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A simple and rapid UV-Visible spectrophotometric method for determination of Mercury (II) using TMPyP in aqueous solutions

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Even though Mercury and its compounds are known to be extremely toxic they are widely distributed in the environment. The main sources of mercury pollution are coal burning power plants, paper, plastic, electrical, paint, and pharmaceutical industries. Uses of mercury as pesticides also add mercury to the environment. Several analytical methods are available to detect heavy metal ions in environmental water samples and biological samples. However, in recent years significant attention has been focused on porphyrins, as the sensitive sensing reagents for spectrophotometric determination of several metal ions. In this study, a simple, rapid and considerably sensitive UV-Visible spectrophotometric method was developed for determination of Hg(II) using, 5, 10, 15, 20-Tetrakis (1-methyl-4-pyridinio) porphyrin tetra (p-toluenesulfonate); (TMPyP) as the sensing reagent. The effects of pH, water hardness and presence of other metal ions such as Cd(II), Cr(III) and Pb(II) for Hg(II) detection were also examined.

Upon addition of Hg(II) ions into an aqueous solution of TMPyP, a new absorption band (Soret band) appeared at 458 nm indicating that, this characteristic absorption band, attributed to Hg(II)-TMPyP complex can be used as a diagnostic absorption for Hg(II) ions. The reaction was very fast and constant absorbance was achieved within 1 min and the system obeys Beer's law for concentration range of Hg(II) between 0.005 mg L^{-1} and 70 mg L^{-1}. The detection limit for Hg(II) with TMPyP was determined to be 0.003 mg L^{-1} which is below the maximum permissible limit (0.005 mg L^{-1}) for wastewater discharge according to EPA effluent discharge standards. The best pH range for Hg(II) detection was found to be pH 7-12. Hg(II) detection was not affected by water hardness. The presence of Mg(II), Cd(II), Cr(III) and Pb(II) ions over a concentration range of 0-100 mg L^{-1} also had no significant effect on the detection of Hg(II) ions. It was possible to successfully remove Hg(II) - TMPyP complex as well as unbound TMPyP from the aqueous solutions using chitosan, before discharging the analyzed aqueous samples. These results indicated that, TMPyP can be used as a promising optical chemical sensor for the detection of Hg(II) in aqueous solutions with satisfactory sensitivity and selectivity.

Keywords: Hg(II), Spectrophotometry, TMPyP