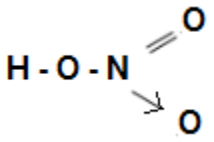
Study of Compounds – Nitric Acid

Nitric Acid

Molecular formula: HNO_3
Relative molecular mass: 63



Laboratory Preparation of Nitric Acid

Reactions:

$KNO_3 + H_2SO_4 \xrightarrow{<200^0C} KHSO_4 + HNO_3$

$NaNO_3 + H_2SO_4 \xrightarrow{<200^0C} NaHSO_4 + HNO_3$

Properties of Nitric Acid

(A) Physical Properties

- Pure acid (98% conc.) is colourless, suffocating and sour to taste.
- It is heavier than water, with a specific gravity of 1.54.
- Boiling point is 86°C, and freezing point is −42°C

(B) Chemical Properties

- Pure nitric acid is colourless, unstable and decomposes slightly even at room temperature and in the presence of sunlight.
  $4HNO_3 \rightarrow 4NO_2 + 2H_2O + O_2$
- Nitric acid is a very strong monobasic acid and ionises almost completely in aqueous solution.
  $HNO_3 \rightleftharpoons H^+ + NO_3^-$
- Nitric acid neutralises alkalis to form salt and water.
  $CaO + 2HNO_3 \longrightarrow Ca(NO_3)_2 + H_2O$
  $CuO + 2HNO_3 \longrightarrow Cu(NO_3)_2 + H_2O$
  $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$
- Nitric acid reacts with carbonates and bicarbonates to produce salt, water and carbon dioxide.
  $Na_2CO_3 + 2HNO_3 \longrightarrow 2NaNO_3 + H_2O + CO_2$
  $NaHCO_3 + HNO_3 \longrightarrow NaNO_3 + H_2O + CO_2$
- Nitric acid oxidises carbon, sulphur and phosphorus to their highest oxides or oxy-acids such as carbon dioxide, sulphuric acid and phosphoric acid.
  $C + 4HNO_3 \longrightarrow 2H_2O + 4NO_2 + CO_2$
  $S + 6HNO_3 \longrightarrow H_2SO_4 + 2H_2O + 6NO_2$
  $P_4 + 20HNO_3 \longrightarrow 4H_3PO_4 + 4H_2O + 20NO_2$

- Cold and dilute nitric acid oxidises metals to their nitrates and liberates nitric oxide.

  $3Cu + 8HNO_3 \longrightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

  $3Zn + 8HNO_3 \longrightarrow 3Zn\ (NO_3)_2 + 4H_2O + 2NO_2$
- Concentrated nitric acid liberates nitrogen dioxide.

  $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

  $Zn + 4HNO_3 \longrightarrow Zn\ (NO_3)_2 + 2H_2O + 2NO_2$
- Nitric acid (1 part by volume) mixed with conc. hydrochloric acid (3 parts by volume) produces a mixture called aqua regia.

  $HNO_3 + 3HCl \longrightarrow NOCl + 2H_2O + 2[Cl]$

  Aqua regia contains nascent chlorine and reacts with noble metals such as gold and platinum to produce chlorides.

  $Pt + 4[Cl] \longrightarrow PtCl_4$

  $Au + 3[Cl] \longrightarrow AuCl_3$

Uses of Nitric Acid

- To etch designs on copper and brassware because it acts as a solvent for several metals except the noble metals.
- To purify gold with impurities of Cu, Ag and Zn which dissolve in nitric acid.
- It acts as a rocket fuel oxidant.
- In preparation of fertilisers such as $Ca(NO_3)_2$ and NH_4NO_3.
- In the preparation of aqua regia, which dissolves noble metals.