Abstract

In this study, several natural materials were investigated for their efficiency to be used as adsorbents or coagulants in wastewater treatment. Granular activated carbon (1-1.25 mm), zeolite (0.5-1 mm and 4-6.5 mm) and limestone (0.5-2 mm) were used as adsorbents. Iron (III) chloride hexahydrate ($FeCl_3$ -$6H_2O$) and Aluminium Sulfate 18-hydrate pure ($Al_2(SO_4)_3$ -$18H_2O$) were used as inorganic coagulants. Chitosan, potato starch and eggshells were used for natural coagulants. Tested parameters for the materials were turbidity, conductivity, pH, TN/NPOC concentrations as well as Cl^-, PO_4^{3-}, NO_3^-, NO_2^- and SO_4^{2-} levels. To test these parameters, series of jar tests were setup (400 mL and 10 L) and performed with domestic wastewater sample taken after primary sedimentation. After the experiments, it was found that alum (AL-1), chitosan (Ch-6) and hybrid adsorbent utilizing both activated carbon and zeolite (0.5-1 mm) (ACZ) performed best. ACZ managed to lower the turbidity to 55.40 NTU which is slightly better compared to samples with only activated carbon (59.29 NTU) and zeolite (0.5-1 mm) (61.60 NTU). It managed to remove 46.42% of PO_4^{3-} from wastewater, which is considerably less compared to the removal rate acquired from activated carbon testings (78.95%), however, when activated carbon was found to be leaching SO_4^{2-} into the system, zeolite managed to lower this leaching rate by 50+%. Even though chitosan performed best, potato starch came in close second. Chitosan lowered the turbidity to 2.54 NTU and potato starch to 7.45 NTU. They both showcased impressive removal rates for nutrients. 53.15%, 76% and 72.12% removal rates were recorded for Cl^-, NO_2^- and PO_4^{3-} respectively for chitosan. Meanwhile, 57.12%, 59% and 55.88% removal rates were recorded for Cl^-, NO_2^- and PO_4^{3-} for potato starch. Results have shown that natural coagulants outperformed inorganics in nearly all of the parameters except for PO_4^{3-} removal thus proving that they are a strong and a more nature friendly alternative to them. Experiments have also proved that a calcination procedure must be followed to efficiently use eggshells and limestone for effective PO_4^3 removal.