Highlights

- Highly efficient CS-NZVI-CMβ-CD composite beads were synthesized to remove Cr (VI) and Cu (II) in solution.
- NZVI gives strength to CS-NZVI-CMβ-CD beads and facilitates magnetic separation.
- CMβ-CD into chitosan incorporates more functional groups for higher sorption.
- Both redox and adsorption processes were proved as the key removal mechanisms.
- Endothermic and exothermic adsorption for Cr (VI) and Cu (II), respectively.