Potential use of *Sargassum cinereum* biomass for removal of Lead: Kinetics, Isotherms, Thermodynamic and Characterization Studies

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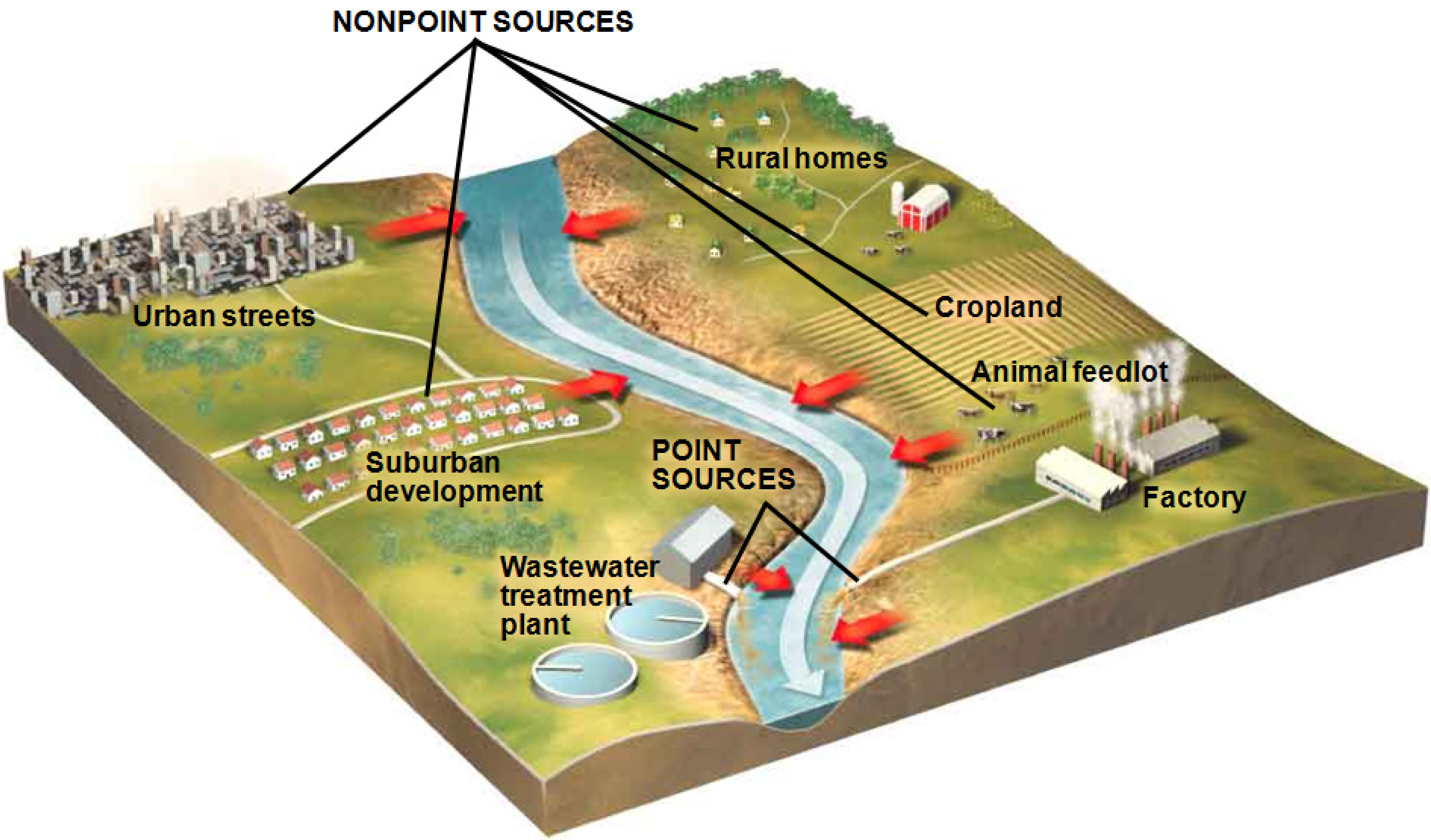
Point and Nonpoint Sources



Collection and preparation of biomass

Collected from Andaman Nicobar islands, washed thoroughly to remove debris, shade dried powdered in domestic mixer. Powdered biomass is rinsed with demineralized water and dried in oven at 70°C, sieved trough 100 sieve and stored in dehumidifier for further studies.

The major advantages of biosorption over conventional treatment methods include

- **Low cost**
- **High efficiency**
- **Minimization of chemical and biological sludge**
- **No additional nutrient requirement**
- **Regeneration of biosorbent and**
- **Possibility of metal recovery**

MODEL CALCULATION

To determine the metal calculations in the parameters the following equation is used:

$$q_e = \frac{V\,(C_i - C_f)}{1000\,w}$$

Where q_e = *metal uptake (mg/g).*

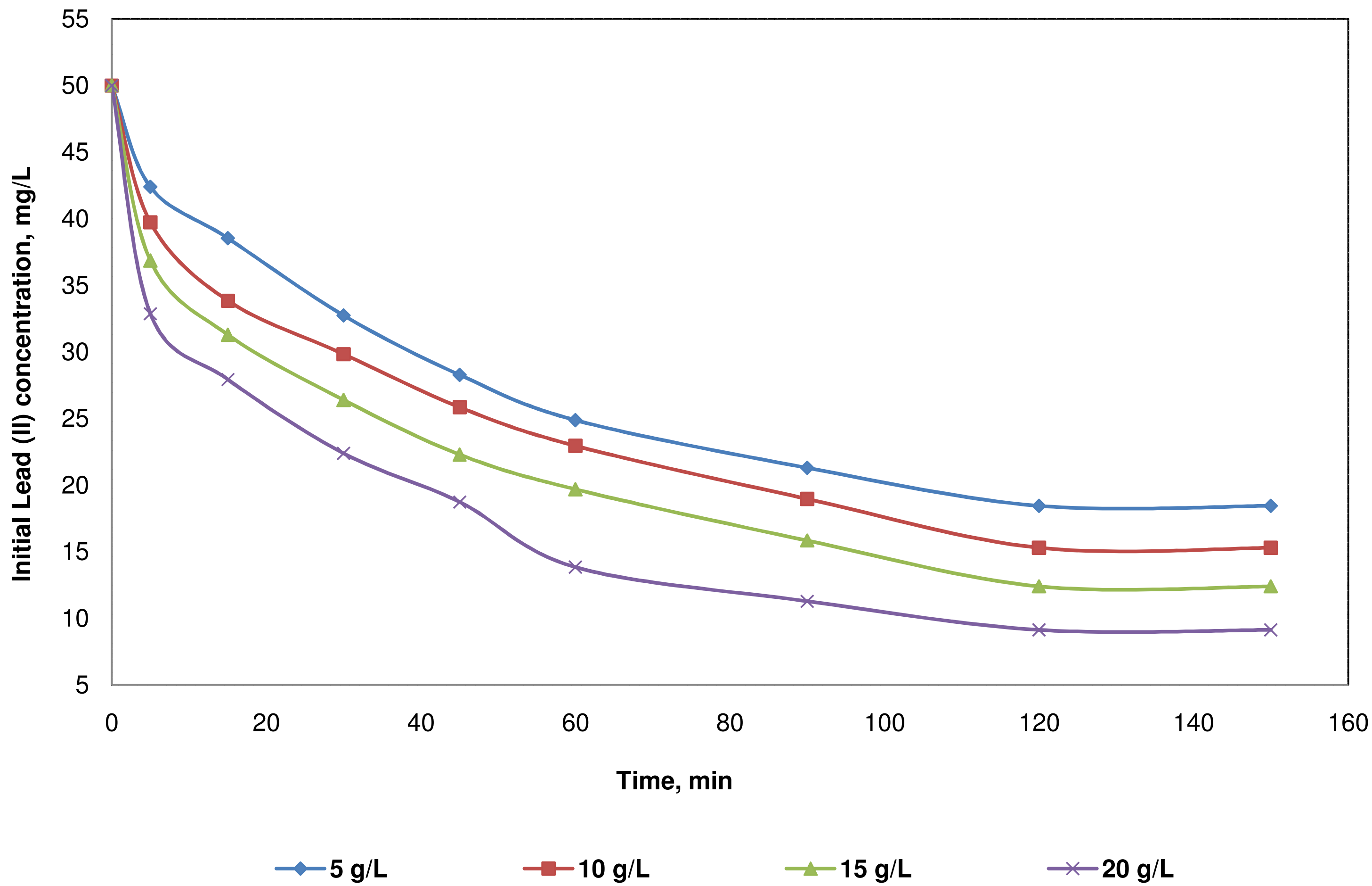
V = volume of metal solution (lit).

C_i = Initial concentration (mg/L).

C_f = *Final* concentration (mg/L).

w = Mass of the adsorbent (gm).

Pb (II)-Equilibrium time



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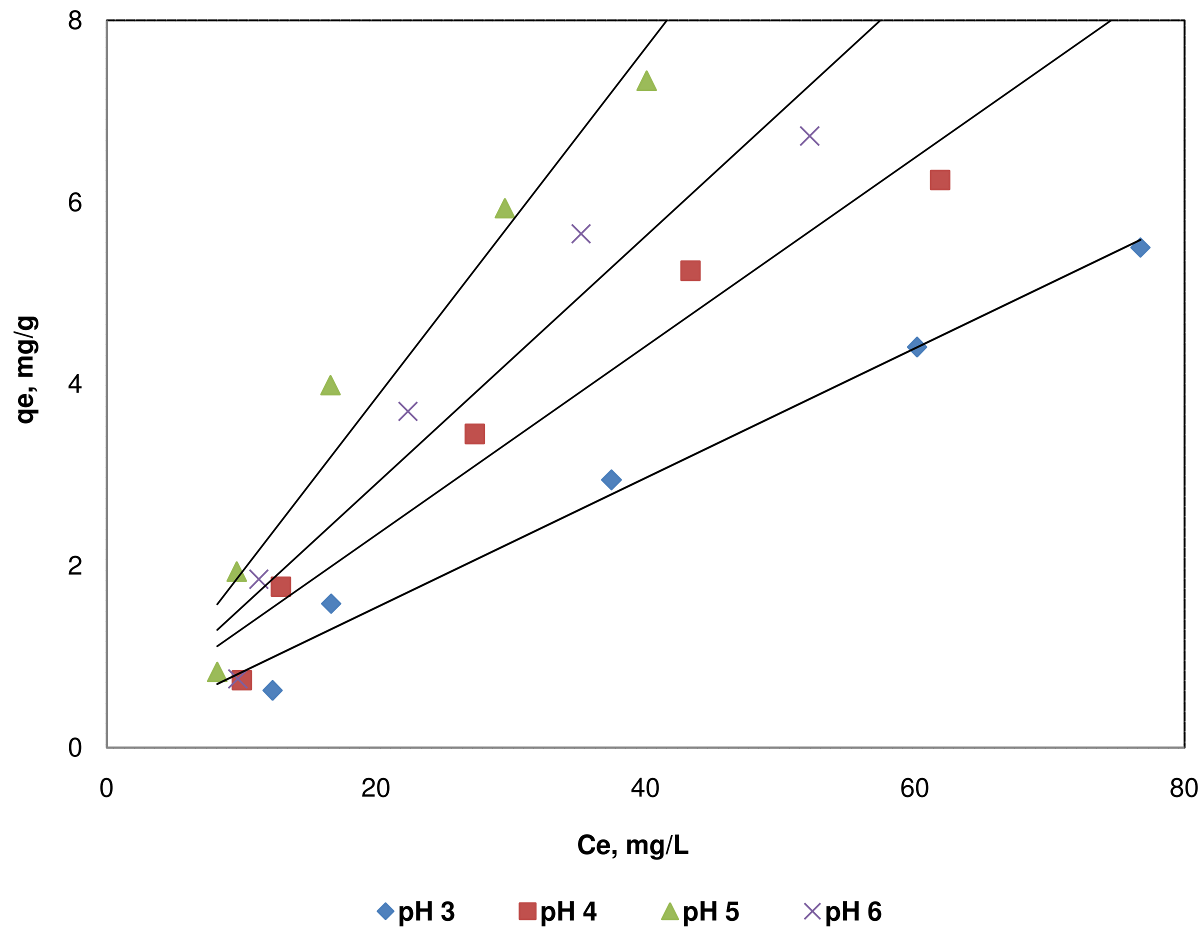
Effect of pH



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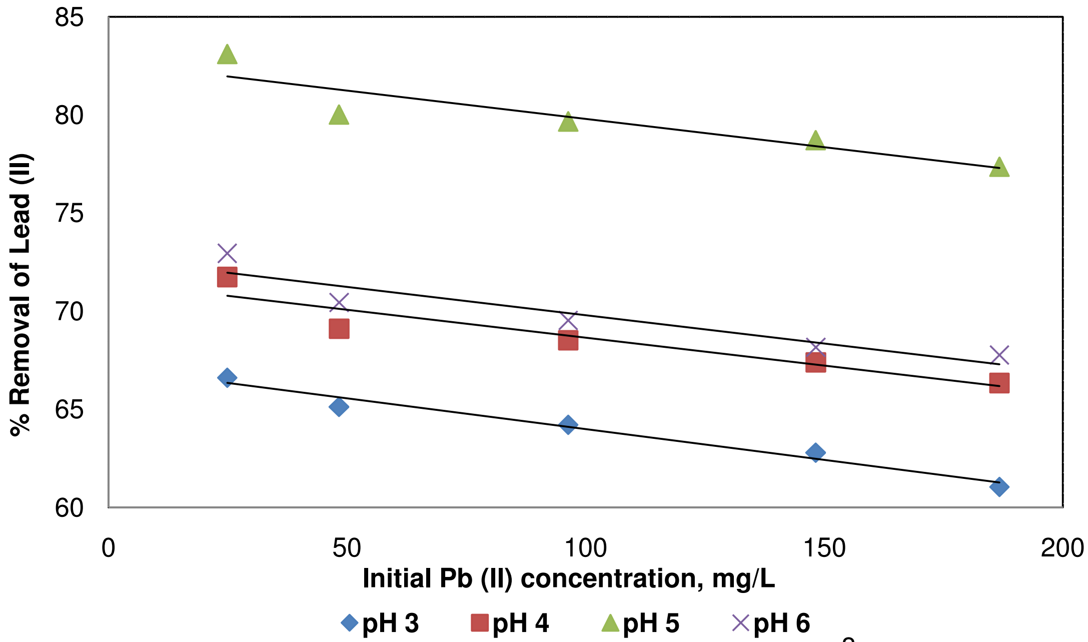
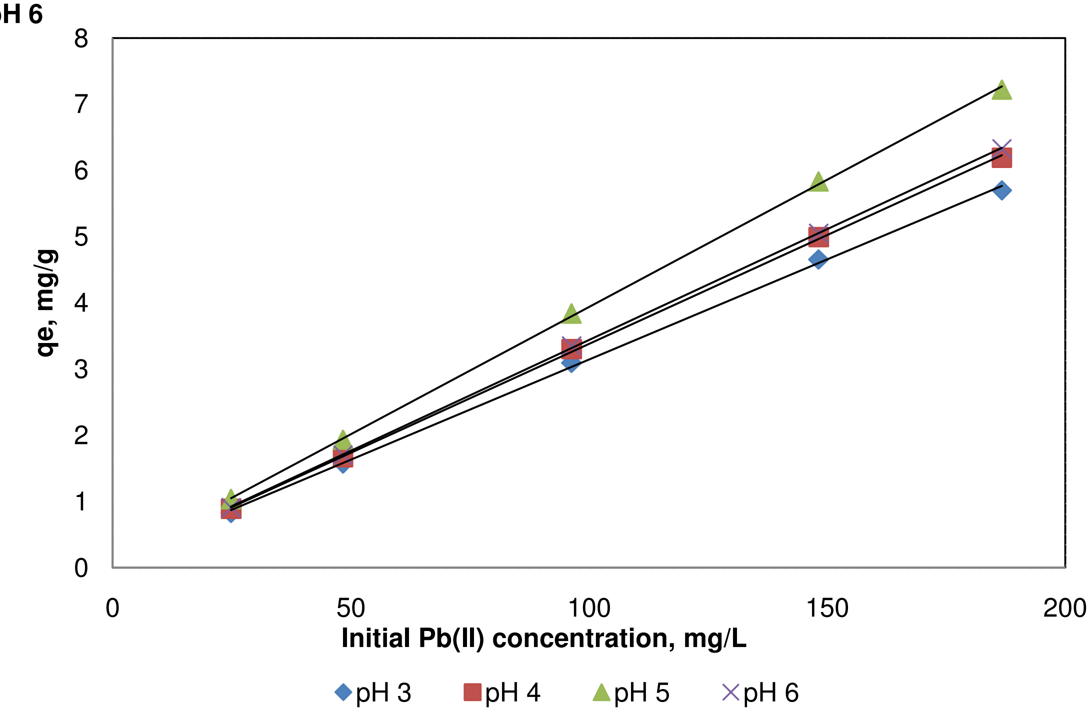
Effect of Initial metal Conc.





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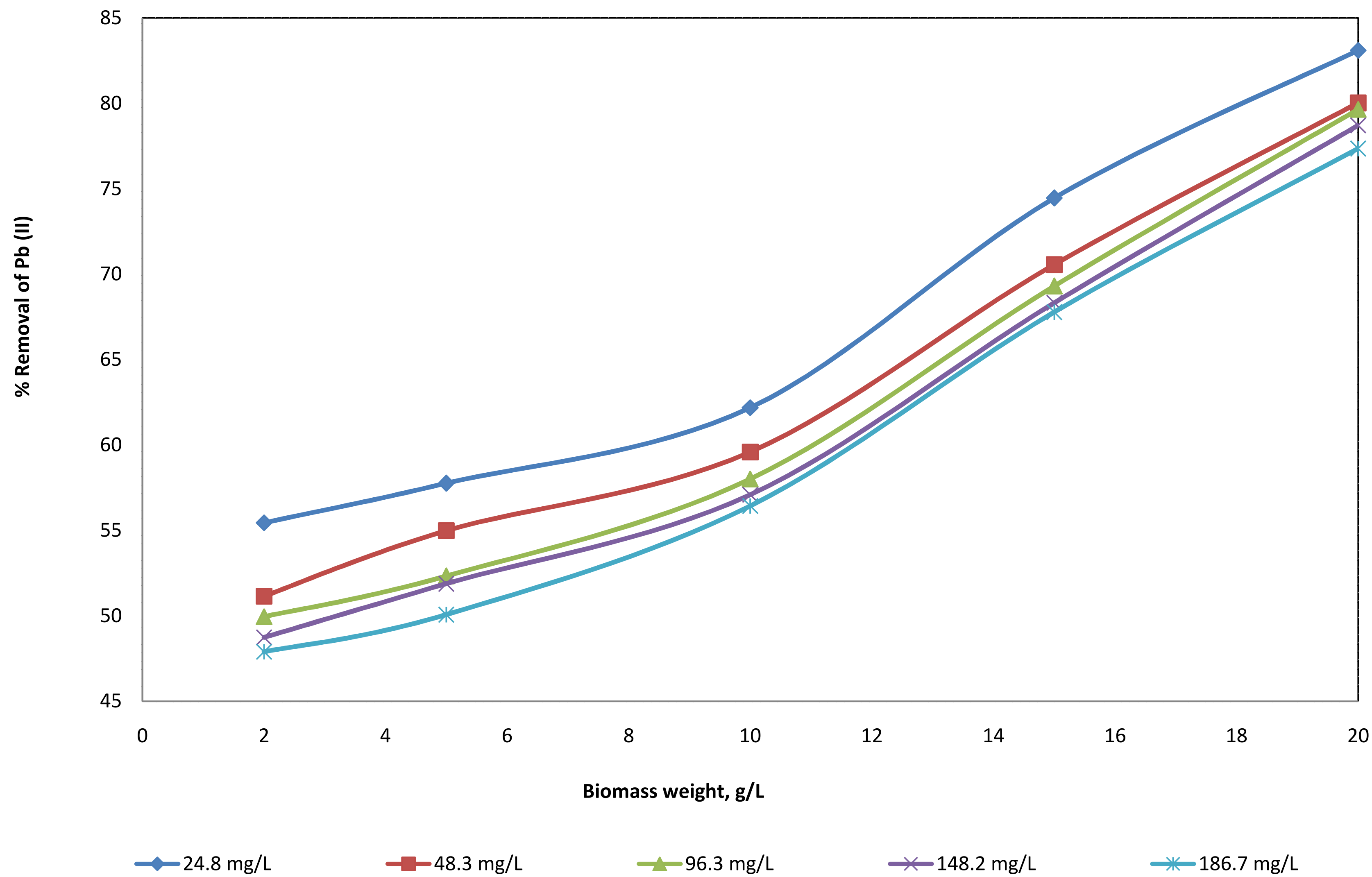
Effect of Biomass weight



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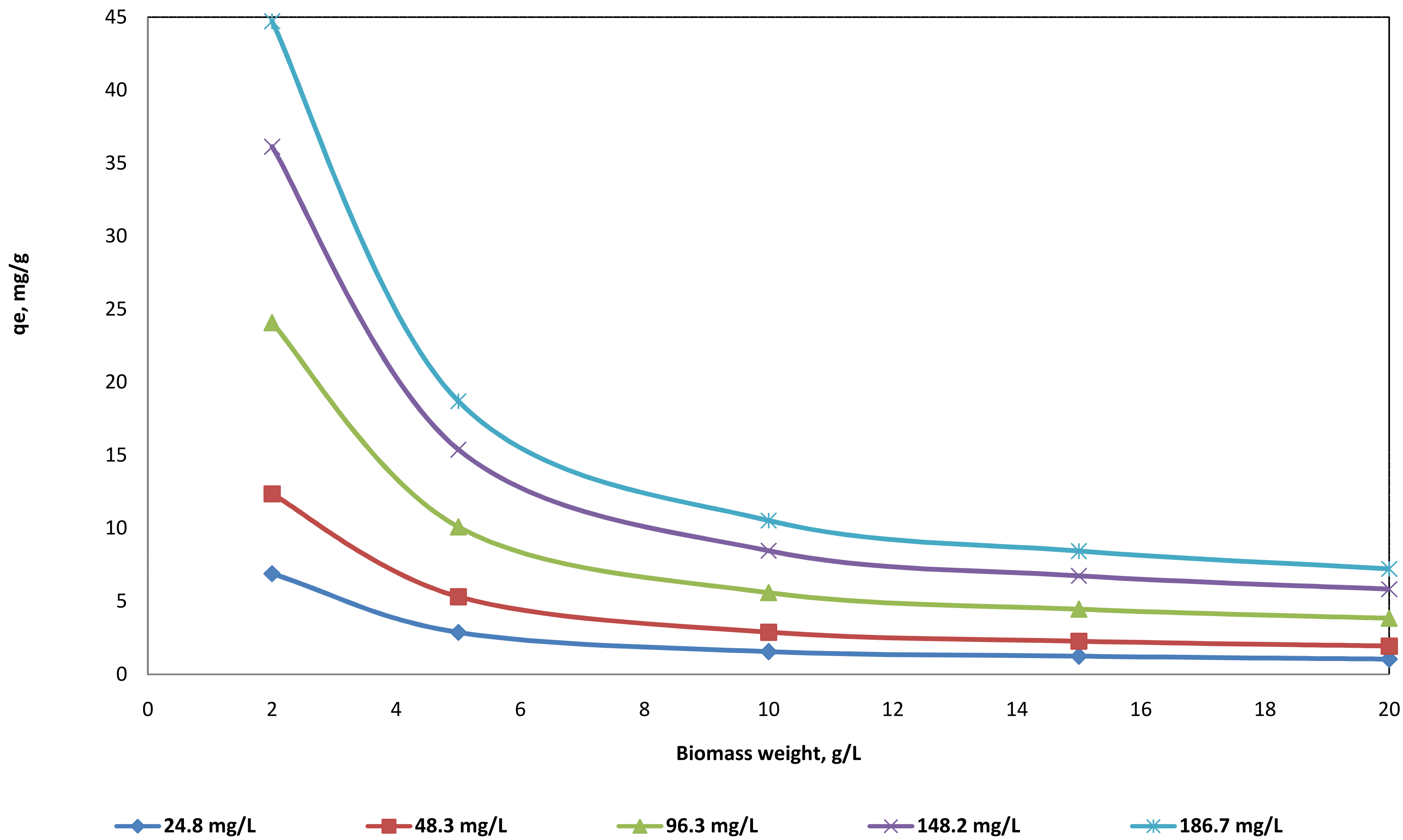
Effect of Biomass weight



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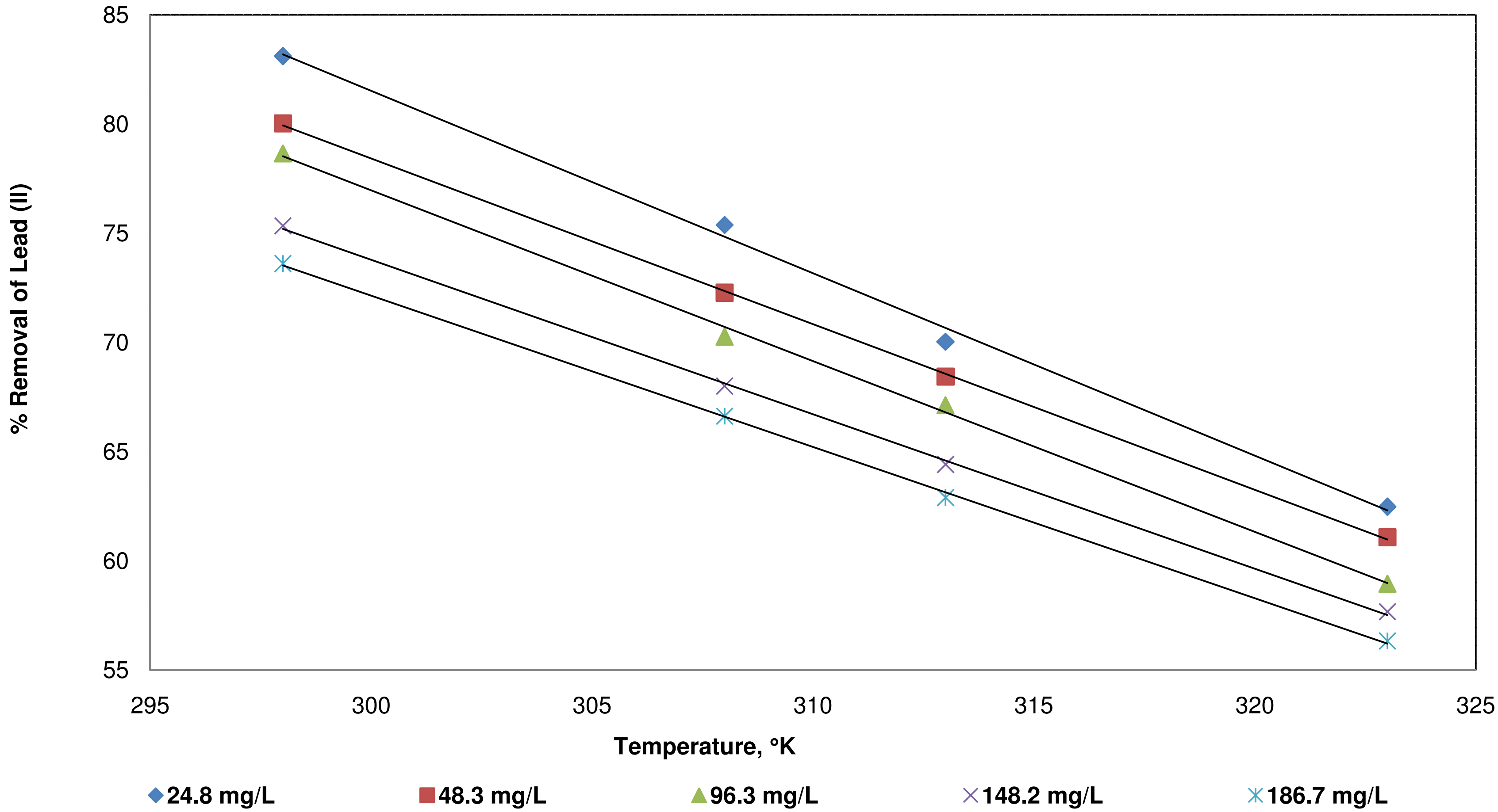
Effect of Temperature



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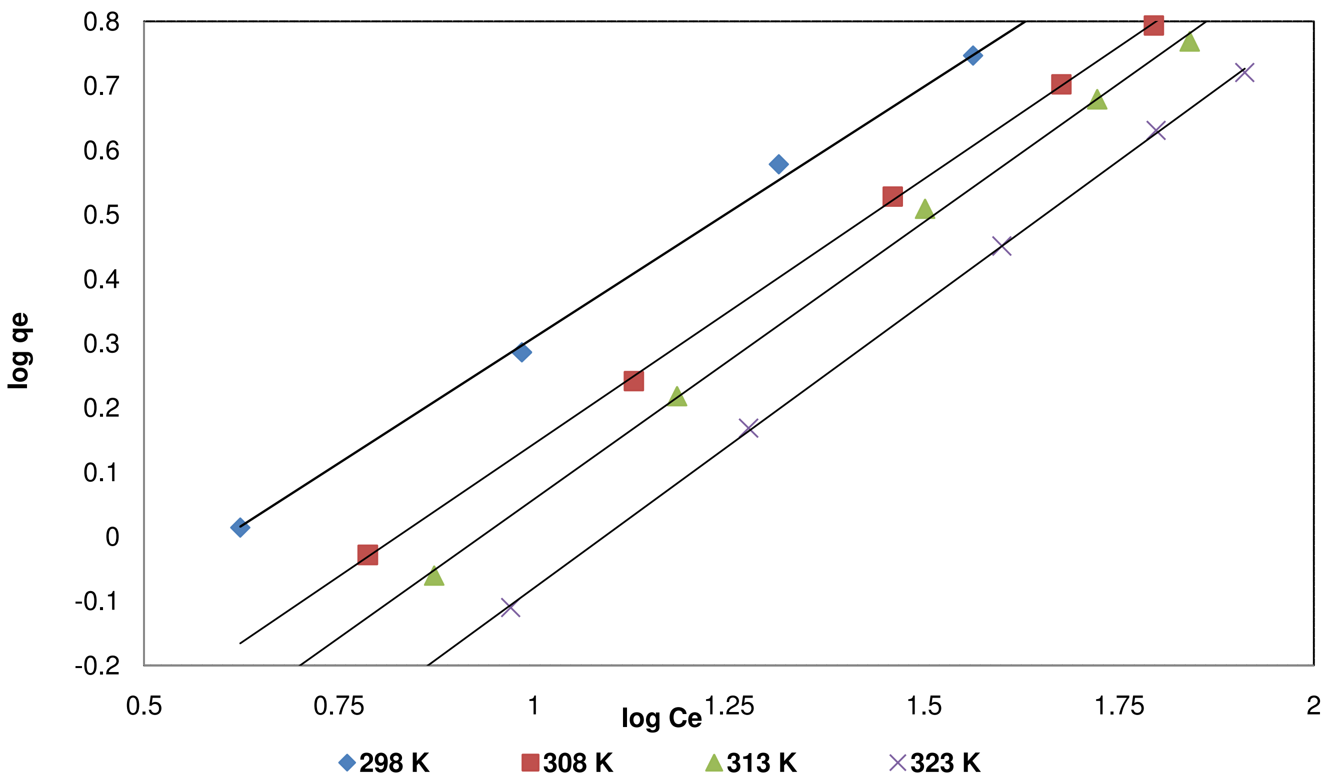
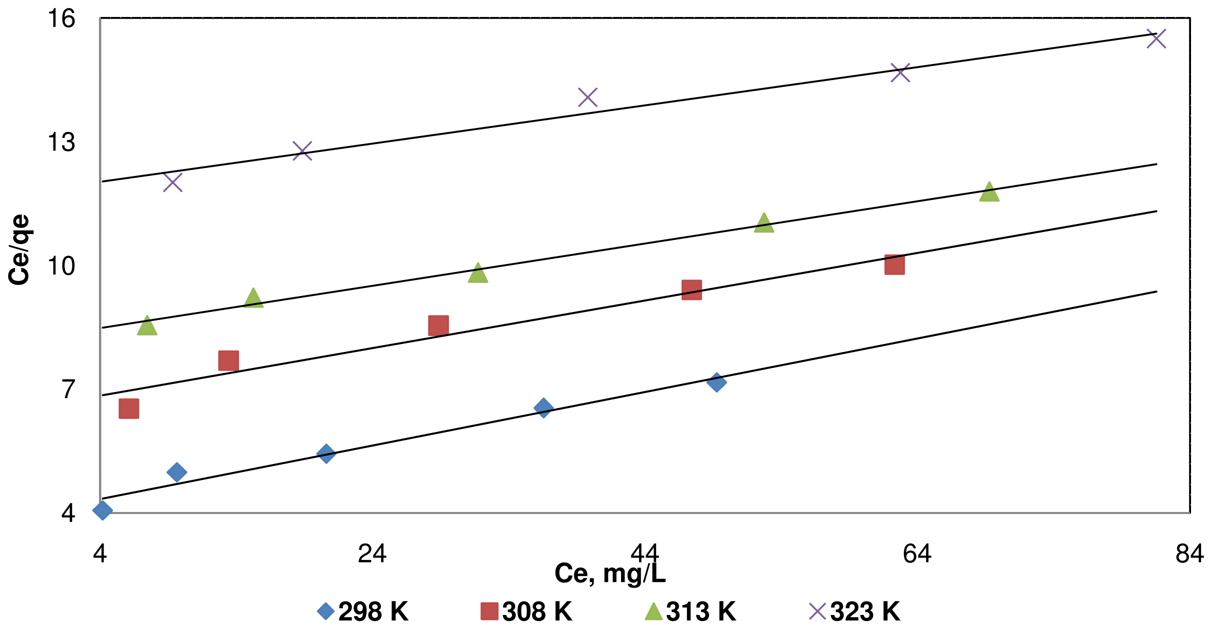
Pb(II)- Freundlich Isotherm

TEMP^0 K	K_F {mg g^{-1})(mg L $^{-1}$)^n}	n	R^2
298	2.95053	1.283532	0.9981
308	4.762116	1.216545	0.9997
313	6.343077	1.162115	0.9987
323	9.206615	1.130454	0.9998



Pb(II)- Langmuir Isotherm

		$Ce/q_e=C_e/q_m +1/K_L q_m$			
Temp		qm	1/KL	KL	R^2
298	298	9.756098	50.93659	0.019632	0.9698
308	308	10.02004	66.52505	0.015032	0.9482
313	313	12.67427	109.4829	0.009134	0.9931
323	323	14.51379	154.3541	0.006479	0.9694



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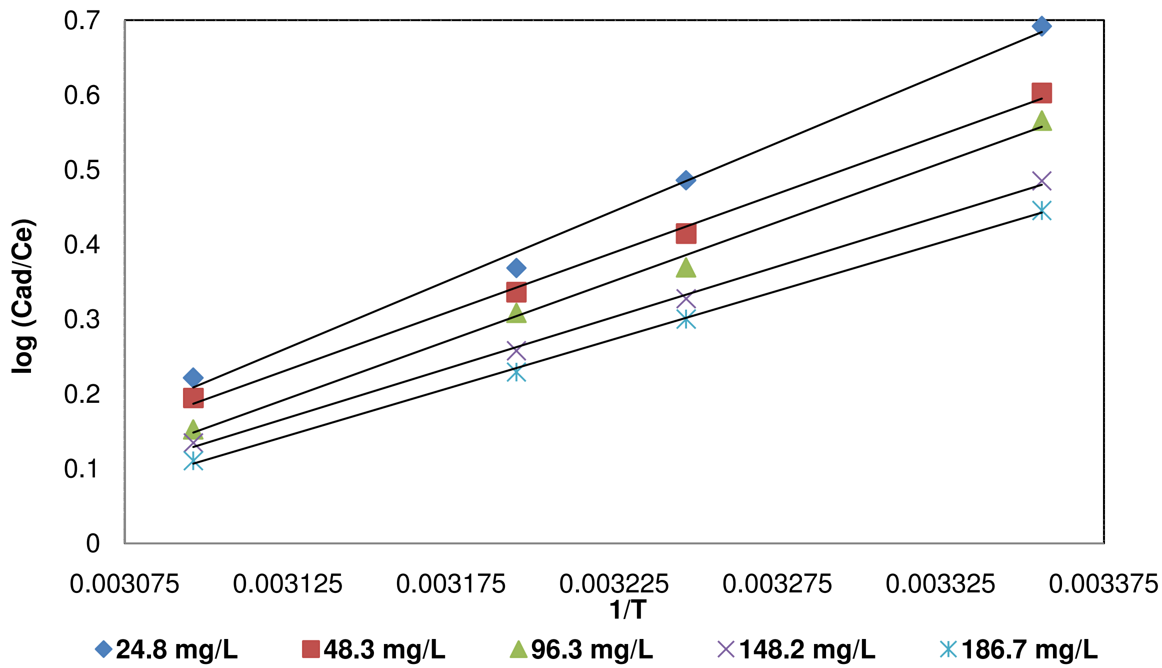
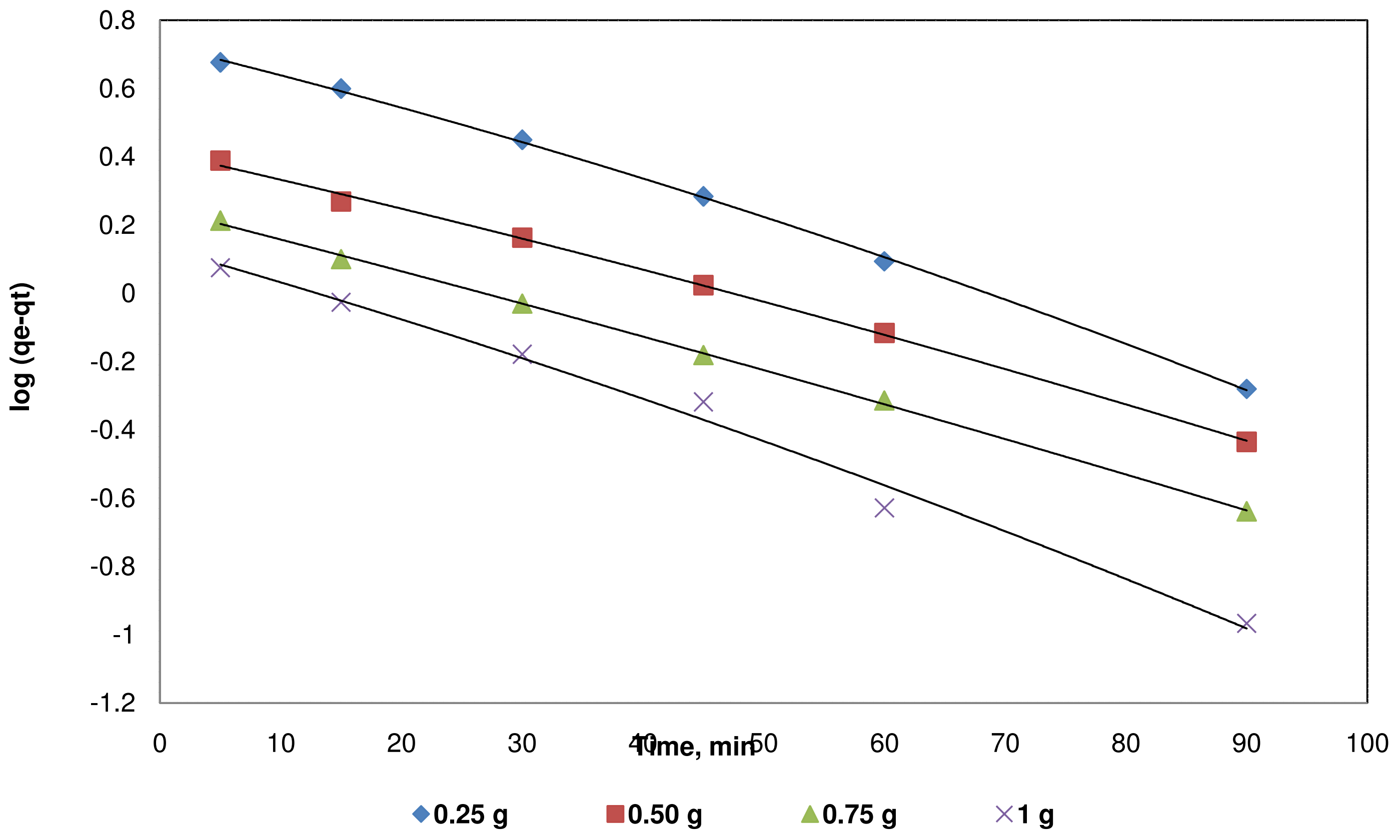
Pb(II)- Thermodynamics



CT	ΔH	ΔS	T	Δg=h-ts
24.86	-35.0393	-104.488	298	31.10235
48.319	-30.0725	-89.5282	308	27.54462
96.34	-30.1357	-90.4626	313	28.28465
148.23	-25.8506	-77.5612	323	25.02643
186.71	-24.7362	-74.5437		31.10235

- Enthalpy Change is negative, so the process is Exothermic nature.
- Gibbs free Energy change is negative it indicates spontaneous process.

Pb(II)- Kinetics
First order kinetics



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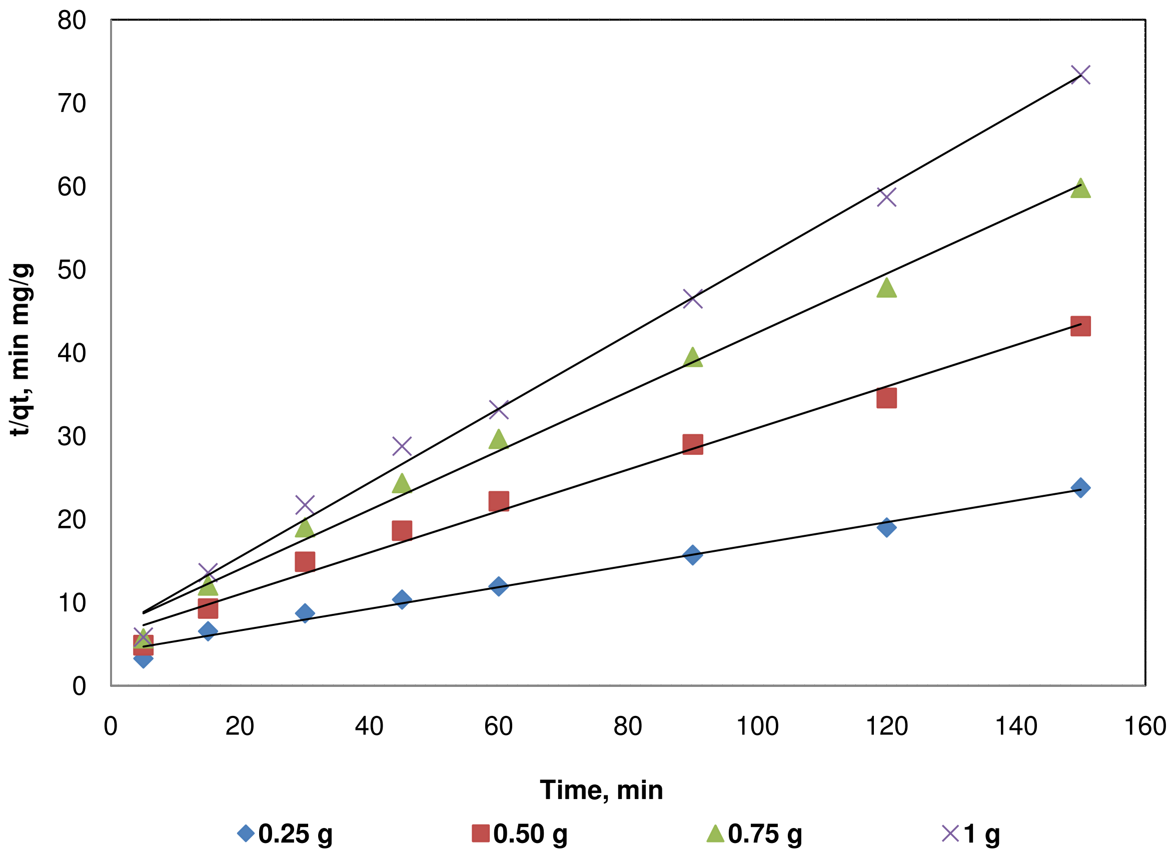
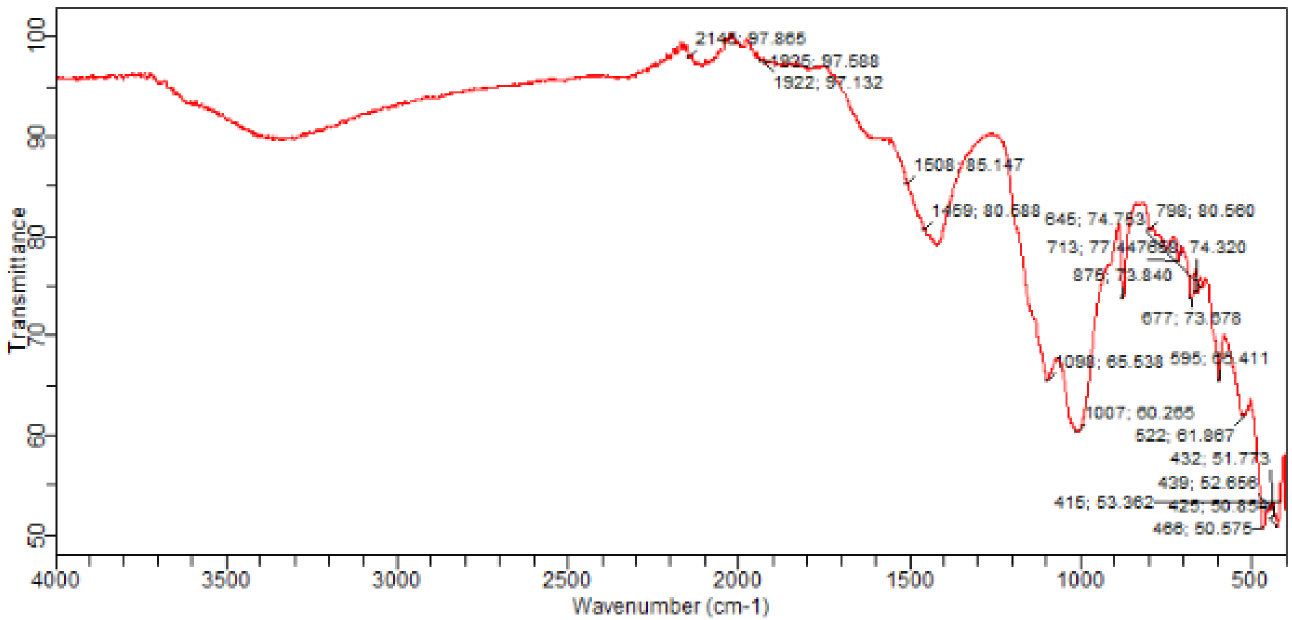
Pb(II)- Kinetics
Pseudo Second order kinetics

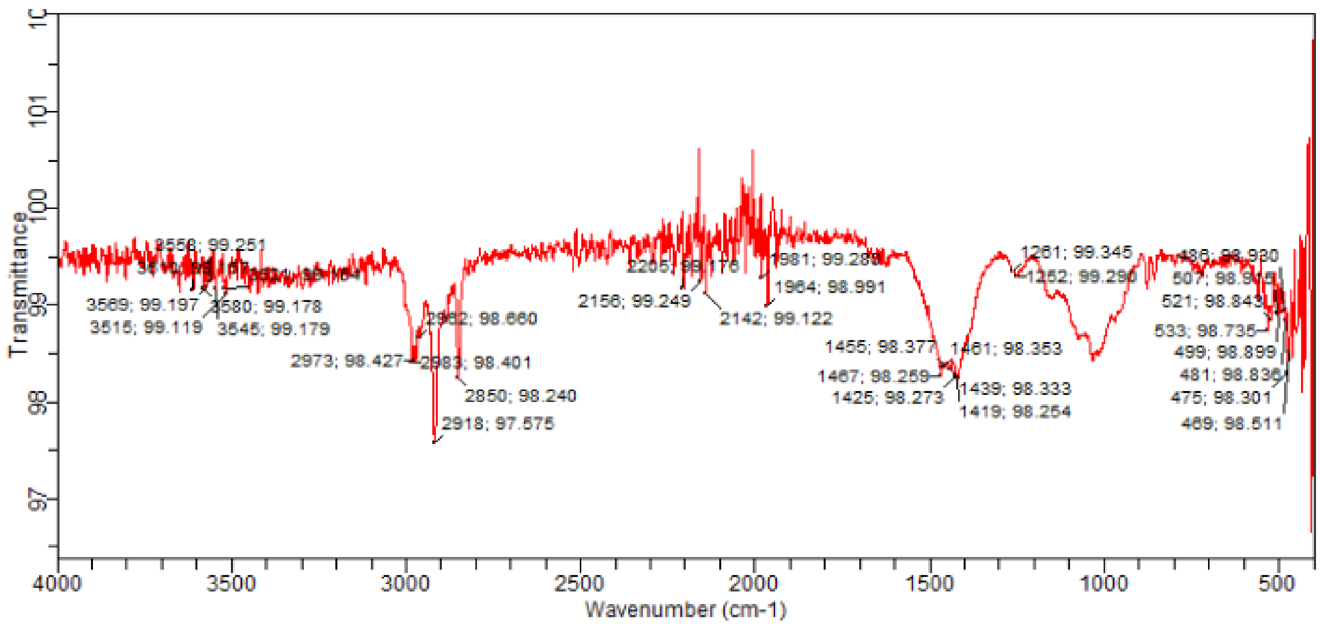


B.W	qe	qe2*constant	K
0.1 g	7.686395	237.9238	0.001355
0.25 g	4.00641	96.43634	0.01037
0.5 g	2.816901	54.77959	0.018255
1 g	2.250731	33.49399	0.029856

- From the Equilibrium kinetics second –order model is well satisfied.



Unloaded *S. cenereum*



Pb (II) loaded *S. cenereum*

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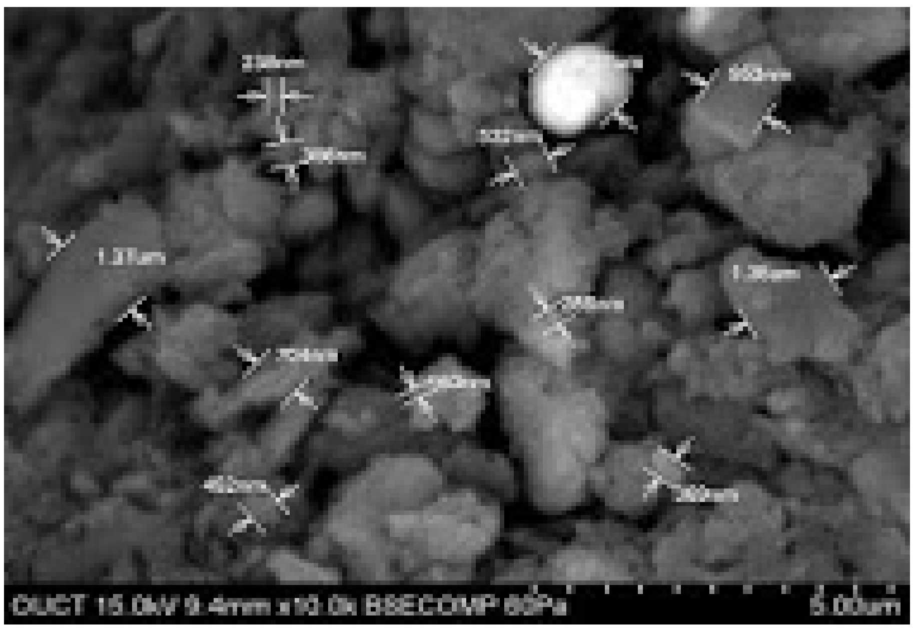
S.No	Band shift position, cm^{-1}		
	Un loaded Biomass	Loaded with Pb^{2}	Description
1	2947.68	2918	C–H stretching vibrations due to lignins (Ahmet et al., 2007)
2	2145.97	2156	Thiocyanate (–SCN)
3	1925.97	1964	Combination of aromatic bonds
4	1508.85	---------	–NH stretching vibration at peptidic bond of protein (Hui and Yu, 2007)
5	1459.80	1439	Symmetric bending vibrations of alkane bonds (–CH_3) (Ahmet et al., 2007)
6	1098.65	1078	C–N, PO^{3}_{4} (ortho phosphate) and organic siloxanes (Deepa et al., 2007)
6	1007.60	1013	C–O characterized by polysaccharides in the biomass (Sujoy and Arun, 2007)
7	876.73	865	(–CH)- 1,3 substitution at aromatic aryl rings
8	798.80	---------	presence of siliceous (Si–C) (Vítor et al, 2009)

Unloaded *S. cenereum*



Pb (II) loaded *S. cenereum*

After Pb^{+2} adsorption the particles have granular, complex, uneven and porous surface textures that were not found in the native biomass *S. Cinereum* algal powder. The similar results were observed in case of Cd^{+2}, Cu^{+2} on the surface of the *Acacia leucocephala* bark powder (Subbaiah et al., 2010).

Conclusions

- **Uptake of metal ions by adsorbent increases with increases in adsorbate concentration.**
- **Uptake of metal ions increases with increase in pH of solution up to certain extent and then decreases.**
- **Decline in sorption capacity with increasing the temperature may be attributed to the physical adsorption.**
- **From the linear Isotherm analysis it is clear that the Freundlich Isotherm well satisfied than Langmuir models.**
- **The coefficients of the model equation are good agreement with the values obtained in graphical analysis.**
- **The metal uptaking capacity is 7.22 mg/g at pH 5.**

- The significant change in the wave number reveals, that the involvement of the C–H stretching vibrations (lignins) (Ahmet et al., 2007) and Thiocynates in the biosorption process
- **After Pb^{+2} adsorption the particles have granular, complex, uneven and porous surface textures that were not found in the native biomass *S. Cinereum* algal powder.**
- ***S. Cinereum* is promising biomass useful for the removal of Pb(II) from waste water.**

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