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**\*Corresponding author:** Nwidi IC, Department of Civil Engineering, University of Nigeria,



where  $Q$  is the amount of metal adsorbed per unit weight of adsorbent at equilibrium,  $Q_0$  is the maximum amount of metal adsorbed per unit weight of adsorbent,  $K$  is the equilibrium constant,  $C_0$  is the initial concentration of metal in solution, and  $C$  is the concentration of metal in solution at equilibrium.

Differentiating equation (17) with respect to time  $t$ , we get:

$$-V \frac{dC}{dt} = -K(C_0 - C)V \quad (18)$$

where  $V$  is the volume of the solution,  $dC/dt$  is the rate of change of concentration of metal in solution with respect to time, and  $K$  is the equilibrium constant.

$$V \frac{dC}{dt} = QC_0 - QC, V(-KC) \quad (22)$$

Integrating equation (22) with respect to time  $t$ , we get:

$$\ln \left( \frac{C_0 - C}{C_0} \right) = -KCt \quad (23)$$

where  $C_0$  is the initial concentration of metal in solution,  $C$  is the concentration of metal in solution at equilibrium,  $K$  is the equilibrium constant, and  $t$  is the time.



