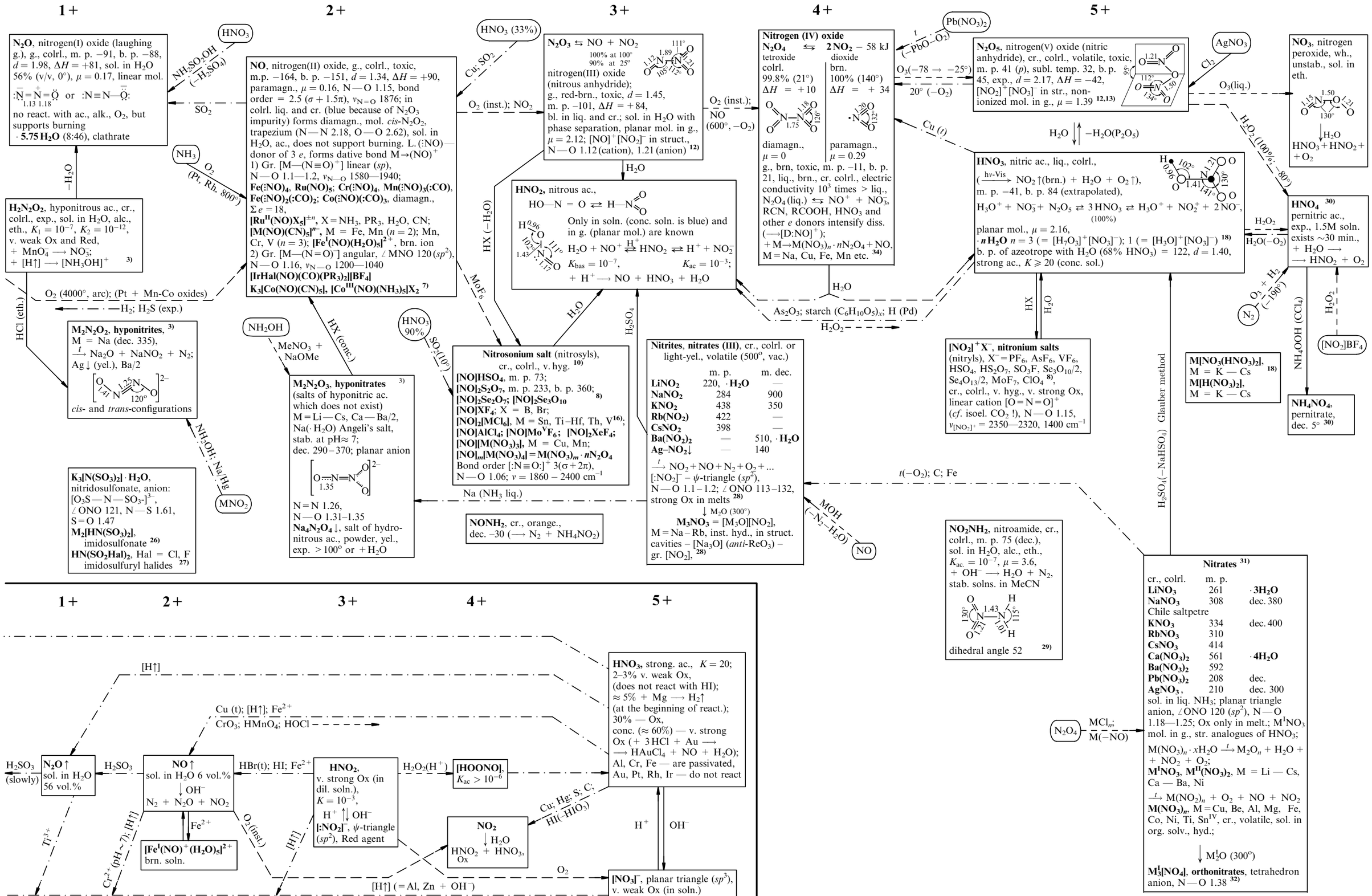
References


1+
2+
3+
4+
5+
N2O, nitrogen(I) oxide (laughing g.), g., colrl., m. p. −91, b. p. −88, d = 1.98, ΔH = +81, sol. in H2O 56% (v/v, 0°), μ = 0.17, linear mol.
no react. with ac., alk., O2, but supports burning
· 5.75 H2O (8:46), clathrate
HNO3
NH2SO2OH (−H2SO4)
SO2
NH3
O2 (Pt, Rh, 800°)
−H2O
H2N2O2, hyponitrous ac., cr., colrl., exp., sol. in H2O, alc., eth., K1 = 10−7, K2 = 10−12, v. weak Ox and Red, + MnO4− ⟶ NO3−; + [H↑] ⟶ [NH3OH]+ 3)
O2 (4000°, arc); (Pt + Mn-Co oxides)
H2; H2S (exp.)
HCl (eth.)
M2N2O2, hyponitrites, 3) M = Na (dec. 335), t⟶ Na2O + NaNO2 + N2; Ag↓ (yel.), Ba/2
cis- and trans-configurations
NH2OH; Na/Hg
MNO2
K3[N(SO3)2] · H2O, nitridosulfonate, anion: [O3S—N—SO3-]3−, ∠ONO 121, N—S 1.61, S=O 1.47
M2[HN(SO3)2], imidosulfonate 26)
HN(SO2Hal)2, Hal = Cl, F imidosulfuryl halides 27)
NO, nitrogen(II) oxide, g., colrl., toxic, m.p. −164, b. p. −151, d = 1.34, ΔH = +90, paramagn., μ = 0.16, N—O 1.15, bond order = 2.5 (σ + 1.5π), νN=O 1876; in colrl. liq. and cr. (blue because of N2O3 impurity) forms diamagn., mol. cis-N2O2, trapezium (N—N 2.18, O—O 2.62), sol. in H2O, ac., does not support burning. L. (:NO)— donor of 3 e, forms dative bond M→(NO)+ 1) Gr. [M—(N≡O)+] linear (sp), N—O 1.1—1.2, νN—O 1580—1940; Fe(:NO)4, Ru(NO)5; Cr(:NO)4, Mn(:NO)3(:CO), Fe(:NO)2(:CO)2; Co(:NO)(:CO)3, diamagn., Σe = 18, [RuII(NO)X5]±n, X = NH3, PR3, H2O, CN; [M(NO)(CN)5]n−, M = Fe, Mn (n = 2); Mn, Cr, V (n = 3); [FeI(NO)(H2O)5]2+, brn. ion 2) Gr. [M—(N=O)−] angular, ∠MNO 120 (sp2), N—O 1.16, νN—O 1200—1040 [IrHal(NO)(CO)(PR3)2][BF4] K3[Co(NO)(CN)5], [CoIII(NO)(NH3)5]X2 7)
HNO3 (33%)
Cu; SO2
O2 (inst.); NO2
HX (−H2O)
MoF6
N2O3 ⇆ NO + NO2 (100% at 100°, 90% at 25°), nitrogen(III) oxide (nitrous anhydride); g., red-brn., toxic, d = 1.45, m. p. −101, ΔH = +84, bl. in liq. and cr.; sol. in H2O with phase separation, planar mol. in g., μ = 2.12; [NO]+[NO2]− in struct., N—O 1.12 (cation), 1.21 (anion) 12)
O2 (inst.); NO (600°, −O2)
H2O
HNO2, nitrous ac., HO—N = O ⇄ H—N(=O)=O; Only in in soln. (conc. soln. is blue) and in g. (planar mol.) are known
H2O + NO+ ⇄ (H+) HNO2 ⇄ H+ + NO2−
Kbas = 10−7, Kac = 10−3;
+ H+ ⟶ NO + HNO3 + H2O
H2O
H2SO4
HNO3 90%
SO2 (10°)
NH2OH
MeNO3 + NaOMe
HX (conc.)
M2N2O3, hyponitrates 3) (salts of hyponitric ac. which does not exist) M = Li—Cs, Ca—Ba/2, Na(· H2O) Angeli's salt, stab. at pH≈ 7; dec. 290–370; planar anion
N=N 1.26, N—O 1.31–1.35
Na4N2O4↓, salt of hydronitrous ac., powder, yel., exp. > 100° or + H2O
Nitrosonium salt (nitrosyls), cr., colrl., v. hyg. 10)
[NO]HSO4, m. p. 73; [NO]2S2O7, m. p. 233, b. p. 360; 8) [NO]2Se2O7; [NO]2Se3O10 [NO]XF4; X = B, Br; [NO]2[MCl6], M = Sn, Ti–Hf, Th, V16); [NO]AlCl4; [NO]MoVF6; [NO]2XeF4; [NO][M(NO3)3], M = Cu, Mn; [NO]m[M(NO3)4] = M(NO3)m · nN2O4 Bond order [:N≡O:]+ 3(σ + 2π), N—O 1.06; ν = 1860 – 2400 cm−1
Na (NH3 liq.)
NONH2, cr., orange., dec. –30 (⟶ N2 + NH4NO2)
Nitrites, nitrates (III), cr., colrl. or light-yel., volatile (500°, vac.)
LiNO2 220, · H2O —
NaNO2 284 900
KNO2 438 350
Rb(NO2) 422 —
CsNO2 398 —
Ba(NO2)2 — 510, · H2O
Ag–NO2↓ — 140
t⟶ NO2 + NO + N2 + O2 + ...
[:NO2]− – ψ-triangle (sp2), N—O 1.1–1.2; ∠ONO 113–132, strong Ox in melts 28)
↓ M2O (300°)
M3NO3 = [M3O][NO2], M = Na – Rb, inst. hyd., in struct. cavities – [Na3O] (anti-ReO3) – gr. [NO2], 28)
MOH (−N2−H2O)
NO
Nitrogen (IV) oxide
N2O4 ⇆ 2 NO2 − 58 kJ
tetroxide colrl. 99.8% (21°) ΔH = +10 diamagn., μ = 0
dioxide brn. 100% (140°) ΔH = + 34 paramagn., μ = 0.29
g., brn, toxic, m. p. –11, b. p. 21, liq., brn., cr. colrl., electric conductivity 10³ times > liq., N2O4 (liq.) ⇆ NO+ + NO3−, RCN, RCOOH, HNO3 and other e donors intensify diss. (⟶[D:NO]+); + M→M(NO3)n · nN2O4 + NO, M = Na, Cu, Fe, Mn etc. 34)
Pb(NO3)2
t (−PbO−O2)
O3(−78 → −25°)
20° (−O2)
Cu (t)
As2O3; starch (C6H10O5)x; H (Pd)
H2O2
t(−O2); C; Fe
N2O5, nitrogen(V) oxide (nitric anhydride), cr., colrl., volatile, toxic, m. p. 41 (p), subl. temp. 32, b. p. 45, exp., d = 2.17, ΔH = −42, [NO2]+[NO3]− in str., non-ionized mol. in g., μ = 1.39 12,13)
AgNO3
Cl2
O3(liq.)
H2O ⇅ −H2O(P2O5)
HNO3, nitric ac., liq., colrl., (hν-Vis⟶ NO2↑(brn.) + H2O + O2↑), m. p. –41, b. p. 84 (extrapolated), H3O+ + NO3− + N2O5 ⇄ 3 HNO3 ⇄ H3O+ + NO2+ + 2 NO3− (100%) planar mol., μ = 2.16, · n H2O n = 3 (= [H7O3]+[NO3]−); 1 (= [H3O]+[NO3]−) 18) b. p. of azeotrope with H2O (68% HNO3) = 122, d = 1.40, strong ac., K ⩾ 20 (conc. sol.)
HX
H2O
[NO2]+X−, nitronium salts (nitryls), X− = PF6, AsF6, VF6, HSO4, HS2O7, SO3F, Se3O10/2, Se4O13/2, MoF7, ClO4 8), cr., colrl., v. hyg., v. strong Ox, linear cation [O=N=O]+ (cf. isoel. CO2 !), N—O 1.15, ν[NO2]+ = 2350—2320, 1400 cm−1
H2SO4 (−NaHSO4) Glauber method
NO3, nitrogen peroxide, wh., unstab., sol. in eth.
H2O
HNO3 + HNO2 + + O2
H2O2 (100%; −80°)
HNO4 30) pernitric ac., exp., 1.5M soln. exists ~30 min., + H2O ⟶ ⟶ HNO2 + O2
H2O2
H2O(−O2)
O2 + H2 (−190°)
N2
NH4OOH (CCl4)
[NO2]BF4
M[NO3(HNO3)2], M = K — Cs 18)
M[H(NO3)2], M = K — Cs
NH4NO4, pernitrate, dec. 5° 30)
NO2NH2, nitroamide, cr., colrl., m. p. 75 (dec.), sol. in H2O, alc., eth., Kac. = 10−7, μ = 3.6, + OH− ⟶ H2O + N2, stab. solns. in MeCN
dihedral angle 52 29)
Nitrates 31)
cr., colrl. m. p.
LiNO3 261 · 3H2O
NaNO3 308 dec. 380
Chile saltpetre
KNO3 334 dec. 400
RbNO3 310
CsNO3 414
Ca(NO3)2 561 · 4H2O
Ba(NO3)2 592
Pb(NO3)2 208 dec.
AgNO3, 210 dec. 300
sol. in liq. NH3; planar triangle anion, ∠ONO 120 (sp2), N—O 1.18—1.25; Ox only in melt.; MINO3 mol. in g., str. analogues of HNO3;
M(NO3)n · xH2O t⟶ M2On + H2O + + NO2 + O2;
MINO3, MII(NO3)2, M = Li — Cs, Ca — Ba, Ni
t⟶ M(NO2)n + O2 + NO + NO2
M(NO3)n, M = Cu, Be, Al, Mg, Fe, Co, Ni, Ti, SnIV, cr., volatile, sol. in org. solv., hyd.;
↓ M2IO (300°)
M2I[NO4], orthonitrates, tetrahedron anion, N—O 1.38 32)
N2O4
MCln; M(−NO)
1+
2+
3+
4+
5+
[H↑]
Cu (t); [H↑]; Fe2+
CrO3; HMnO4; HOCl
N2O ↑ sol. in H2O 56 vol.%
H2SO3 (slowly)
H2SO3
NO ↑ sol. in H2O 6 vol.%
↓ OH−
N2 + N2O + NO2
HBr(t); HI; Fe2+
HNO2, v. strong Ox (in dil. soln.), K = 10−3, H+ ⇅ OH− [:NO2]−, ψ-triangle (sp2), Red agent
H2O2(H+)
[HOONO], Kac > 10−6
Fe2+
[FeI(NO)+(H2O)5]2+ brn. soln.
Ti3+
Cr2+ (pH ~ 7); [H↑]
O2 (inst.)
[H↑]
NO2 ↓ H2O HNO2 + HNO3, Ox
Cu; Hg; S; C; HI(−HIO3)
O2
[H↑] (= Al, Zn + OH−)
HNO3, strong. ac., K = 20; 2–3% v. weak Ox, (does not react with HI); ≈ 5% + Mg ⟶ H2↑ (at the beginning of react.); 30% — Ox, conc. (≈ 60%) — v. strong Ox (+ 3 HCl + Au ⟶ ⟶ HAuCl4 + NO + H2O); Al, Cr, Fe — are passivated, Au, Pt, Rh, Ir — do not react
H+ OH−
[NO3]−, planar triangle (sp3), v. weak Ox (in soln.)