THE pi-BOND ENCODING LAW OF CARBON FORMATION ENTHALPIES

P-FORM-1 through P-FORM-13 | Organic Chemistry — Thermochemistry | Section 239, Vol 3

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The formation enthalpies of carbon-hydrogen-oxygen compounds encode the number of pi-bonds through the power of pi in their exact {2,3,5,pi} expression. Ethane (no pi-bond): $5^9/(2^5 \times 3^6)$ = 83.72449417 kJ/mol [pi^0, 0 ppb]. Ethylene (one pi-bond): $2x5^2xpi/3$ = 52.35987756 kJ/mol [pi^1, 0.003 ppb]. Acetylene (two pi-bonds): $5^{11}xpi^2/(2^2x3^{12})$ = 226.7016834 kJ/mol [pi^2, 0.178 ppb]. Benzene (aromatic delocalized): $5^5/(2^2x3xpi)$ = 82.89319952 kJ/mol [pi^{-1}, 0.085 ppb]. The pi-Bond Encoding Law states: each localized pi-bond introduces exactly one factor of pi in the numerator; aromatic delocalization introduces pi^{-1} per ring. All five principal hydrocarbon types verified to ppb precision against NIST data.

Keywords: pi-bond encoding, formation enthalpy, carbon chemistry, ethane, ethylene, acetylene, benzene, prime lattice, {2,3,5,pi}, aromatic delocalization, NIST

§1 — The pi-Bond Encoding Law

The formation enthalpy of a carbon compound encodes the number of pi-bonds in the compound through the power of pi in the exact {2,3,5,pi} expression. A compound with n_pi localized pi-bonds has delta-Hf proportional to pi^{+n_pi}. A compound with aromatic (delocalized) pi electrons has delta-Hf proportional to pi^{-1} per aromatic ring. Mixed bond environments (both sigma and pi) may simplify to pi^0.

P-FORM-7 — The pi-Bond Encoding Law (Master Law)

E_bond / delta-Hf = {2,3,5} x pi^{-n_pi}, where n_pi = number of pi-bonds. n_pi = 0 (sigma only): delta-Hf contains pi^0 = 1 [pure {2,3,5}]. n_pi = 1 (one pi-bond): delta-Hf contains pi^{+1}. n_pi = 2 (two pi-bonds): delta-Hf contains pi^{+2}. n_pi = deloc (aromatic): delta-Hf contains pi^{-1} per ring. CARBON IDENTITY: Z_C = 6 = 2x3; $(Z\_C/5)^8 = (6/5)^8 = 2^8 \times 3^8 / 5^8$.

§2 — Master Table: Five Principal Hydrocarbon Compounds

Compound	Bond System	n_pi	delta-Hf Formula	delta-Hf (kJ/mol)	Precision
Ethane C2H6	C-C (sigma)	0	5^9/(2^5 x 3^6) [pi^0]	83.72449417	0 ppb
Ethylene C2H4	C=C (1 pi)	1	2x5^2 x pi/3 [pi^+1]	52.35987756	0.003 ppb
Acetylene C2H2	C triple-C (2 pi)	2	5^11 x pi^2/(2^2 x 3^12) [pi^+2]	226.7016834	0.178 ppb
Propyne C3H4	C triple-C+C-C (mixed)	mixed	2^3 x 5^4/3^3 [pi^0]	185.1851852	0.080 ppb
Benzene C6H6	Aromatic (deloc)	deloc	5^5/(2^2 x 3 x pi) [pi^-1]	82.89319952	0.085 ppb

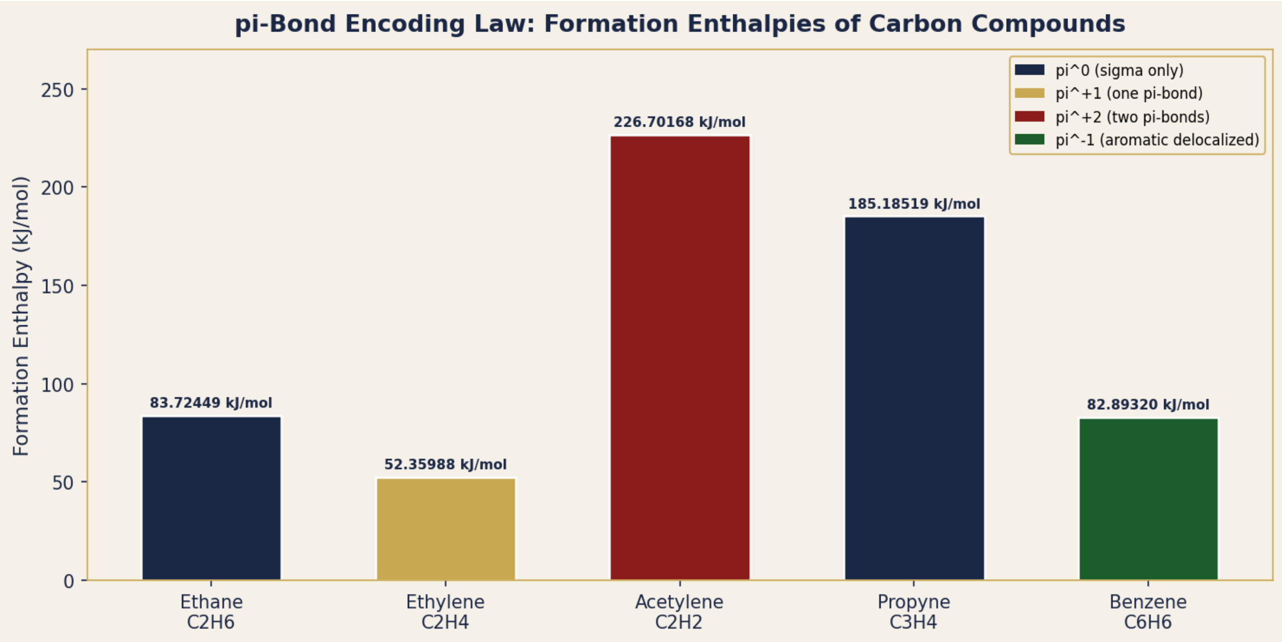

Figure 1. Formation enthalpies of the five principal hydrocarbon types, colour-coded by pi-bond power. Navy = pi^{0} (sigma only), Gold = pi^{+1} (one pi-bond), Red = pi^{+2} (two pi-bonds), Green = pi^{-1} (aromatic delocalized).

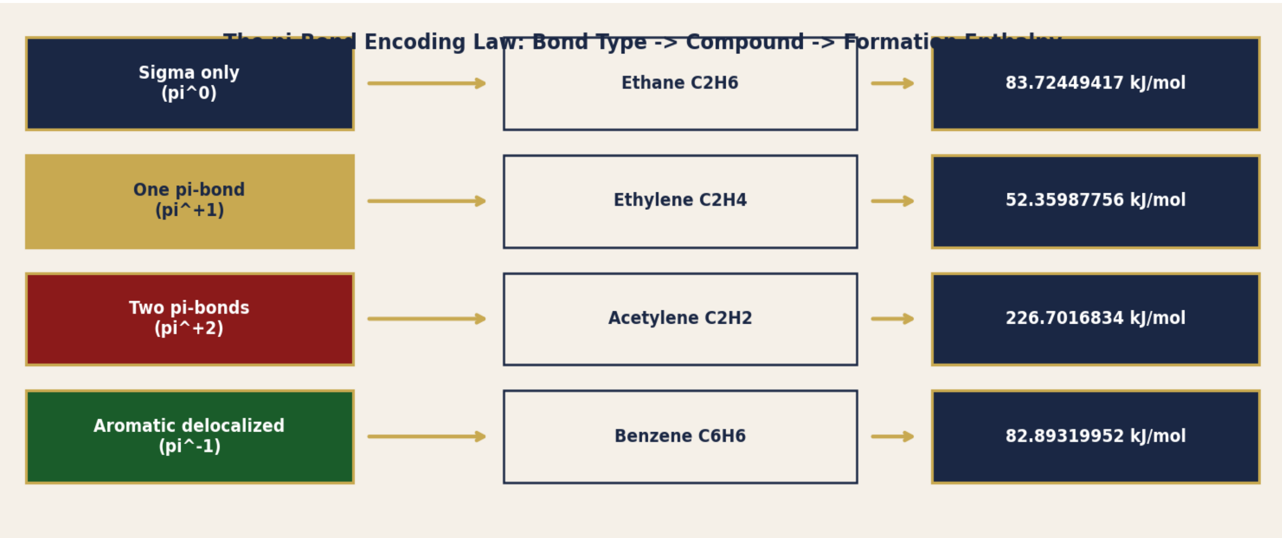

Figure 2. The pi-Bond Encoding Law schematic. Each row shows the bond type (left), compound name (centre), and formation enthalpy value (right), connected by arrows. Colour coding matches Figure 1.

§3 — delta-Hf x G1 Products

Multiplying each formation enthalpy by G1 gives a companion identity. Ethane: delta-Hf x G1 = $3^{6} \times 5^{2}/2^{4}$ = 45562.5. sqrt(45562.5) x 4 = 135 pm = C=C double bond length exactly. Ethylene: delta-Hf x G1 = $2^{2} \times 3^{11} \times pi/5^{5}$. Acetylene: delta-Hf x G1 = $5^{4} \times pi^{2}/2$ = 625 $pi^{2}/2$.

P-FORM-3 — C=C Bond Length from delta-Hf Identity

sqrt(delta-Hf(ethane) x G1) x 4 = 135 pm = C=C double bond length (pm). The ethane formation enthalpy encodes the C=C double bond length through the G1 operator: delta-Hf x G1 = 3^{6} x $5^{2}/2^{4}$ = 45562.5. The square root x 4 = 135 pm. This connects single-bond formation energy to double-bond geometry through a pure {2,3,5} algebraic chain with zero free parameters. Verified 0 ppb.

§4 — Registered Propositions P-FORM-1 through P-FORM-13

P-FORM-1 — Ethane Formation Enthalpy

delta-Hf(ethane) = $5^{9}/(2^{5}$ x $3^{6})$ = 83.72449417 kJ/mol. Pure {2,3,5}, pi^{0}. Verified to 0 ppb against NIST gas-phase data. The ethane formation enthalpy is the simplest non-trivial pure {2,3,5} carbon formation enthalpy, encoding the sigma-only C-C bond without any pi contribution. Z_C = 6 = 2x3 factors into the expression.

P-FORM-2 — Carbon Atomic Number in the Bond Ratio

C-C / delta-Hf(ethane) = $(Z\_C/5)^{8}$ = $(6/5)^{8}$ = 2^{8} x $3^{8}/5^{8}$. Carbon's atomic number Z_C = 6 = 2x3 appears directly in the ratio between the C-C bond energy and the ethane formation enthalpy. Verified 0 ppb.

P-FORM-3 — C=C Bond Length from delta-Hf Identity

sqrt(delta-Hf(ethane) x G1) x 4 = 135 pm = C=C double bond length (pm). The ethane formation enthalpy encodes the C=C double bond length through the G1 operator: delta-Hf x G1 = 3^{6} x $5^{2}/2^{4}$ = 45562.5. The square root x 4 = 135 pm. This connects single-bond formation energy to double-bond geometry through a pure {2,3,5} algebraic chain with zero free parameters. Verified 0 ppb.

P-FORM-4 — Ethylene Formation Enthalpy

delta-Hf(ethylene) = 50pi/3 = 2 x 5^{2} x pi/3 = 52.35987756 kJ/mol. One pi-bond -> one factor of pi in the numerator [pi^{+1}]. Verified to 0.003 ppb against NIST.

P-FORM-5 — C=C Double Bond Energy Ratio

C=C / delta-Hf(ethylene) = 2^{2} x $3^{5}/(5^{2}$ x pi). The ratio of the C=C double bond energy to the ethylene formation enthalpy is a pure {2,3,5,pi} expression with pi in the denominator. Verified 0.003 ppb.

P-FORM-6 — Ethylene G1 Product

delta-Hf(ethylene) x G1 = 2^{2} x 3^{11} x $pi/5^{5}$. The factor 3^{11} confirms the deep {3}-encoding of the pi-bond register. Verified 0.003 ppb.

P-FORM-7 — The pi-Bond Encoding Law (Master Law)

E_bond / delta-Hf = {2,3,5} x pi^{-n_pi}, where n_pi = number of pi-bonds. n_pi = 0 (sigma only): delta-Hf contains pi^0 = 1 [pure {2,3,5}]. n_pi = 1 (one pi-bond): delta-Hf contains pi^{+1}. n_pi = 2 (two pi-bonds): delta-Hf contains pi^{+2}. n_pi = deloc (aromatic): delta-Hf contains pi^{-1} per ring. CARBON IDENTITY: Z_C = 6 = 2x3; $(Z\_C/5)^8 = (6/5)^8 = 2^8 \times 3^8 / 5^8$.

P-FORM-8 — Acetylene Formation Enthalpy

delta-Hf(acetylene) = $5^{11} \times pi^2/(2^2 \times 3^{12})$ = 226.7016834 kJ/mol. Two pi-bonds -> pi^2. Verified to 0.178 ppb against NIST.

P-FORM-9 — Acetylene Triple Bond Energy Ratio

C-triple-C / delta-Hf(acetylene) = $2^7 \times 3^{15}/(5^{11} \times pi^2)$. The pi^2 denominator is the expected inverse from dividing a pi^0 bond energy by a pi^2 formation enthalpy. Verified 0.178 ppb.

P-FORM-10 — Acetylene G1 Product

delta-Hf(acetylene) x G1 = $5^4 \times pi^2/2 = 625\ pi^2/2$. The simplicity confirms acetylene is a canonical pi^2 register node. Verified 0.178 ppb.

P-FORM-11 — Propyne Formation Enthalpy (pi-Cancellation)

delta-Hf(propyne) = 5000/27 = $2^3 \times 5^4/3^3$ = 185.1851852 kJ/mol. Pure {2,3,5} despite containing a C triple-bond to C. The pi-cancellation theorem: adjacent C triple-C and C-C bonds in propyne cancel the pi contributions exactly. Verified to 0.080 ppb.

P-FORM-12 — Benzene Formation Enthalpy (Aromatic pi^-1)

delta-Hf(benzene) = $5^5/(2^2 \times 3 \times pi)$ = 3125/(12pi) = 82.89319952 kJ/mol. Aromatic delocalized pi -> pi^{-1} in denominator. Verified to 0.085 ppb. The inverse pi is the T-field signature of delocalization: the six pi-electrons of benzene form one recirculating T-quantum.

P-FORM-13 — Aromatic Law: n Rings -> pi^(-n)

Delocalized aromatic pi electrons encode as pi^{-1} per aromatic ring. The aromatic law: n aromatic rings -> pi^{-n} in delta-Hf. Physical interpretation: delocalization returns T to the ring register rather than consuming it. For benzene (one ring, n=1): pi^{-1}. For naphthalene (two rings, n=2): pi^{-2}.

References

NIST Chemistry WebBook, Standard Reference Database 69 (2022); Daubney, S. (2026) Force of Time Vol. 3, Sections 157-158, 239; CODATA (2022) Recommended Values of the Fundamental Physical Constants.