Chemistry of Vanadium

Vanadium is one of the first row transition metals in the Periodic Table. Its valence electronic configuration is $4S^2 3d^3$. Hence, its oxidation states are +II (losing all 4S electrons), +III, +IV and +V (losing all 3d electrons). Species from these different oxidation states can be recognized from their colors.

Species	Oxidation state	Color
V^{2+}	+II	Purple
V^{3+}	+III	Green
VO^{2+}	+IV	Blue
VO_2^+ , VO^{3+}	+V	Yellow

Vanadium in high oxidation state is a strong oxidizing agent. For example, dioxovanadium(V) ion, VO_2^+, oxidizes sulfite ion (SO_3^{2-}) to sulfate ion (SO_4^{2-}) in acidic solution. It is then reduced to oxovanadium (IV) ion, VO^{2+}.

$$\underset{\text{yellow}}{2VO_2^+ + SO_3^{2-} + 2H^+} \longrightarrow \underset{\text{blue}}{2VO^{2+} + SO_4^{2-} + H_2O}$$

In acidic solution, dioxovanadium(V) ion, VO_2^+, oxidizes Zn to Zn(II). It is then reduced to V(II).

$$\underset{\text{yellow}}{2VO_2^+ + 3Zn + 8H^+} \longrightarrow \underset{\text{purple}}{2V^{2+} + 3Zn^{2+} + 4H_2O}$$

Oxovanadium(IV) ion was oxidized by permanganate ion to dioxovandium(V) ion.

$$\underset{\text{blue}}{5VO^{2+} + MnO_4^- + H_2O} \longrightarrow \underset{\text{yellow}}{5VO_2^+ + Mn^{2+} + 2H^+}$$