-S	N-S	N-S	N-S
Mortality rate	0	0	9.2	9.1	N-S	N-S	N-S	N-S
Biomass	0	0	2	1	N-S	N-S	N-S	N-S

Setup C-Control

Table 9: Sudamdih coal washeri water

Parameters	‘ 0’day	After 10 days	After 20 days	After 30 days
pH (A/B)	5.2	5.1	5.0	4.9
Color(O.D)	0.208	0.220	0.226	0.261
TDS (mg/l)	200	204	209	220
TS (mg/l)	310	320	326	345
TSS (mg/l)	110	116	117	125
Oil / grease (mg/l)	0.066482	0.076502	0.102653	0.111232

Table 9: Steel waste water

Parameters	‘ 0’day	After 10 days	After 20 days	After 30 days
pH (A/B)	3.4	3.2	3.2	3.1
Color(O.D)	0.059	0.141	0.154	0.242
TDS (mg/l)	789	792	796	799
TS (mg/l)	1250	1256	1262	1270
TSS (mg/l)	461	464	466	471
Oil / grease (mg/l)	0.010538	0.010512	0.0010261	0.000202

Table 9: a) *Eichornia* (Bore well water)

Parameters	‘ 0’day	After 10 days	After 20 days	After 30 days
pH (A/B)	7.2	7.4	7.5	7.8
Color(O.D)	0.082	0.062	0.021	0.012
TDS (mg/l)	415	408	401	396
TS (mg/l)	425	400	394	391
TSS (mg/l)	10	8	7	5
Oil / grease (mg/l)	0.00055	0.00024	0.00016	0.00009

Table 9: b) *Lemna* (Bore well water)

Parameters	‘ 0’day	After 10 days	After 20 days	After 30 days
pH (A/B)	7.2	7.2	7.4	7.6
Color(O.D)	0.082	0.078	0.056	0.045
TDS (mg/l)	415	414	412	410
TS (mg/l)	425	420	418	408
TSS (mg/l)	10	6	6	2
Oil / grease (mg/l)	0.00055	0.00042	0.00039	0.00021

Table 9: c) *Azolla* (Bore well water)

Parameters	‘ 0’day	After 10 days	After 20 days	After 30 days
pH (A/B)	7.2	7.5	7.8	N-S
Color(O.D)	0.082	0.060	0.025	N-S
TDS (mg/l)	415	409	407	N-S
TS (mg/l)	420	416	414	N-S
TSS (mg/l)	10	7	7	N-S
Oil / grease (mg/l)	0.00055	0.00032	0.00015	N-S

Table 9: d) *Eichornia* (plant)

Characters	‘ 0’day	After 10 days	After 20 days	After 30 days
Root (no. in count)	30	30	29	29
Leaf (no. in count)	5	5	4	4
Pigment (mg/gm)	6.3	5.7	4.0	3.0
Starch (mg/ml)	1.23	1.13	0.47	0.36
protein	3.3	2.9	2.5	1.9
Mortality rate	0	8	9.5	9.5
Biomass	0	1	1	1

Table 9: e) *Lamina* (plant)

Characters	‘ 0’day	After 10 days	After 20 days	After 30 days
Root (no. in count)	12	12	10	10
Leaf(no. in count)	4	4	3	3
Pigment (mg/gm)	10.41	8.56	8.32	6.55
Starch (mg/ml)	1.57	0.73	0.47	0.08
protein	3.5	2.8	2.3	1.8
Mortality rate	0	9	9.6	9.6
Biomass	0	1	3	3

Table 9: f) *Azolla* (plant)

Characters	‘ 0’day	After 10 days	After 20 days	After 30 days
Root (no. in count)	3	3	N-S	N-S
Leaf(no. in count)	5	5	N-S	N-S
Pigment (mg/gm)	8.68	5.68	N-S	N-S
Starch (mg/ml)	0.08	0.05	N-S	N-S
protein	3.3	2.6	N-S	N-S
Mortality rate	0	9	N-S	N-S
Biomass	0	1	N-S	N-S

This study reported the applications, efficiencies, and challenges of oil and grease wastewater treatment from industrial wastewater and municipal water stream. The results showed that the concentrations of oil and grease discharged into the ecosystem lead to increase environmental impact. The desired development for effective removal of oil and grease is discussed as emerging pollutants. aquatic plants were selected to eliminate O&G concentration from industrial waste water. After treatment of effluents it showed that the Color, TDS, TS, TSS, Oil & grease is continuously reduced after subsequent days of continuous examination. So the conclusion is industrial effluents are purified through aquatic plants.

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