Use of Washed Quarry Dust in the Treatment of Industrial Effluents: Case Study of Electroplating Industry

Julius Kalionci Mungathia

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ABSTRACT

This study records laboratory scale experiments to test the efficiency of washed quarry dust in the removal of heavy metals such as zinc and copper from wastewater of electroplating industry, before safe disposal into public sewer. The washed quarry dust collected from Aristocrust quarries in Mlolongo was prepared and characterized for various physiochemical properties. The wastewater samples were collected from Master Platers Ltd, located in Nairobi's industrial area. To determine the heavy metal removal efficiency of washed quarry dust (WQD), samples of wastewater were treated by batch and column adsorption experiments. The concentration of heavy metals in the industrial effluent (C_o) were analyzed and compared to that treated with the adsorbent. The heavy metals analyzed were zinc, copper, cadmium, chromium, arsenic, lead and iron. It was established that zinc and copper concentrations were high in the industrial effluents while the concentrations of other metals were within the requirements of the Kenya Standard; KS1966-2:2007.

Batch adsorption tests were carried out to determine the influence of process variables such pH, washed quarry dust size and contact time in the removal of heavy metals. The experimental results showed that zinc and copper ions' removal efficiency, increased with increasing wastewater pH and contact time up to pH 7 and 120 minutes respectively. After pH 7, removal efficiency decreased with increasing pH. The adsorption of zinc and copper were almost zero after optimum contact time of 120 minutes.

Thereafter, wastewater samples of known heavy metal concentrations (C_o) were passed through the 0.5, 0.75 and 1 M columns at varying flow rate of 6, 9 and 12 ml/min.

Treated samples collected at different depths of WQD column were analyzed for concentrations of zinc and copper ions using atomic absorption spectrometer. The removal efficiency was around 94% and 92% for zinc and copper respectively using column depth of 1 M at a flow rate of 12 ml/min.

The adsorption model adopted was described by extended Langmuir adsorption isotherm since the adsorption process involved competitive adsorption in the presence of more than one heavy metal in the wastewater. The model represented the data well with monosolute correlation coefficient of 0.999 and 0.996 for zinc and copper ions respectively. Bohart-Adams equation was applied in the design of other adsorption columns using the laboratory results of three columns. The service time predicted using Bohart-Adams equation for 0.5, 0.75 and 1m column at a linear flow rate of 1.8 l/min/m^2 were similar to those found in the laboratory column experiment.

From the column experimental results, washed quarry dust filtration has a high potential to be used in the removal of heavy metals from industrial wastewater. Unlike other adsorbents, WQD is readily available, efficient and cost effective.