Standardization of Bone Char Preparation for Drinking Water Defluoridation

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OUTLINE

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- Results
- Conclusion and Recommendation

Introduction

- Fluoride in drinking water can be beneficial or dangerous to human kind depending on its concentration.
- The permissible levels of fluoride as per WHO guidelines is 1.5mg/L (WHO 2011) and as per TBS guidelines is 4.0 mg/L (TBS 2003)
- There is no treatment for fluorosis, which leaves prevention as the only means of controlling the disease

Background Work

- Previous work involved charring bones between 400°C to 600°C but the physical properties, i.e, surface area, pore size distribution and morphology were not studied.
- As a result there is no consistent data for developed properties of BC, hence different mechanism of fluoride removal.

Effect of fluoride ingestion

Dental fluorosis (mottling of teeth)

skeletal fluorosis, bone malformation

Crippling fluorosis

Crippling fluorosis

Objective

- To standardize bone char preparation for fluoride removal

Method and Materials

i. Water samples were collected and fluoride concentration were mapped:

- 500 ml polythene bottle

ii. BC preparation:

- Calcination temperatures: 400 ^{o}C, 500 ^{o}C, 600 ^{o}C for 3hrs each
- Rate of heating: 8 ^{o}C/min to calcined temperatures

Method and Materials....

- BC was grinded and sieved: 250-500µm, 500-1000µm, 1000-1800µm

- BC surface area and pore volume were determined by BET analysis

- BC surface morphology was determined by SEM

Methods and materials…..

1. Conducted Column experiments in order to:
   - Assess effect of temperatures and particle sizes on fluoride removal
   - Determine BC fluoride removal capacity.
   - Develop empirical method for predicting treated water volume at known initial fluoride concentrations, flow rate and bone char dosage

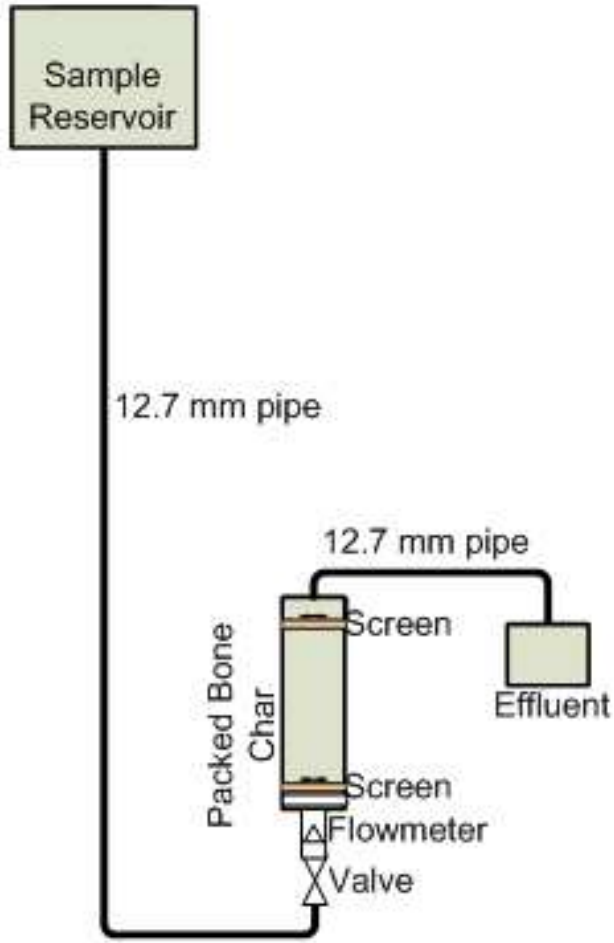
Method and materials….

2. Conducted Batch experiment in order to:

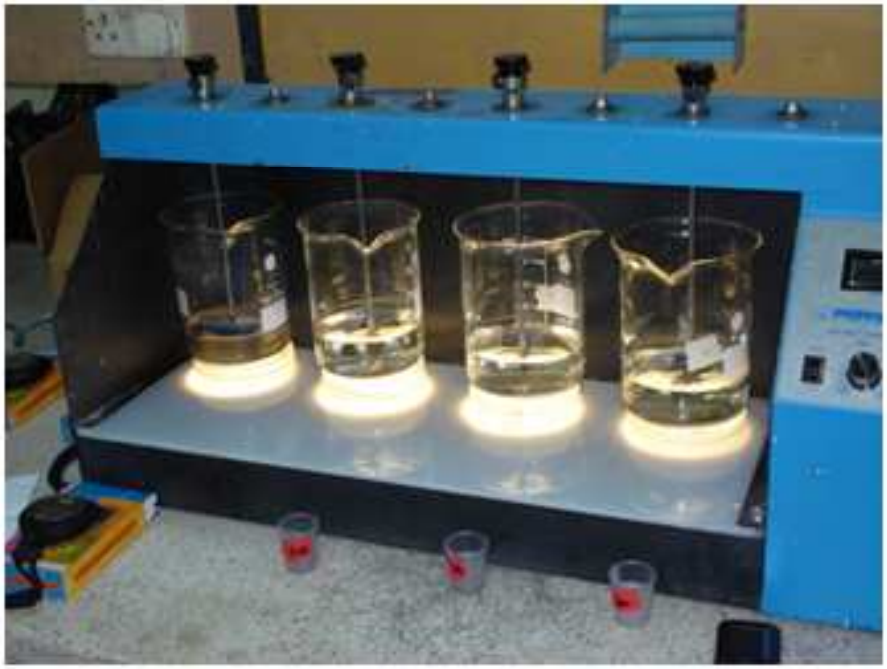
- Determine BC equilibrium adsorption isotherms (Langmuir and Freundlich isotherm models)

- Determine removal kinetics of the prepared BC.

Experiment set up



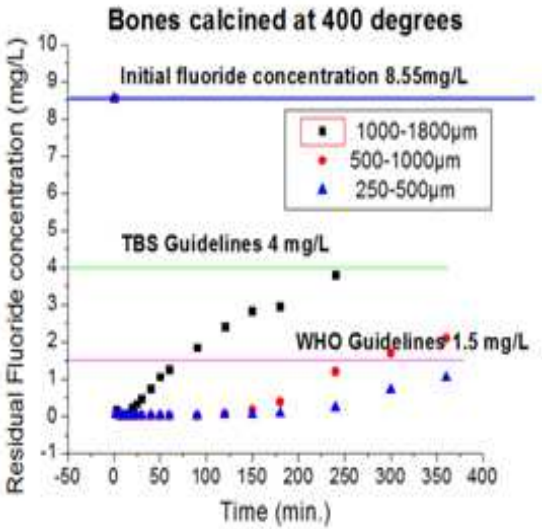
Column Experiment set up

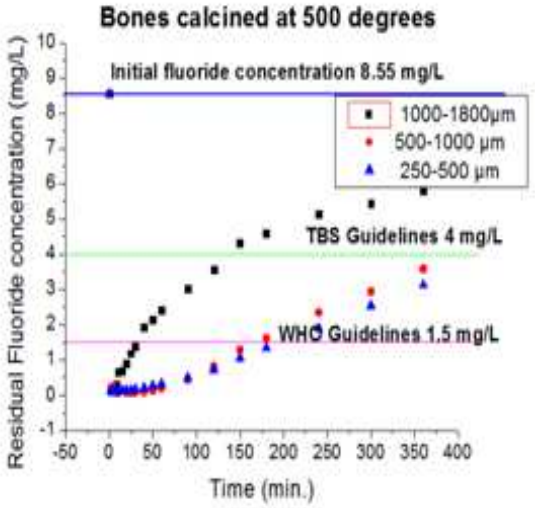


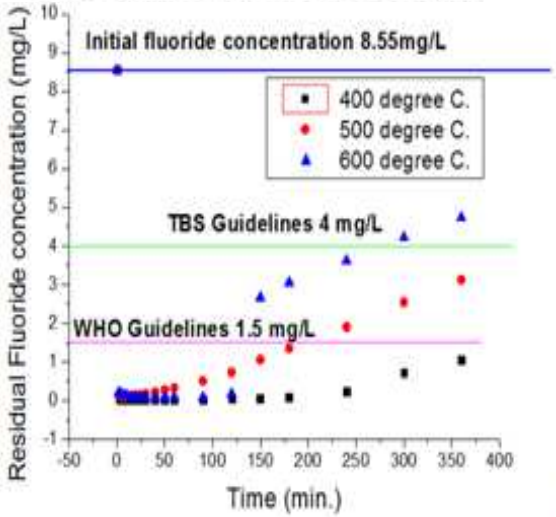
Batch Experiment set up

RESULTS

Effect of particle size and calcination temperature on fluoride removal

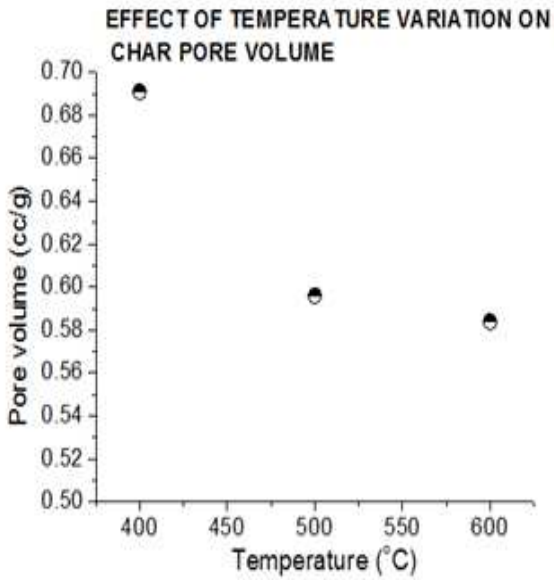


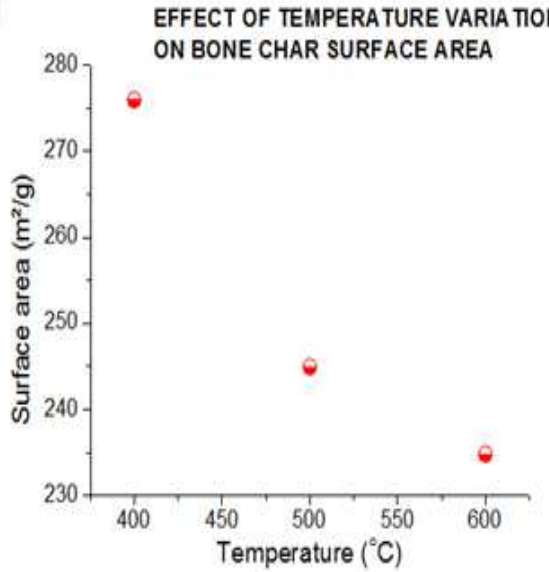


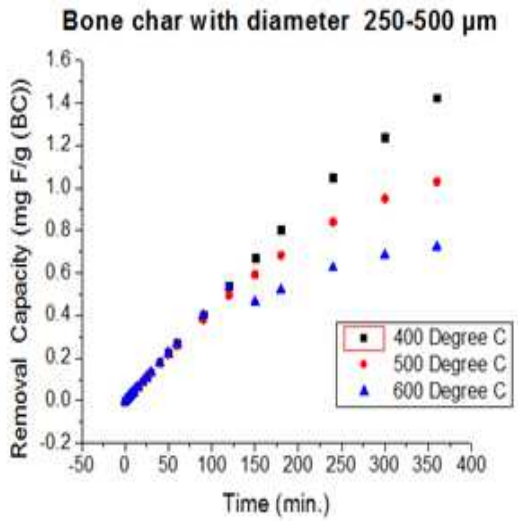


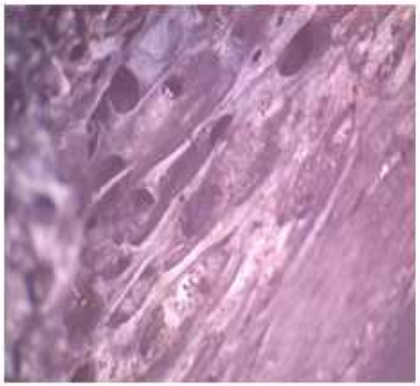
Effect of bone char calcination temperature on fluoride adsorption

BC preparation







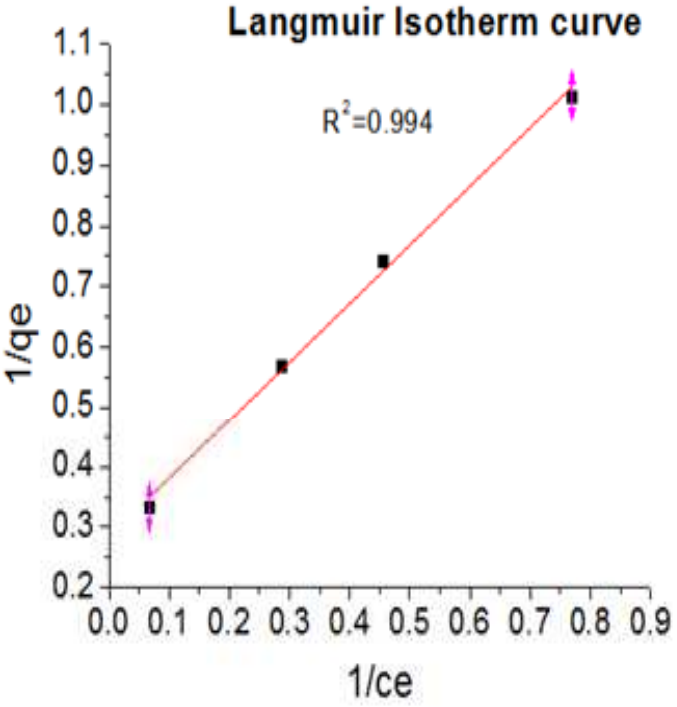


Calcined at 400°C Calcined at 500°C Calcined at 600°C

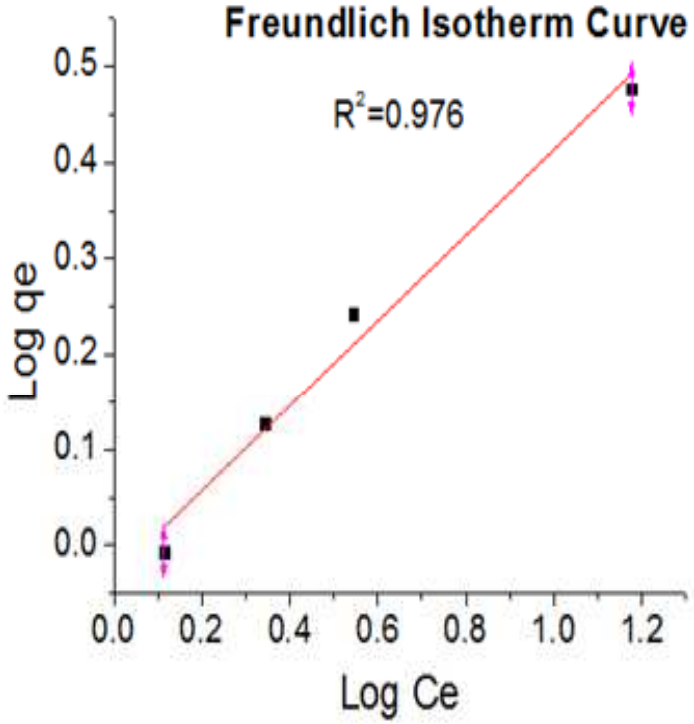
Characterization of bone char

RESULTS....

Langmuir linear egn: $\frac{1}{q_e} = \frac{1}{Q} + \frac{1}{Qb} * \frac{1}{C_e}$



Freundlich linear eqn: $\log(q_e) = \log(K_d) + \frac{1}{n} * \log(C_e)$



Isotherm Parameters

Temp. (°C)	Q (mg/g)	b (L/mg)	r	1/n	K_d (L/g)
400	3.512	0.294	0.1394	0.44552	0.9289

Results….

- If the value of r (separation factor) is between 0 and1, indicates that the adsorption process is favorable (Hameed et al., 2008; Mitali et al., 2006)

- If the value of 1/n is below one indicates a normal and favorable adsorption process (Dada et al., 2012)

Reaction kinetics

- **Pseudo first order**

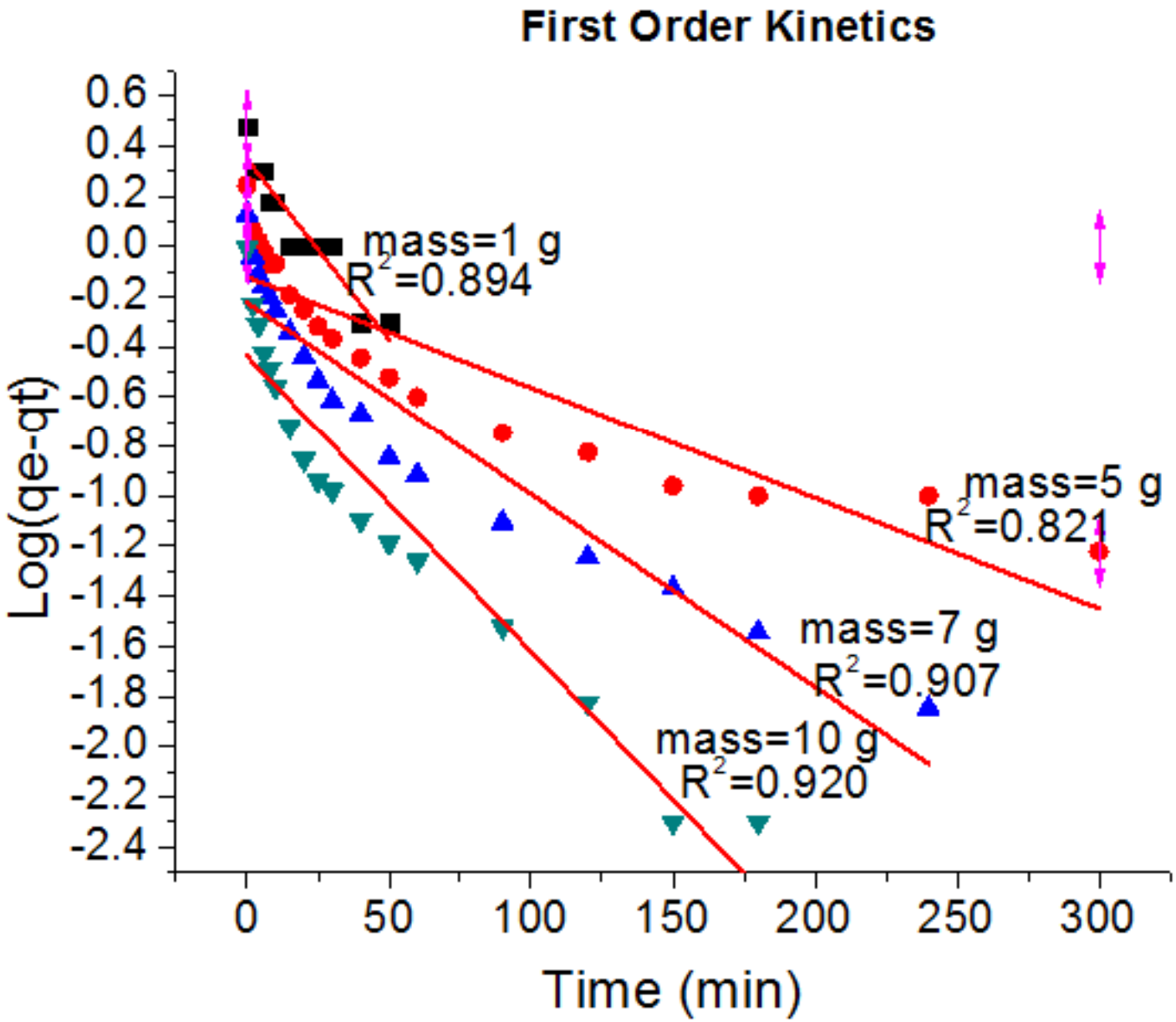
$$\log(q_e - q_t) = \log q_e - \frac{k_1 t}{2.303}$$

- **Pseudo second order**

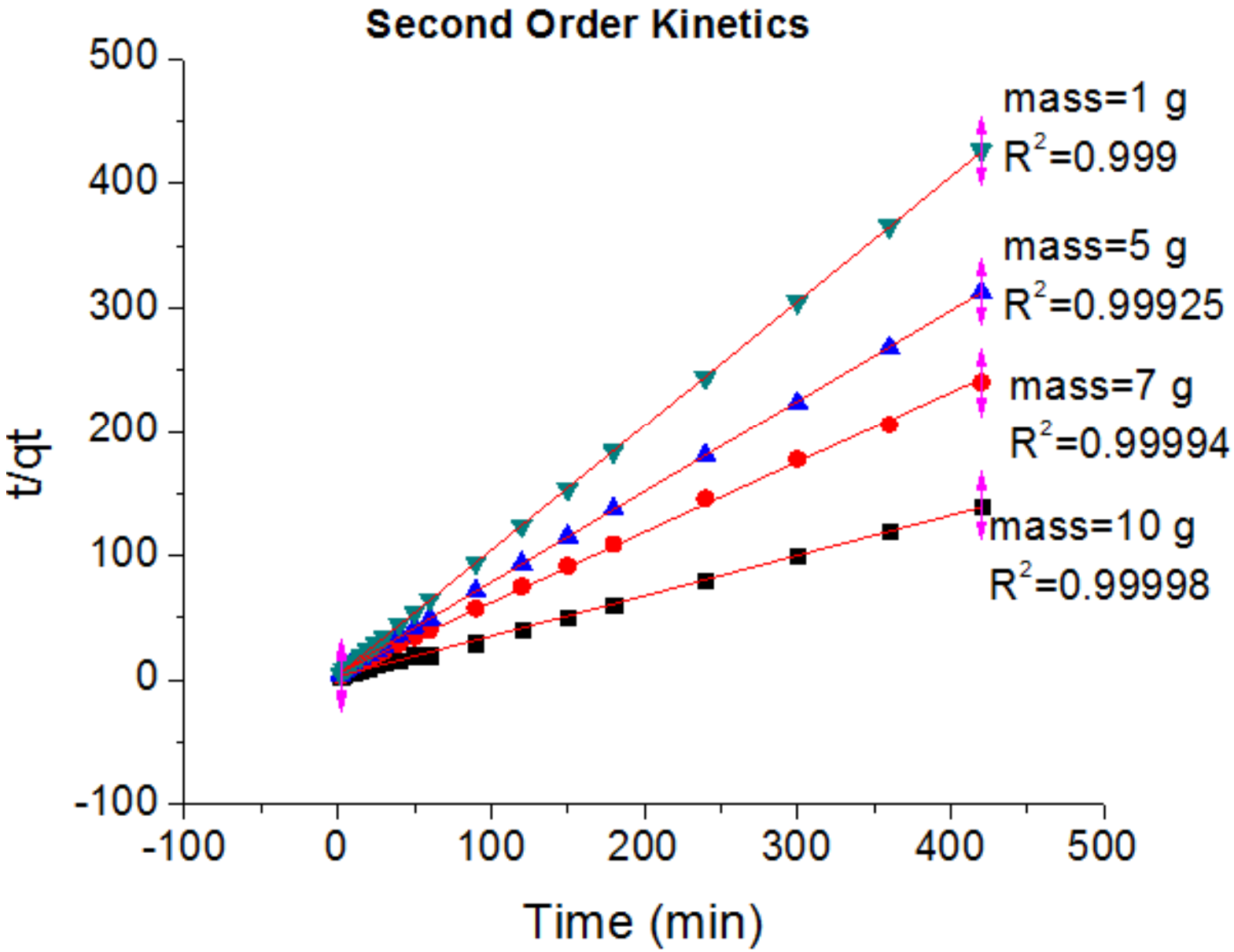
$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t$$

- **Note that for the model to be applicable the plot have to give a linear relationship**

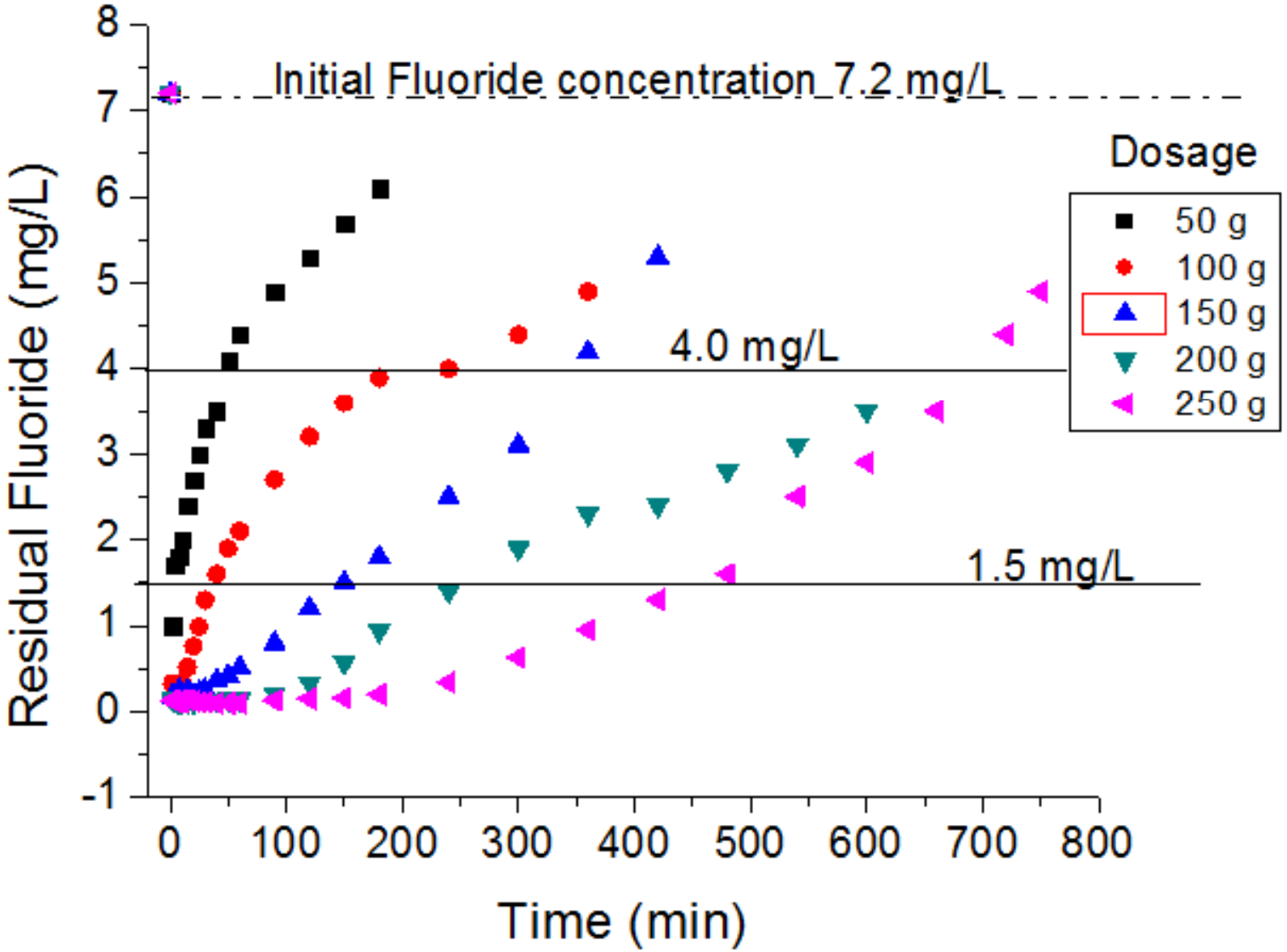
Pseudo first order reaction



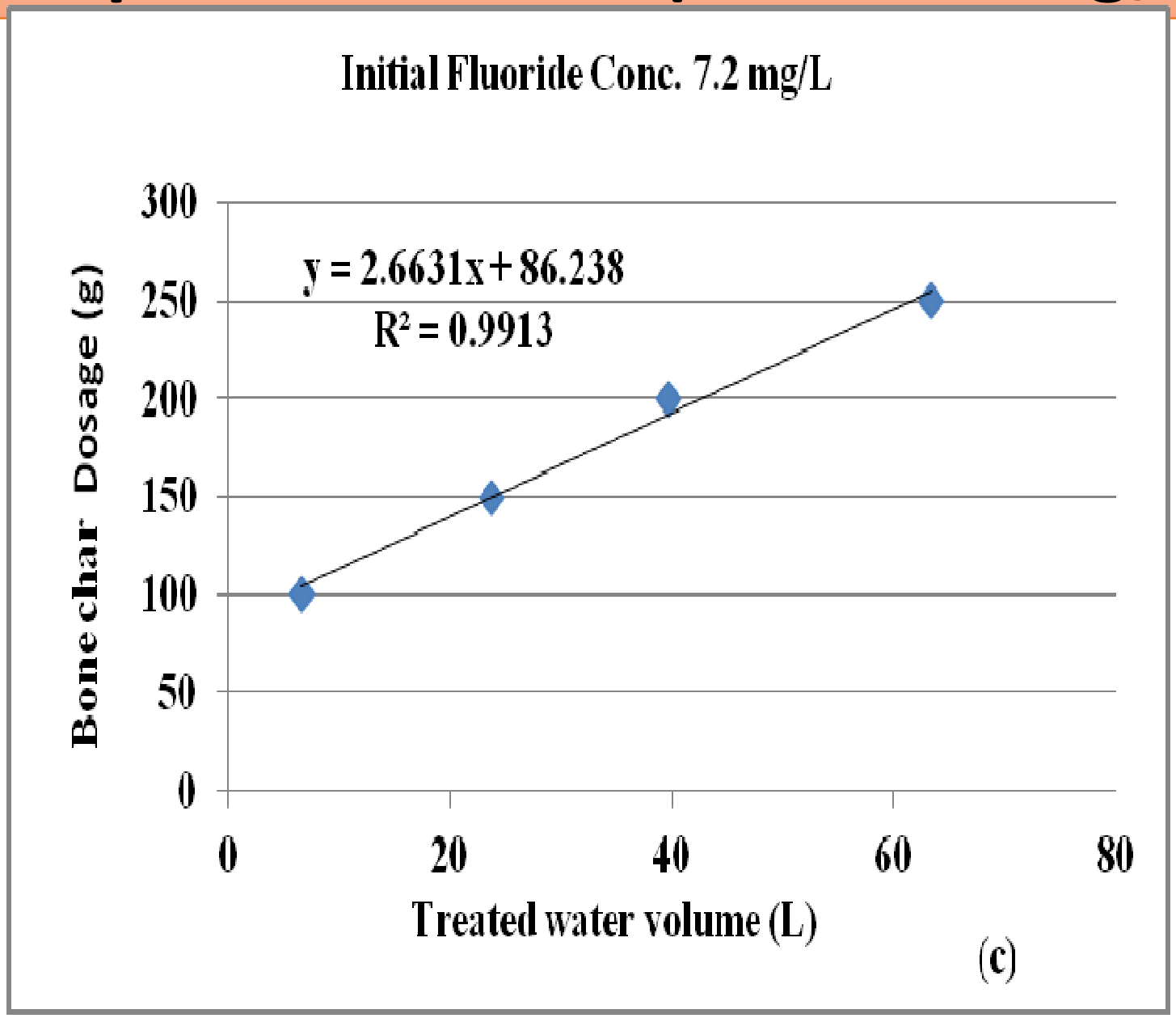
Pseudo second order reaction



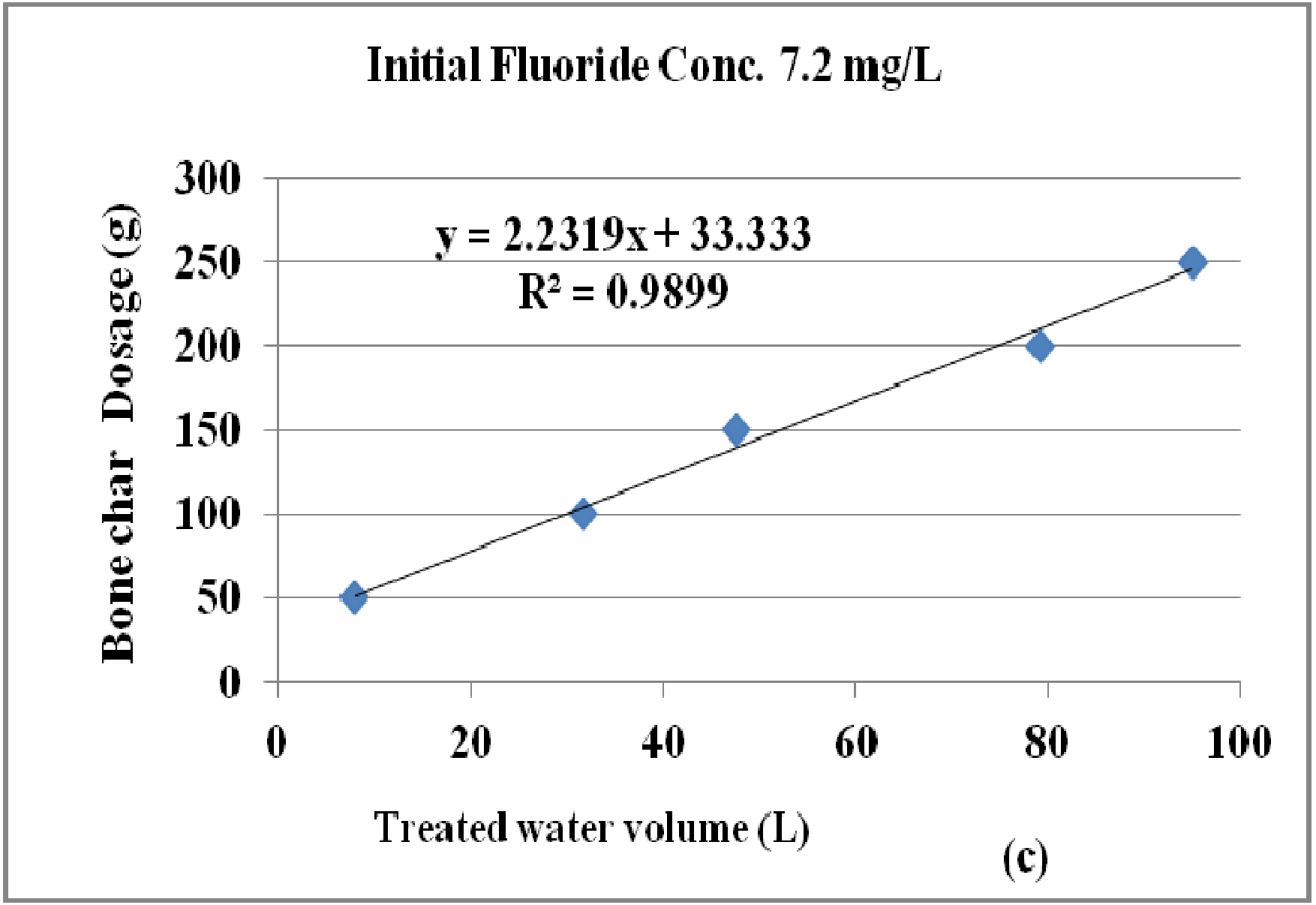
Predicting Best fit equations



Empirical Formula (Limit:1.5 mg/L)



Empirical formular (Limit: 4.0 mg/L)



CONCLUSIONS

- Sintering effect on the surface of BC was increased as the calcination temperature was increased from 400 ^{o}C to 500 ^{o}C and 600 ^{o}C.
- Favourable preparation condition for calcination of BC and particle sizing were found to be 400 ^{o}C for three hours attained at heating rate of 8 ^{o}C/min and particle sizes ranging of 250 - 500 µm.

Recommendations

- This work present a basic understanding on mechanism behind the fluoride removal by BC based on developed properties of the adsorbents
- The bone char calcined at heating rate of 8 ^{o}C/min to 400 ^{o}C and charred for three hours with diameter of 250 -500 µm is recommended to be used for large discharge volumes.

Papers published

- 1. Mbabaye G.K., Mtalo F., Minja, R.J.A., Legonda I. (2017). Standardazing deflouridation of community waters using bone char. *Journal of water supply: Research and Technology-AQUA /66.2/2017 page 131*. (Published)
- 2. Mbabaye G.K., Mtalo F., Minja, R.J.A., Legonda I., Mkongo G. Flouride occurance in domestic water sources in Tanzania. A case of Meru district Arusha Region. *Tanzania Journal of Science (UDSM)*

- **THANK YOU FOR YOUR ATTENTION**