APPENDIX C:

EQUATIONS USED

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- The generalized form of the **Freundlich** (Freundlich, 1906) equation is

$$q_e = KF\ C_e^{\ 1/n} \qquad \ldots\ldots\ (1)$$

where K_F is the Freundlich isotherm constant related to sorption capacity; n is the constant related to affinity of the Cr VI ion on immobilized beads.

- The **Langmuir** sorption isotherm for a solute in a liquid solution is expressed as

$$q_e = q_m\ b\ C_e / (1 + bC_e) \qquad \ldots\ldots\ (2)$$

where b = binding capacity of the solute on the sorbent surface (L/mg), C = metal ion concentration at any time (mg/L), C_e = metal ion concentration at equilibrium (mg/L), m= amount of cell mass (g), q = amount of metal adsorbed per unit weight of biosorbent (mg/g), q_e = amount of metal adsorbed per unit weight of biosorbent at equilibrium (mg/g), q_m = maximum amount of metal adsorbed per unit weight of biosorbent (mg/g).

- The linearized form of equation (2) is

$$1/q_e = 1/q_m b\ .\ 1/C_e + 1/q_m \qquad \ldots\ldots\ (3)$$

$1/q_e$ vs $1/C_e$ gives the straight line with slope $1/q_m b$ and $1/q_m$ as intercepts. b is the sorption isotherm constant (L/mg).

- **Dubinin-Radushkevich** (D-R) isotherm was used to determine the type of adsorption or adsorption mechanism for remediation of Cr VI by alginate beads. A linear form of D-R isotherm is:

$$lnQ = lnQ_m - k\varepsilon^2 \qquad \text{..... (4)}$$

where Q_m is the Dubinin-Radushkevich monolayer capacity (mg/g), k is a constant related to adsorption energy, and ε is the Polanyi potential which is related to the equilibrium concentration as follows

$$\varepsilon = RT\, ln\, [1 + 1/C_e] \qquad \text{..... (5)}$$

where R is the gas constant (8.31 J/(mol K)) and T is the absolute temperature, K; the constant k gives the mean free energy, E (kJ/mol), of sorption per molecule of the sorbate when it is solution and can be computed using the relationship

$$E = 1/\sqrt{2}\, k \qquad \text{..... (6)}$$

- The first primary isotherm equation used was:

$$q_e = [(C_0 - C_e)/V] \times M \qquad \text{..... (7)}$$

where q_e is the amount of metal adsorbed (mg/g) on the beads-biomass, at equilibrium, C_0 is the initial metal ion concentration in solution (mg/L), C_e is the equilibrium metal ion concentration in solution (mg/L), V is the volume of the medium (L), M is the amount of the biomass used in the reaction mixture.

- Of the various isotherm models that were studied, the following linearized **Langmuir** equation was used:

$$C_e/q_e = 1/Q^0 b + C_e/Q^0 \qquad \text{..... (8)}$$

Where Q^0 is the amount of adsorbate at complete monolayer coverage (mg/g), which gives the maximum sorption capacity of the sorbent and "b" (L/mg) is the Langmuir isotherm constant that relates to the energy of adsorption.

- The **Freundlich** isotherm is expressed as:

$$q_e = K_F C_e^{1/n} \qquad \text{..... (9)}$$

- A linear form of the above expression is:

$$\log q_e = \log K_F + 1/n \log C_e \qquad \text{..... (10)}$$

where K_F is the Freundlich constant and "n" is the Freundlich exponent.