etics of biodegradation of
nge due to addition of
orides

DEPARTMENT OF CIVIL ENGINEERING

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nor: Sunderramieddy)

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ntroduction

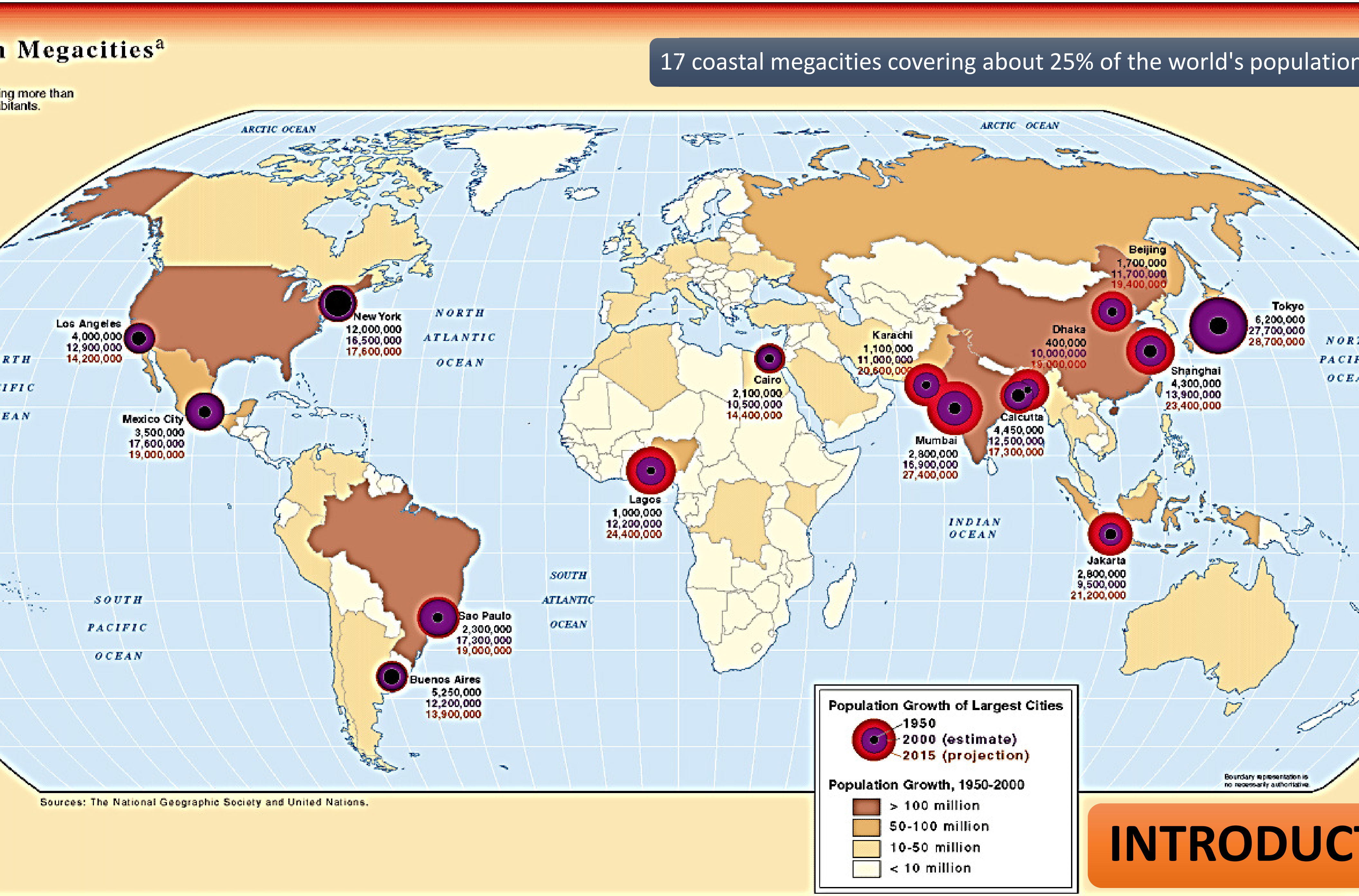
bjectives of the study

Methodology

esults

onclusions

17 coastal megacities covering about 25% of the world's population



INTRODUCT


Seafood processing industry


Pickling


Sauces
Breakfast Cereals
CHOCO
Canned Fruits
LITCHIES
PEARS
FRUIT COCKTAIL
CHERRIES
BAKED BEANS
vegetable canning


Cheese processing


fishmeal manufact

Wastewater characteristics of from various fishery product and vegetable pickling industries

ct	Unit	Canned sardine	Canned shrimp[2]	Canned mussel/oyster	Tuna	Fish meal	Kim chi pickles [3]	Cucumber pickles [1]	Sa
ewater	m^3/ton	9	60	20-120	22	97	0.6	17	
	kg/ton	9	120	60	15	194	0.7	33	
	kg/ton	5-6	54	-	11	-	-	5	
	kg/ton	27	42	-	6	-	-	-	
s ine		Off-load, sauce filling/can washing	Brine filling, cooking, sealing, can washing	cooking, washing	cooking, sauce filling/sealin g/ can washing	Off-load, centrifuging, storage	Fermenting	Fermenting, pickle washing	Fe pic
ater	% of total volume	39 (seawater)	2 – 2.5 [2]	3 [3]	3 [3]	95 (seawater)	100	56	
	g NaCl/L	30-35	20 – 30 [2]	21[3]	23 [3]		100	30 – 200	
		UNEP, 1999	UNEP, 1999	UNEP, 1999	UNEP, 1999	UNEP, 1999	Choi & Park,1999	Middlebrook 1979	Mi 19

material
, 1971
for waste brine only

Wastewater characteristics of from various fishery product and vegetable pickling industries (Dan N. P, 2001).

- Highly saline wastewater is
during the manufacture of chem
as pesticides, pharmaceuticals,
and during oil and gas recovery
(Henze M et al., 1995). In addi
salt concentration found in th
leachates (Ellouze M et al., 2008

Characteristics of leachates (Pirbazari, 1996).

Leachate		Domestic waste landfill	Hazardous
COD	mg/L	3,050 – 3,450	9,000 – 10
BOD $_5$	mg/L	1,505 – 1,710	6,950 – 7,5
TOC	mg/L	905 – 965	3,040 – 3,5
SS	mg/L	460 – 565	862 – 946
TDS	mg/L	5,800 – 6,250	22,600 – 2
TKN	mg/L	75 - 84	160 – 180
Oil and grease	mg/L	60 – 80	
pH		-	4.3 – 6.0

resence of salinity up to certain concentration (1-2 g/L) has been sho
o improve anaerobic sludge digestion, while concentrations over 20 g
an cause severe osmotic stress in bacteria leading to plasmolysis and
oss of cell activity (Glenn E., 1995).

High salt content in wastewater is known to significantly reduce
reatment efficiency of conventional activated sludge, nitrification a
enitrification processes (Kargi F and Uygur A., 1996).

Effects of high salt concentrations on biological treatment process are
great concern and present a challenge to the environmental engineers
heir safe disposal.

TED SLUDGE PROCESS :

Adverse effects of high salinity in activated sludge process

thors	Experiment	Results
Moran (1965)	Increasing influent from 100 mg Cl/L → 20,000 mg Cl/L (≈ 33 g NaCL/L) over 2 to 3 weeks	- Solid losses → disrupting clarifier - 10% loss in BOD_5 removal - Inhibiting nitrification
4)	Changing TDS up to 35,5 g NaCL/L	- Decreasing BOD_5 removal from 97% to 25% for 6 days after - Rapid die-off of rotifers & stalked/mobile ciliata protozoa - Turbid in effluent
nfelder	Operating continuous flow activated sludge with low F/M ratio at ≤ 35 g NaCl/L	- Slight effect on BOD removal - Effluent SS did not increased due to low F/M
	If salt content > 35g/L	- Decreasing the population of protozoa and then disappeared - Increasing effluent SS
-Attar (1995)	Increasing salt content to 10 g/L and 30 g NaCL/L	- Decrease in substrate utilization rate - But increasing biomass yield due to selecting salt tolerant species (halophilic bacteria such as Zooglea ramugera, Halobacteriaceace etc.)
al. (1996)	Oil-field brine with salt content of 29 g/L	- Increasing wash-out of activated sludge as hydraulic loadings > 2.5m^3/m^3.day
r (1996)	Increasing in influent salt contents over 1% for RBC	- Decreasing COD removal rate & efficiency. - COD removal was down to 60% at 5% salt content. - Increasing salt content caused linear reduction in COD removal efficiency.

rse effect of salt on activated sludge process (Dan N. P, 2001).

OBIC TREATMENT :

	Experiment	Results
. (1984)	AF with surface area of 600 m^2/m^3 at 30 g NaCl/l	Decrease in gas production (dropped 65%) - TOC removal was decreased from 98% to 70% - Decrease in pH from 6.8 to 5.4
	at salt content of 60 g/L -	Gas production dropped below 15% - TOC removal < 20%
l. (1995)	UASB and AF	- Reducing 50% methanogenic activity at salt content > 33 g NaCl /L
		- Shocked at concentrations ranging from 10-21 g NaCl/L for unadapted sludge
l. (1993)	Anaerobic and aerobic system at 32 g/L (NaCl)	Low COD removal for whole system (50%). COD removal (70%) could be improved at very low F/M ratio (0.02 for anaerobic and 0.04 for aerobic process
al. (1995)	Anaerobic batch digestion	- Decreasing 50% of methane activity as increasing. TDS by 10-25 g NaCl/L

ctives of the study:

determine the BOD exertion rates of glucose–glutamic a
GA) solution mixed with sewage under controlled addition
orides of 0 to 20 g/L at 20°C.

develop a mathematical equation derived from experimen
ults in order to describe both stimulation as well as inhibit
ects by a single expression and validate it by fitting aga
ondary data reported in the literature.

HODOLOGY :

- **rab samples** of sewage were collected from STP of **MNIT Jaipur.**
- **GA solution of 150 mg/L** each was prepared and 6 mL of it was mixe ith sewage a controlled manner for making test samples.
- amples having different chloride additions of **up to 20 g/L** (zer hloride sample means no additional NaCl to the GGA-sewage sampl ere prepared using **analytical grade NaCl**.
- **OD** test was carried out by as per APHA et al., 2010.
- ettled biomass from SST of **STP Delawas,** Jaipur (based o onventional ASP) was used as **"seed" for BOD analysis**.

HODOLOGY …

- All experiments were conducted at a temperature of **20°±2°C.**
- For the first, two sets of samples having, **0 to 8 and 0 to 20 g** of chlorides concentrations, BOD exertion was monitor every day for a **5- day period.** However, in the third set havi chloride concentrations of **0 to 12 g/L**, the BOD exertion w monitored up to **three-day period.** In addition, in the fourth s of experiments with **10 to 20 g/L** of chlorides concentratio only **BOD_5** exertion was monitored.
- Trial version of **STATISTICA 2014 software** was used f data analysis.

lation of Kinetic coefficient K

THEORETICAL CALCULATIONS OF BOD = $Y=L_0\,(1-10^{-(kt/2.303)})$

ULTIMATE BOD CALCULATIONS:

COD of sewage sample was considered as its **ultimate BOD.**

The **theoretical COD of 373 mg/L** as determined from the chemical formula of **GGA solution** was considered as its ultimate BOD.

$$\frac{(373\ \text{mg/L} * 6\ \text{mL}) + (\text{COD of sample mg/L} * \text{mL of Sample})}{(\text{mL of GGA }(6) + \text{mL of sample taken})}$$

ULTS

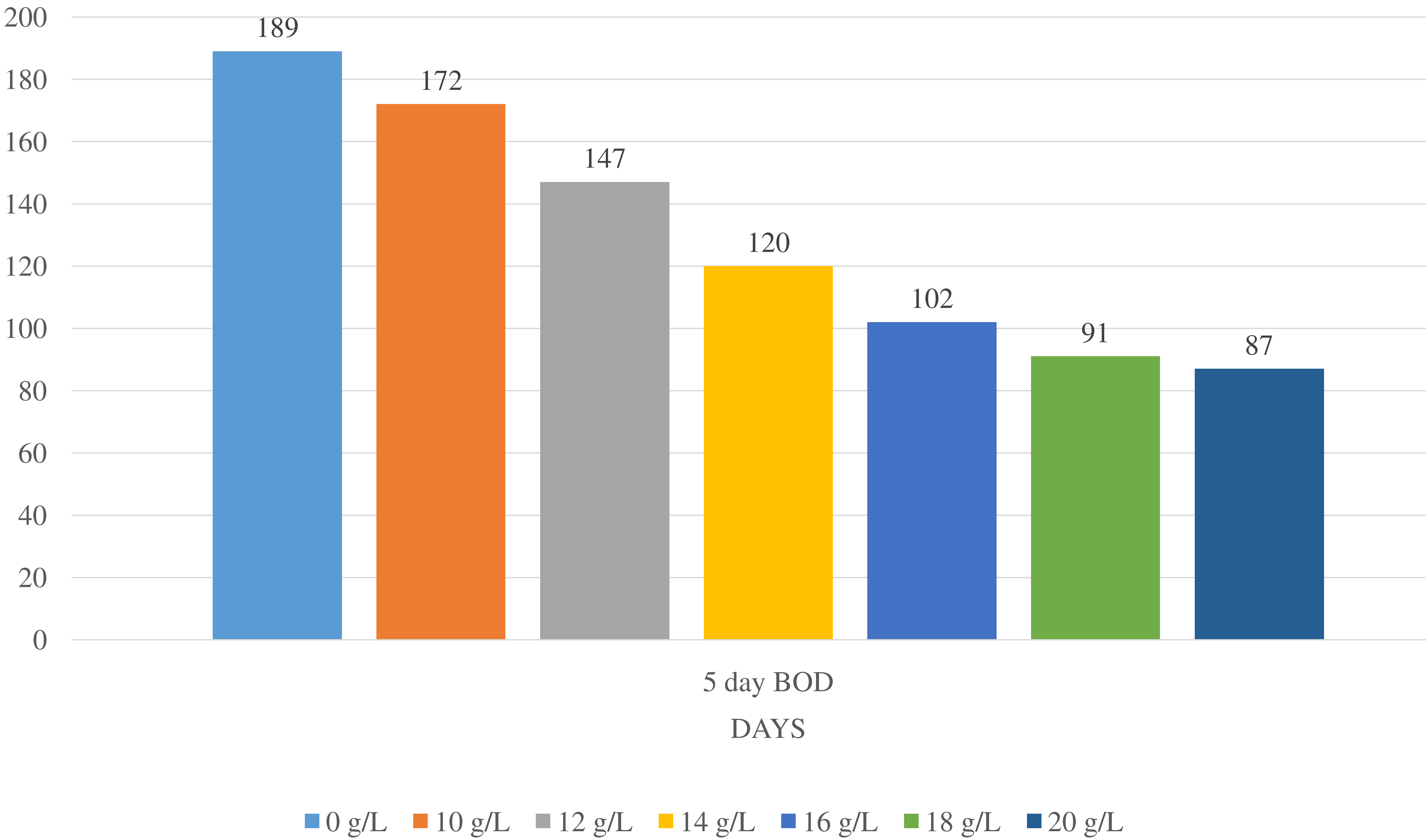
ABLE-1 BOD observations at low chloride concentrations of 0 to 0.8 mg/L

Days	Average BOD (mg/L)				
	0 g/L Chlorides	0.2 g/L Chlorides	0.4 g/L Chlorides	0.60 g/L Chlorides	0.80 g/L Chlorides
1	45	51	64	Not observed	Not observed
2	55	62	72	Not observed	Not observed
3	87	85	90	Not observed	Not observed
4	115	117	120	Not observed	Not observed
5	126	134	143	147	147

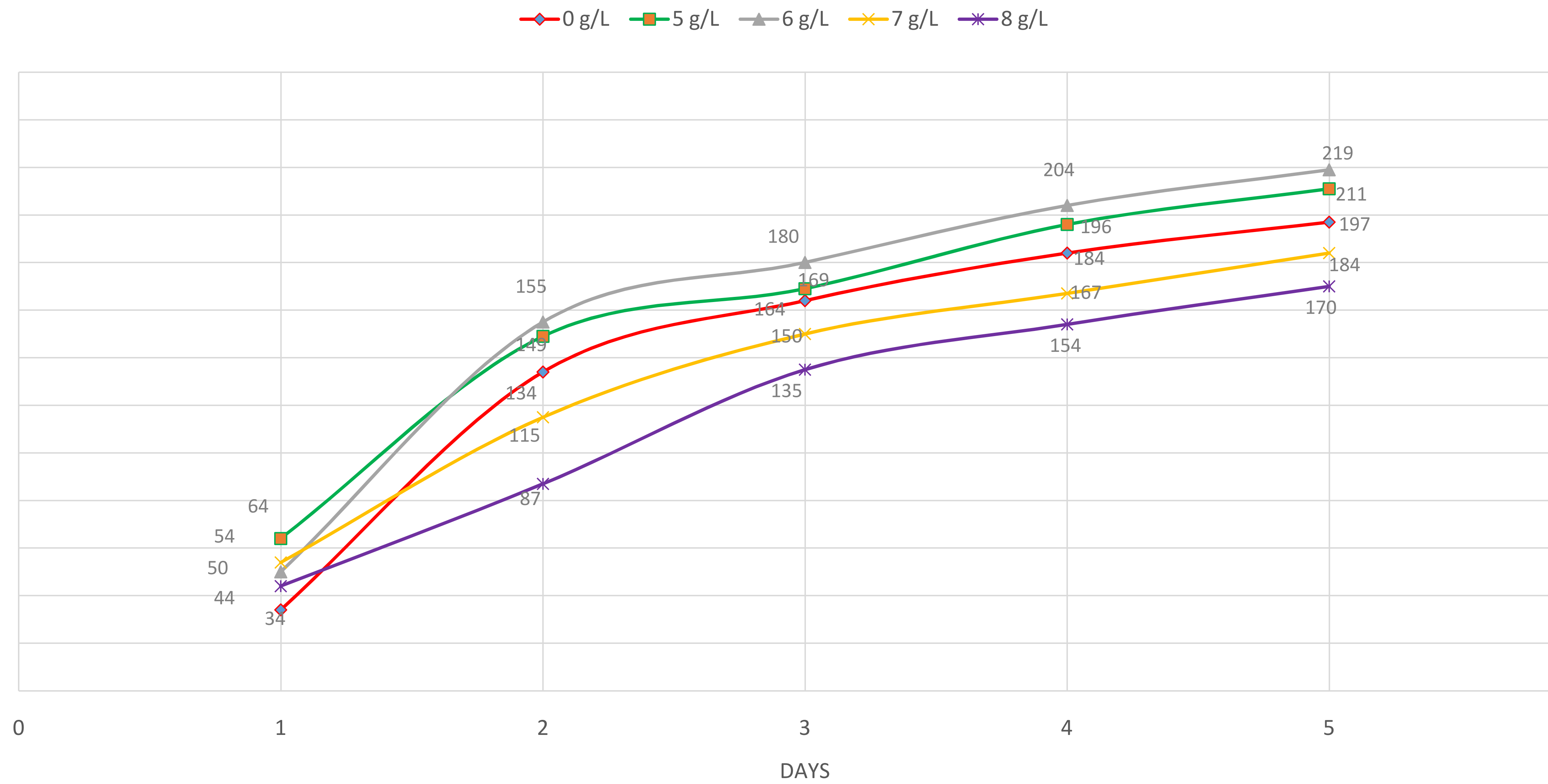
E-2 BOD exertion at high chloride concentrations of 0-20 g/L

s	Average BOD (mg/L)				
	0 g/L Chlorides	5 g/L Chlorides	10 g/L Chlorides	15 g/L Chlorides	20 g/L Chloride
	52	**60**	30	Not observed	Not obse
	85	**93**	71	Not observed	Not obse
	142	**115**	129	Not observed	Not obse
	167	**186**	137	Not observed	Not obse
	194	**200**	**180**	**131**	**104**

RE-1 BOD$_5$ exertion at different chloride concentrations of 10-20 mg/L



RE-2 BOD exertion at 0, 5, 6, 7 and 8 g/L of chloride concentrations.



Reaction constant (k) per day				
0 g/L of Cl	5 g/L of Cl	6 g/L of Cl	7 g/L of Cl	8 g/L of Cl
0.11	0.2	0.16	0.17	0.14
0.24	0.28	0.29	0.2	0.14
0.21	0.22	0.24	0.19	0.16
0.19	0.21	0.22	0.16	0.15
0.17	0.18	0.2	0.15	0.13

e-3 BOD exertion rate (k) of the samples
ied chloride concentrations of 0 to 8 g/L

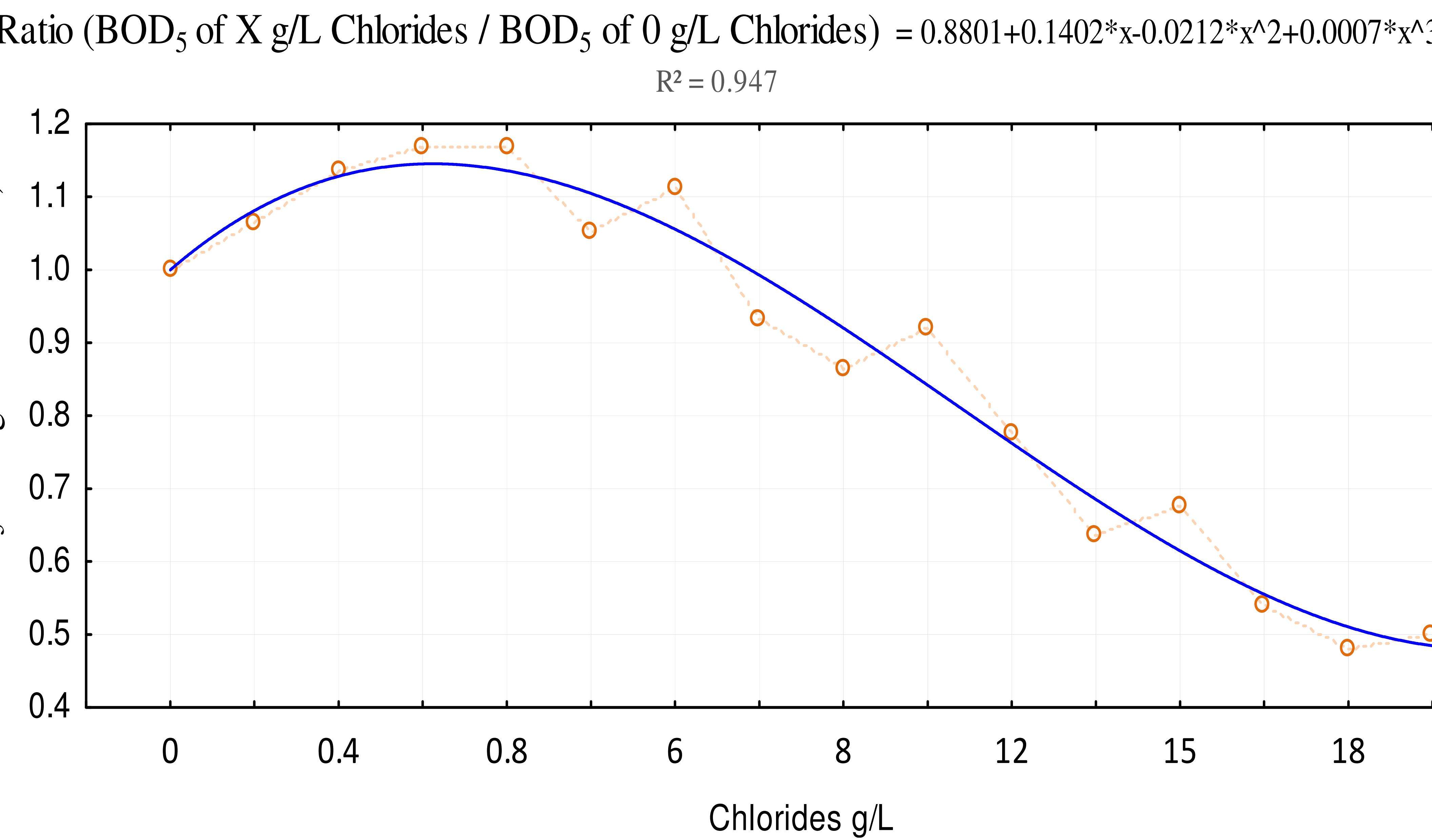
Table-4 BOD exertion rate (k) of the sa
at high chloride concentrations of 0 to 20

Days	Reaction constant (k) per			
	0 g/L of Cl	5 g/L of Cl	10 g/L of Cl	15 g/L of Cl
1	0.16	0.19	0.09	Not observed
2	0.14	0.16	0.11	Not observed
3	0.18	0.13	0.15	Not observed
4	0.16	0.19	0.12	Not observed
5	0.16	0.17	0.14	0.09

(X)	Ratio (BOD$_5$ at X g/L Chlorides / BOD$_5$ at zero Chloride)
	1
	1.063
	1.134
	1.166
	1.166
	1.050
	1.111
	0.934
	0.862
	0.918
	0.777
	0.634
	0.675
	0.539
	0.481
	0.498

Table-6 Derived data of BOD exertion ratios at different chloride concentrations

RE- 3 Curve between BOD_5 exertion ratios and chloride concentrations.



Observed and Predicted values of variance data under varied chloride concentrations

Author	Chlorides (x) g/L	Observed value in literature		Predicted value of BOD_5 mg/L using our model	% Error ((obs-pre)/obs)
		BOD_5 Value at X g/L of Cl	BOD_5 Value of 0 g/L Cl		
Shivani et.al., (2012)	5	285	337	384	-34.73
	10	255	337	291	-14.11
	15	200	337	194	3
	20	221	337	271	-22.62
Gotaas (1949)	0.55	272	236	225	17.27
	1.65	240	236	250	-4.166
	3.65	250	236	270	-8
	6.4	243	236	258	-6.17
	9.2	215	236	218	-1.39
	13.75	236	236	147	37.71
	18.35	242	236	151	37.60

LUSIONS

Chloride concentrations of up to 0.8 g/L showed stimulation of biodegradat
process

Concentrations from 0.8- 6.0 g/L showed no inhibition of biodegradation. This n
perhaps be due to the fact up to this salinity, the cells exhibit a higher activity thar
the freshwater medium. Microbiological studies for supporting the hypothesis
underway.

Further increase in salinity (7 to 20 g/L of chlorides) restricts the osmo-regulat
processes responsible for the breakdown of organic compounds within the cells
microorganisms. As a result, the kinetic reaction rates of decomposition reacti
suffer and show continuous inhibition.

A single third order polynomial curve was able to represent both the stimulatior
well as inhibition of the biological process due to the concentration of salt up to
g/L.

The results may help formulate strategy for environmentally safe Co-disposal of
rejects as well as high salt containing **industrial wastewaters with sewage**.

nces

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