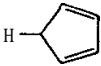
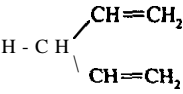
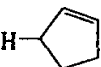
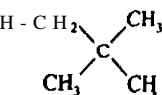
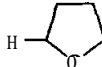
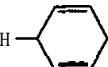


ภาคผนวก

1. เอนทัลปีพันธะ

| บอนด์ | ΔH_f° , kJ/mol | บอนด์ | ΔH_f° , kJ/mol |
|--------------------------|----------------------------------|------------------------|----------------------------------|
| Carbon | | Carbon | |
| $(CH_3)_2C-CH_3$ | 335 | $CF_3-(N=NCF_3)$ | 231.0 |
| $(CH_3)_2C-C(CH_3)_2$ | 282.4 | $H_2C=NH$ | 644(21) |
| $CH_3-C_6H_5$ | 389 | $HC\equiv N$ | 937 |
| $CH_3-CH_2C_6H_5$ | 301 | CH_3-NO | 174.9(38) |
| $(CH_3)_3C-C(C_6H_5)_2$ | 63 | C_2H_5-NO | 175.7(54) |
| $CH_3-allyl$ | 301 | $C, H, -NO$ | 167.8(75) |
| $CH_3-vinyl$ | 121 | $(CH_3)_2CH-NO$ | 171.5(54) |
| $CH_3-C\equiv CH$ | 490 | $n-C_4H_9-NO$ | 215.5(42) |
| $CH_2=CH-CH=CH_2$ | 418 | C_6H_5-NO | 215.5(42) |
| $HC\equiv C-C\equiv CH$ | 628 | Cl_3C-NO | 134 |
| $H_2C=CH_2$ | 682 | F_3C-NO | 130 |
| $HC\equiv CH$ | 962 | C_6F_5-NO | 211.3(42) |
| $CH, -CN$ | 506(21) | $NC-NO$ | 121(13) |
| CH_3-CH_2CN | 305(8) | $CH, -NO_2$ | 247(13) |
| $CH_3-CH(CH_3)CN$ | 331(8) | $C_2H_5-NO_2$ | 259 |
| $CH_3-C(C_6H_5)CN(CH_3)$ | 251 | $c - o$ | 1076.5(4) |
| $CH_3CH_2-CH_2CN$ | 321.8(71) | $CH, -OCH_3$ | 335 |
| $NC-CN$ | 603(21) | $CH_3-OC_6H_5$ | 381 |
| $C_6H_5-C_6H_5$ | 418 | $CH_3-OCH_2C_6H_5$ | 280 |
| $CH, -CF_3$ | 423.4(46) | $C_2H_5-OC_6H_5$ | 213 |
| CH_2F-CH_2F | 368(8) | $C_6H_5CH_2-OCOCH_3$ | 285 |
| CF_3-CF_3 | 406(13) | $C_6H_5CH_2-OCOC_6H_5$ | 289 |
| $CF_2=CF_2$ | 318(13) | $CH_3CO-OCH_3$ | 406 |
| $CF, -CN$ | 501 | $CH_3-OSOCH_3$ | 280 |
| $CH, -CHO$ | 314 | $CH_2=CHCH_2-OSOCH_3$ | 209 |
| $CH, -CO$ | 342.1 | $C_6H_5CH_2-OSOCH_3$ | 222 |
| CH_3CO-CF_3 | 308.8 | $c = o$ | 749 |
| $CH_3CO-COCH_3$ | 280(8) | $H_2C=O$ | 732 |
| $C_6H_5CO-COC_6H_5$ | 277.8 | $OC=O$ | 532.2(4) |
| $Aryl-CH_2COCH_2-aryl$ | 273.6 | $SC=O$ | 628 |
| $C_6H_5CH_2-COOH$ | 284.9 | $C\equiv O$ | 1075 |
| $(C_6H_5CH_2)_2CH-COOH$ | 248.5 | $C - P$ | 513(8) |
| $C-Cl$ | 397(29) | $c - s$ | 699(8) |
| $C - F$ | 536(21) | CH_3-SH | 305(13) |
| $C - H$ | 337.2(8) | $CH_3-SC_6H_5$ | 285(8) |
| $C - I$ | 209(21) | $CH_3-SCH_2C_6H_5$ | 247(8) |
| $C - N$ | 770(4) | $o c - s$ | 310.4 |
| CF_3-NF_2 | 272(13) | $c - s e$ | 582(96) |
| CH_3-NH_2 | 331(13) | $c - c$ | 607(21) |
| $C_6H_5CH_2-NH_2$ | 301(4) | H_3C-CH_3 | 368 |
| $CH_3-NHC_6H_5$ | 285 | | |
| $CH_3-N(CH_3)C_6H_5$ | 272 | | |
| $C_6H_5CH_2-NHCH_3$ | 289(4) | | |
| $C_6H_5CH_2-N(CH_3)_2$ | 255(4) | | |
| $CH_3-(N=NCH_3)$ | 219.7 | | |
| $C_2H_5-(N=NC_2H_5)$ | 209.2 | | |
| $(CH_3)_3C-N=NC(CH_3)_3$ | 182.0 | | |
| $Aryl-CH_2N=NCH_2-aryl$ | 157 | | |

เอนทัลปีพันธะ (ต่อ)

| บอนด์ | ΔH_{298}° kJ/mol | บอนด์ | ΔH_{298}° kJ/mol |
|---|----------------------------------|---|----------------------------------|
| Hydrogen | | Hydrogen | |
| H - H | 436.002(4) | H-CHCl, | 414.2 |
| H- ² H or H-D | 439.446(4) | H-CCl ₃ | 377(8) |
| ² H- ² H or D-D | 443.546(4) | H-CBr ₃ | 377(8) |
| H - Br | 365.7(21) | H-CCl ₂ CHCl ₂ | 393(8) |
| H - C | 337.2(8) | H-CH ₂ F | 423(8) |
| H - CH | 452(33) | H-CHF, | 423(8) |
| H-CH, | 473(4) | H-CF, | 444(13) |
| H-CH, | 431(8) | H-CF ₂ Cl | 435(4) |
| ² H-C ² H ₄ or D-CD ₄ | 442.75(25) | H-CH ₂ CF ₃ | 446(45) |
| H-C≡CH | 523(4) | H-CF ₂ CH ₃ | 416(4) |
| H-CH=CH ₂ | 427 | H-CF ₂ CF ₃ | 431(63) |
| H-CH ₂ CH ₃ | 410(4) | H-CH ₂ I | 431(8) |
| H-CH ₂ C≡CH | 392.9(50) | H-CHI, | 431(8) |
| H-CH ₂ CH=CH ₂ | 356 | H-CN | 540(25) |
| H-cyclopropyl | 423(13) | H-CH ₂ CN | ca. 389 |
| H-CH ₂ CH ₂ CH ₃ | 410(8) | H-CH(CH ₃)CN | 377(8) |
| H-CH(CH ₃) ₂ | 395.4 | H-C(CH ₃) ₂ CN | 364(8) |
| H-cyclobutyl | 397(13) | H-CH ₂ NH ₂ | 397(8) |
| H-CH ₂ CH(CH ₃) ₂ | 360 | H-CH ₂ Si(CH ₃) ₃ | 414(4) |
| H-CH(CH ₃)CH ₂ CH ₃ | 397(4) | H-CH ₂ COCH ₃ | 393(75) |
| H-C(CH ₃) ₃ | 381 | H-Cl | 431.8(4) |
| H-  | 339(4) | H-CO | 126(8) |
| H-C  | 335(4) | H-CHO | 364(4) |
| H-  | 343(4) | H-COOH | 377 |
| H-C  | 414(4) | H-COCH ₃ | 364(4) |
| H-C(CH ₃) ₂ CH=CH ₂ | 331 | H-COCH ₂ CH ₃ | 364(4) |
| H-cyclopentyl | 395(42) | H-  | |
| H-CH ₂ C(CH ₃) ₃ | 418(4) | H-COC ₆ H ₅ | 364(4) |
| H-C ₆ H ₅ | 431 | H-COCF ₃ | 381(8) |
| H-CH ₂ C ₆ H ₅ | 356(4) | H-F | 568.6(13) |
| H-C(C ₆ H ₅) ₃ | 314 | H-I | 298.7(8) |
| H-  | 310 | H-N | 314(17) |
| H-cyclohexyl | 399.6(42) | H-NH | 377(8) |
| H-cycloheptyl | 387.0(42) | H-NH | 435(8) |
| H-norbomyl | 406(13) | H-NHCH ₃ | 431(8) |
| H-CH ₂ Br | 410(25) | H-N(CH ₃) ₂ | 397(8) |
| H-CHBr ₂ | 435 | H-NHC ₆ H ₅ | 335(13) |
| H-CH ₂ Cl | 423 | H-N(CH ₃)C ₆ H ₅ | 310(13) |
| | | HNF ₂ | 318(13) |
| | | H-N, | 356 |
| | | H-NO | <205 |
| | | H-O | 428.0(21) |
| | | H-OH | 498.7(8) |
| | | H-OCH ₃ | 436.8(42) |
| | | H-OCH ₂ CH ₃ | 436.0 |
| | | H-OC(CH ₃) ₃ | 439(4) |
| | | H-OC ₆ H ₅ | 368(25) |
| | | H-ONO | 327.605 |

เกณฑ์ลิพินซ์ (ต่อ)

| บอนด์ | ΔH_f° , kJ/mol |
|---|----------------------------------|
| Nitrogen | |
| N - N | 945.33(59) |
| N - Br | 276(21) |
| ON - Br | 28.7(15) |
| N - Cl | 389(50) |
| ON - Cl | 159(6) |
| O ₂ N - Cl | 142(4) |
| N - F | 301(42) |
| FN - F | 318(21) |
| F ₂ F - N | 243(8) |
| ON - F | 236(4) |
| O ₂ N - F | 188(21) |
| N - I | 159(17) |
| F ₂ N - NF ₂ | 88(4) |
| H ₂ N - NH ₂ | 297(8) |
| H ₂ N - NHCH ₃ | 271 |
| H ₂ N - N(CH ₃) ₂ | 264 |
| H ₂ N - NHC ₆ H ₅ | 213 |
| HN - N ₂ | 38 |
| ON - N | 480.7(42) |
| ON - NO | 39.8(8) |
| O ₂ N - NO | 57.3(21) |
| HN = NH | 456(42) |
| N ≡ N | 946 |
| N - O | 630.57(13) |
| HN = O | 481 |
| NN - O | 167 |
| ON - O | 305 |
| N - P | 617(21) |
| N - S | 464(21) |
| Phosphorus | |
| P - P | 490(11) |
| P - Br | 266.5 |
| P - C | 513(8) |
| P - Cl | 289(42) |
| P - F | 439(96) |
| P - H | 343(29) |
| P - N | 617(21) |
| P - O | 596.6 |
| Br ₃ P = O | 498(21) |
| Cl ₃ P = O | 510(21) |
| F ₃ P = O | 544(21) |
| P - S | 346.0(17) |
| P = S | 347 |
| P - s e | 363(10) |
| P - Te | 298(10) |

| บอนด์ | ΔH_f° , kJ/mol |
|--|----------------------------------|
| Oxygen | |
| O - O | 498.34(20) |
| O - Br | 235.1(4) |
| HO - CH ₃ | 377(13) |
| HO - CH = CH ₂ | 364 |
| HO - CH ₂ CH = CH ₂ | 456 |
| HO - C ₆ H ₅ | 431 |
| HO - CH ₂ C ₆ H ₅ | 322 |
| HO - CHO | 402(13) |
| HO - COCH ₃ | 452(21) |
| HO - COC ₂ H ₅ | 180 |
| O - Cl | 272(4) |
| HO - Cl | 251(13) |
| O - F | 222(17) |
| O - FO | 467 |
| FO - OF | 261(84) |
| O - I | 184(21) |
| HO - I | 234(13) |
| O - N | 630.57(13) |
| HO - NCH ₃ | 209 |
| HO - OC(CH ₃) ₃ | 192(8) |
| HO - OH | 213.8(21) |
| O - ON | 268(4) |
| CF ₃ O - OCF ₃ | 192 |
| CH ₃ O - OCH ₃ | 157.3(8) |
| C ₂ H ₅ O - OC ₂ H ₅ | 159 |
| C ₃ H ₇ O - OC ₃ H ₇ | 155 |

2. คุณสมบัติทางเทอร์โมไดนามิกส์ของสาร

| สาร | an-w | ΔH_f° (kcal/mol) | ΔG_f° (kcal/mol) | S° (cal/deg/mol) |
|----------------------|---------|----------------------------------|----------------------------------|----------------------------|
| β -D-Arabinose | ของแข็ง | -252.84 | | |
| β -L-Arabinose | ของแข็ง | -252.84 | | |
| L-Arginine | ของแข็ง | -148.66 | | |
| D-Arginine | ของแข็ง | -149.05 | -57.43 | 59.9 |
| L-Ascorbic acid | ของแข็ง | -278.34 | | |
| L-Asparagine | ของแข็ง | -163.50 | -126.73 | 41.7 |
| Citric acid | ของแข็ง | -369.0 | -295.5 | 39.73 |
| Ethanol | ของเหลว | -66.20 | -41.63 | 38.49 |
| | ก๊าซ | -56.03 | -40.13 | 67.54 |
| P-D-Fructose | ของแข็ง | -302.2 | | |
| Fumaric acid | ของแข็ง | -193.84 | -156.70 | 39.7 |
| D-Galactonic acid | ของแข็ง | -384.8 | | |
| D-Galactose | ของแข็ง | -304.1 | -219.60 | 49.1 |
| D-Glucose | | | | |
| α | ของแข็ง | -304.26 | -217.6 | 50.7 |
| β | ของแข็ง | -302.76 | | |
| D-Glutamic acid | ของแข็ง | -240.19 | -773.87 | 45.7 |
| L-Glutamic acid | ของแข็ง | -241.32 | -174.78 | 44.98 |
| L-Glutamine | ของแข็ง | -197.3 | | |
| Glutaric acid | ของแข็ง | -229.44 | | |
| Glycerol | ของเหลว | -159.76 | -114.01 | 48.87 |
| Itaconic acid | ของแข็ง | -201.08 | | |

คุณสมบัติทางเทอร์โมไดนามิกส์ของสาร (ต่อ)

| สาร | สถานะ | ΔH_f° (kcal/mol) | ΔG_f° (kcal/mol) | S° (cal/deg/mol) |
|------------------|---------|----------------------------------|----------------------------------|----------------------------|
| D-Lactic acid | ของแข็ง | -165.88 | 34.3 | |
| L-Lactic acid | ของแข็ง | -165.89 | -124.98 | 34.00 |
| | ของเหลว | -161.2 | 123.84 | 45.9 |
| β -Lactose | ของแข็ง | -534.1 | -374.52 | 92.3 |
| D-Leucine | ของแข็ง | -152.36 | -82.87 | 49.71 |
| L-Leucine | ของแข็ง | -154.6 | -82.76 | 50.62 |
| Maleic acid | ของแข็ง | -188.94 | -149.40 | 38.1 |
| L-Malic acid | ของแข็ง | -263.78 | -211.45 | |
| D-Mannitol | ของแข็ง | -139.61 | -225.20 | 57.0 |
| D-Mannose | ของแข็ง | -301.9 | | |
| Methane | ก๊าซ | -17.8 ^o | -12.15 | 44.52 |
| Methanol | ของเหลว | -57.13 | -39.87 | 30.41 |
| | ก๊าซ | -48.06 | -38.82 | 57.29 |
| L-Methionine | ของแข็ง | -180.4 | -120.88 | 55.32 |
| Raffinose | ของแข็ง | -761 | | |
| D-Ribose | ของแข็ง | -251.16 | | |
| Sucrose | ของแข็ง | 331.9 | -369.1 a | 86.1 |
| Urea | ของแข็ง | -79.71 | -47.19 | 25.00 |
| Xylitol | ของแข็ง | -267.32 | | |
| D-Xylose | ของแข็ง | -252.8 | | |

3. ค่าการนำความร้อน

| สาร | อุณหภูมิ (K) | k (Wm ⁻¹ K ⁻¹) | (Btuh ⁻¹ ft ⁻¹ °F ⁻¹) |
|------------------------------|-----------------|--|---|
| <u>ของแข็ง : โลหะ</u> | | | |
| อลูมิเนียม | 573 | 230 | 133 |
| ทองบรอนซ์ | | 189 | 109 |
| ทองแดง | 373 | 377 | 218 |
| เหล็กพีด | 291 | 61 | 35 |
| เหล็กหล่อ | 326 | 48 | 27.6 |
| ตะกั่ว | 373 | 33 | 19 |
| เหล็กกล้าไร้สนิม | 293 | 16 | 9.2 |
| เหล็ก (1%C) | 291 | 45 | 26 |
| <u>ของแข็ง ที่ไม่ใช่โลหะ</u> | | | |
| ใยหิน | 273 | 0.16 | 0.09 |
| อิฐก่อสร้าง | 293 | 0.69 | 0.4 |
| สำลี | 303 | 0.050 | 0.029 |
| แก้ว | 303 | 1.09 | 0.63 |
| ยาง | 273 | 0.15 | 0.087 |
| ใยแก้ว | | 0.041 | 0.024 |
| <u>ของเหลว</u> | | | |
| กรดอะซิติค (50%) | 293 | 0.35 | 0.20 |
| เอทานอล (80%) | 293 | 0.24 | 0.137 |
| กลีเซอรอล (40%) | 293 | 0.45 | 0.26 |
| น้ำ | 303 | 0.62 | 0.356 |
| น้ำ | 333 | 0.66 | 0.381 |
| <u>ก๊าซ</u> | | | |
| อากาศ | 273 | 0.024 | 0.014 |
| อากาศ | 373 | 0.031 | 0.018 |
| คาร์บอนไดออกไซด์ | 273 | 0.015 | 0.0085 |
| ออกซิเจน | 273 | 0.024 | 0.0141 |
| ไอน้ำ | 373 | 0.025 | 0.0145 |