

Trends in the M^{2+}/M Standard Electrode Potentials

Understanding the thermodynamic balance of transition metals in aqueous solutions.



Core Concepts

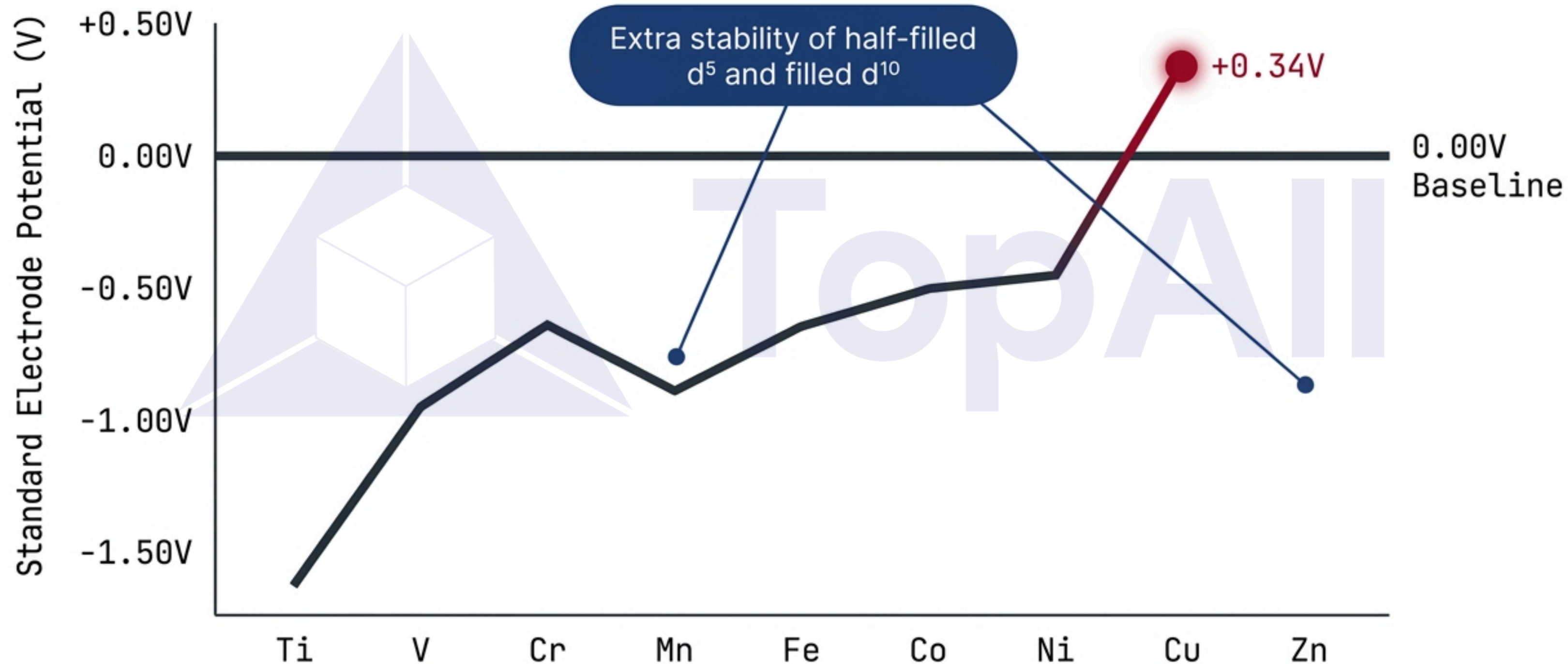
Standard Electrode Potential (E°)

The measure of a metal's tendency to get reduced. A negative E° indicates a metal is easily oxidized and acts as a strong reducing agent (can liberate H_2 from acids).

Hydration Enthalpy ($\Delta_{\text{hyd}}H^\circ$)

The energy released when gaseous ions dissolve in water. This is the thermodynamic “payback” that drives the dissolution of metals into aqueous solution.

The Rising E° Trend Line





You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



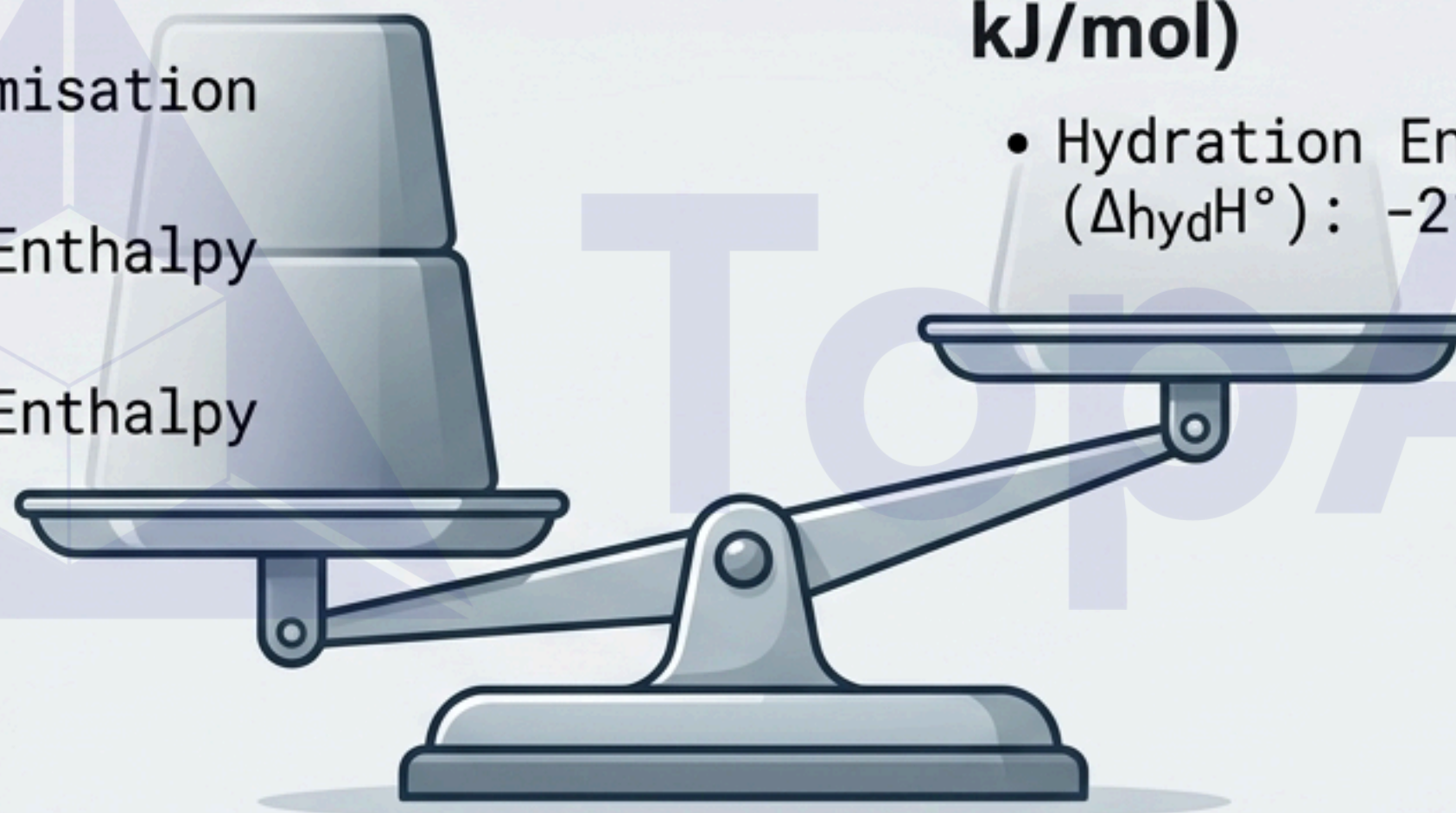
The Thermodynamics of Copper

The Costs: High Energy Input Required (+3,042 kJ/mol)

- Enthalpy of Atomisation ($\Delta_a H^\circ$): +339
- 1st Ionisation Enthalpy ($\Delta_i H_1^\circ$): +745
- 2nd Ionisation Enthalpy ($\Delta_i H_2^\circ$): +1958

The Payback: Insufficient Energy Released (-2,121 kJ/mol)

- Hydration Enthalpy ($\Delta_{hyd} H^\circ$): -2121



The high energy required to transform Cu(s) to $\text{Cu}^{2+}(\text{aq})$ is not balanced by its hydration enthalpy. This net energy deficit forces a positive E° (+0.34V).

Chemical Consequence: Copper vs. Acids

Because Copper has a positive E° (+0.34V), it lacks the thermodynamic drive to reduce H^+ to H_2 gas.

With Dilute HCl (Non-Oxidizing)

Action: $Cu + HCl \rightarrow$

Result: **No Reaction.**

Why: Cu cannot **displace hydrogen**. It acts as a “noble” metal in standard mineral acids because E° is positive.

With Hot Conc. HNO_3 (Oxidizing)

Action: $Cu + 4HNO_3 \rightarrow$

Result: $Cu(NO_3)_2 + 2NO_2 + 2H_2O$

Why: The acid itself acts as the oxidizing agent (reducing nitrate to nitrogen dioxide), completely bypassing the need to reduce H^+ .

Practice Check

Which of the following 3d transition metals will NOT liberate hydrogen gas when treated with dilute non-oxidizing acids?

[Option A] Titanium (Ti)

[Option B]

[Option B] Manganese (Mn)

[Option C] Iron (Fe)

[Option D] Copper (Cu)

Watch for this!

Don't assume every transition metal has a negative E° just because they are metals. Copper is the one exception in the entire 3d series with a positive E° value (+0.34V), rendering it incapable of reducing H^+ to H_2 .

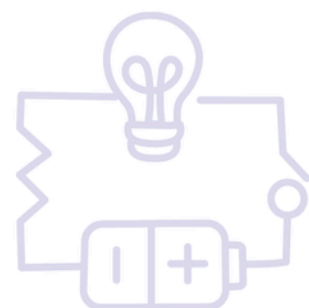
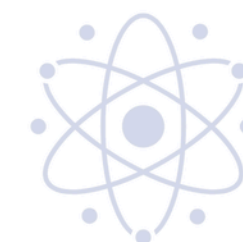
Module Summary

- **The General Trend:** M^{2+}/M standard electrode potentials become progressively less negative across the 3d series due to increasing ionization enthalpies (with notable dips for the stable half-filled d^5 of Mn and filled d^{10} of Zn).
- **The Copper Anomaly:** Copper is the unique exception with a positive E° (+0.34V). Its hydration enthalpy cannot compensate for its massive atomization and ionization energy costs, rendering it unreactive with standard non-oxidizing acids.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter

