Bond Enthalpies

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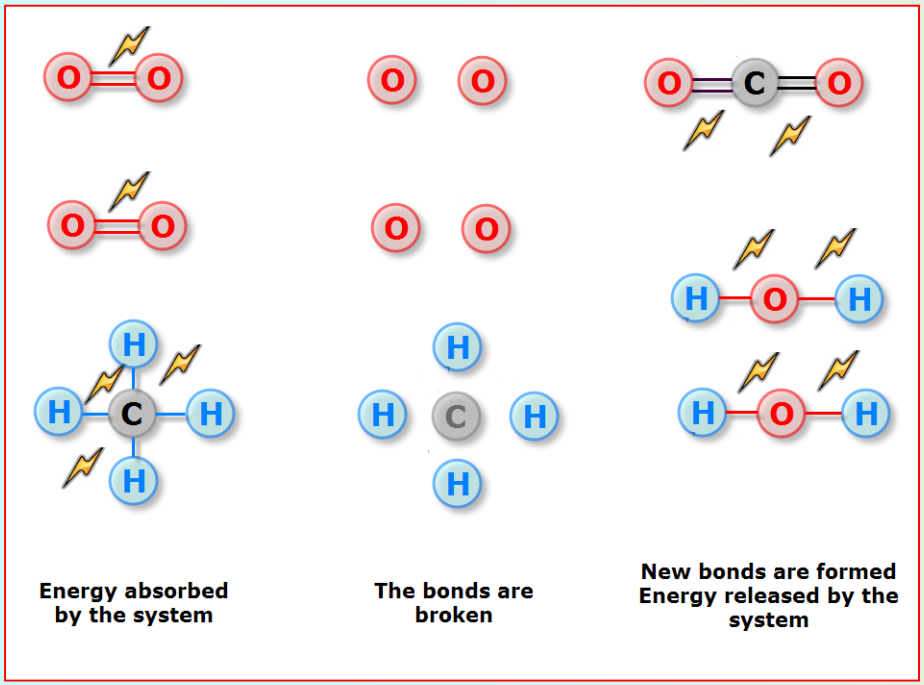

In the combustion of methane bonds are broken and new ones formed.

A Reaction: The Process of Breaking and Forming Bonds

We can think of a reaction as a process in which the bonds of the reactants absorb energy when they break, and the bonds of the products release energy when they form.

To break a bond, the system must absorb energy (endothermic process).

Conversely, when a bond is formed, energy is released in the process (exothermic process).

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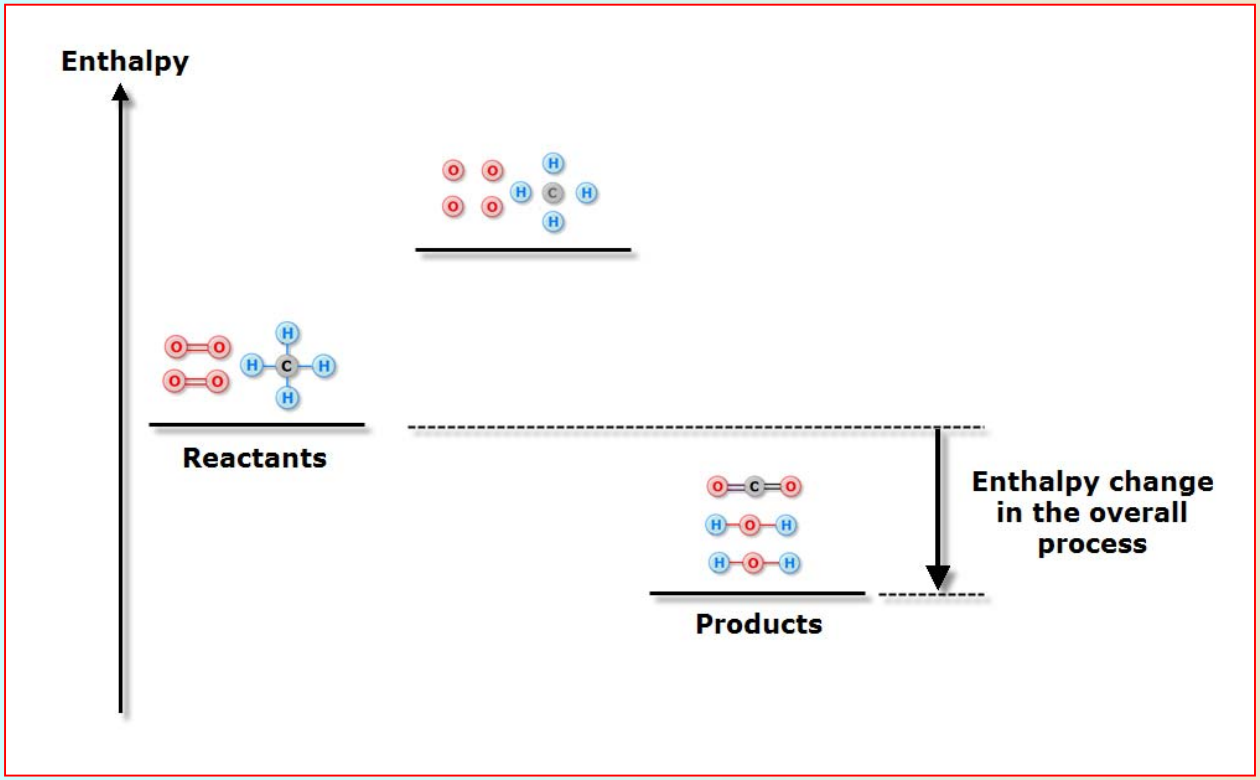

Enthalpy Diagrams

In the previous example, the enthalpy diagram would look as it appears in the picture.

When the system absorbs energy (to brake the bonds) the value of enthalpy increases and when new bonds are formed the system releases energy and the value of enthalpy decreases.

Depending on the overall change in enthalpy the process will be exothermic or endothermic.

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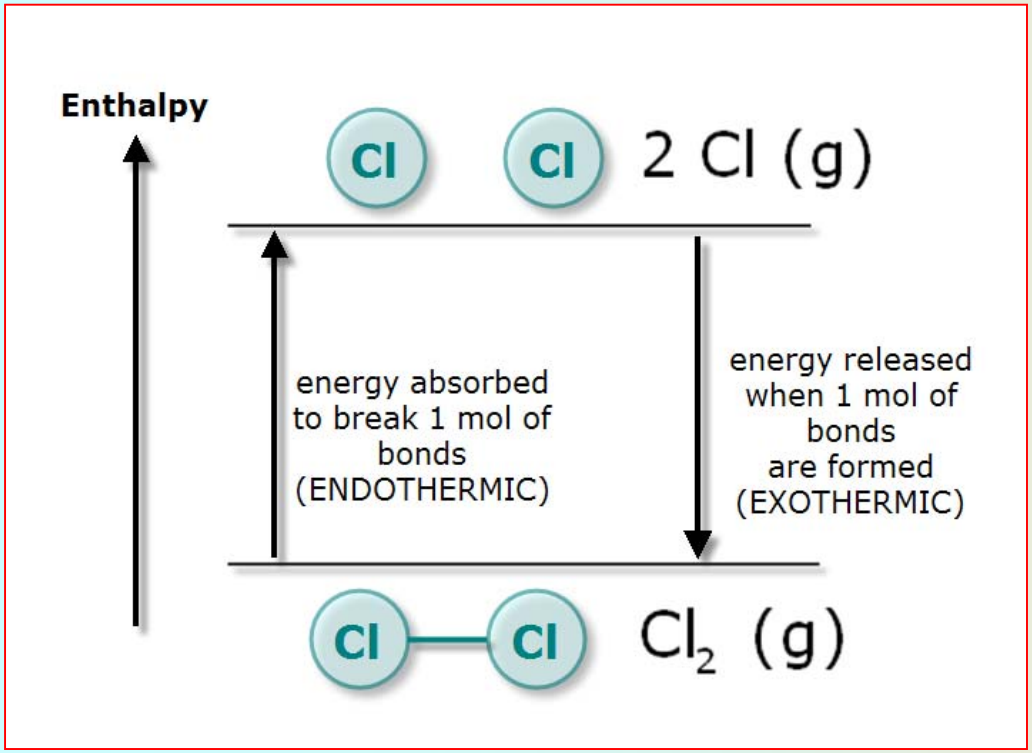

The Bond Enthalpy

The bond enthalpy is the enthalpy change (ΔH) for the breaking of a particular bond in a mole of a gaseous substance.

Tabulated bond enthalpies are always a positive quantity (the system absorbs energy, endothermic process): it means that this energy what is required to break a mol of bonds

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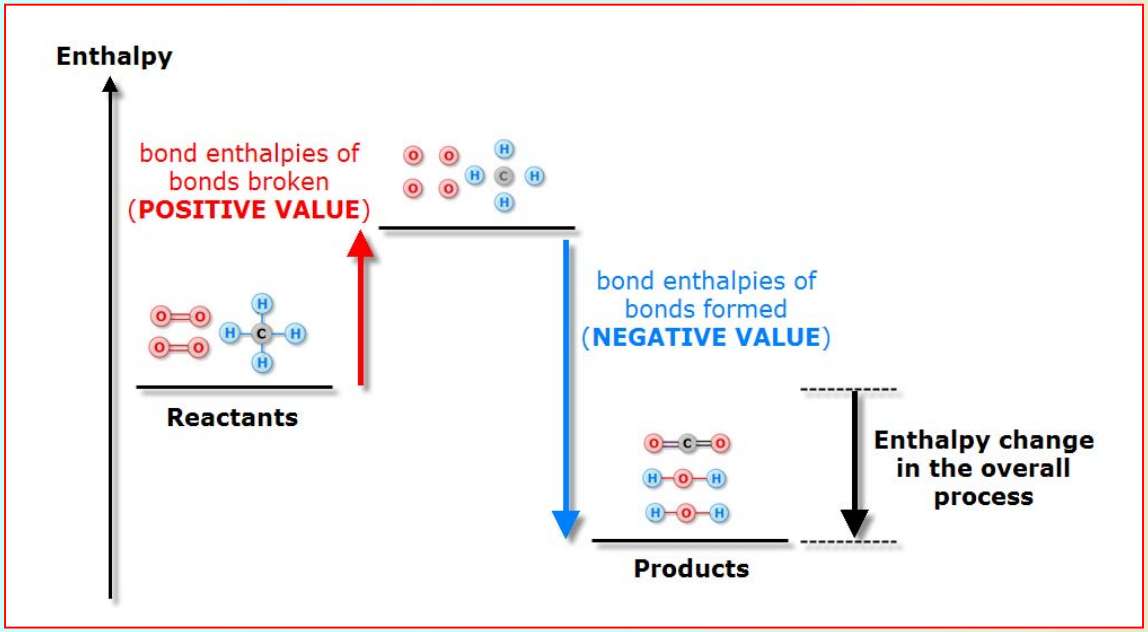
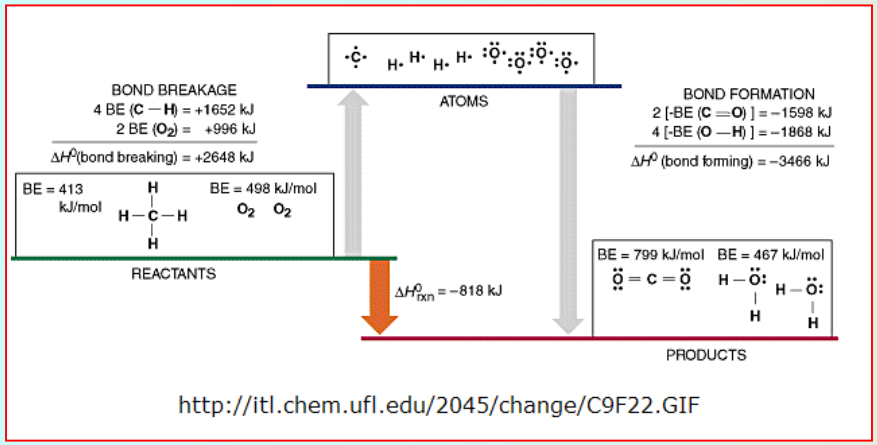


Bond Enthalpies and the Enthalpies of Reactions

The enthalpy of the reaction is estimated as the sum of the bond enthalpies of the bonds broken (positive values, endothermic processes) minus the sum of the bond enthalpies of the new bonds formed (negative values, exothermic processes)

$$\Delta H_{rxn} = \Sigma \text{ (bond enthalpies of bonds broken)} - \Sigma \text{ (bond enthalpies of bonds formed)}$$



http://itl.chem.ufl.edu/2045/change/C9F22.GIF

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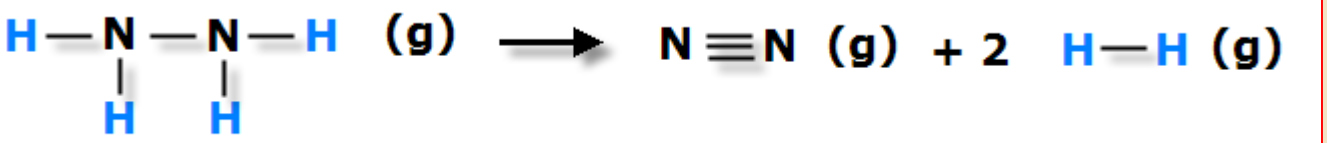
Bond Enthalpies

Exercise

Estimate ΔH for the following reaction:



Average Bond Enthalpies (kJ/mol)

Single Bonds

C—H	413	N—H	391	O—H	463	F—F	155
C—C	348	N—N	163	O—O	146		
C—N	293	N—O	201	O—F	190	Cl—F	253
C—O	358	N—F	272	O—Cl	203	Cl—Cl	242
C—F	485	N—Cl	200	O—I	234		
C—Cl	328	N—Br	243			Br—F	237
C—Br	276			S—H	339	Br—Cl	218
C—I	240	H—H	436	S—F	327	Br—Br	193
C—S	259	H—F	567	S—Cl	253		
		H—Cl	431	S—Br	218	I—Cl	208
Si—H	323	H—Br	366	S—S	266	I—Br	175
Si—Si	226	H—I	299			I—I	151
Si—C	301						
Si—O	368						

Multiple Bonds

C=C	614	N=N	418	O_2	495
C≡C	839	N≡N	941		
C=N	615			S=O	523
C≡N	891			S=S	418
C=O	799				
C≡O	1072				

Bond Enthalpies

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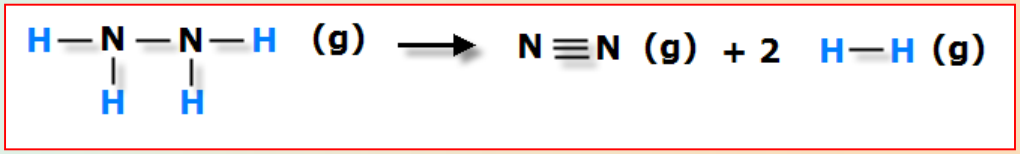

Bond enthalpies of bonds broken:

4 mol N-H ... 4 * 391 kJ = +1564 kJ
1 mol N-N ... 1 * 163 kJ = + 163 kJ
Sum of enthalpies... + 1727 kJ

Bond enthalpies of bonds formed:

2 mol H-H ... 2 * (-436 kJ) = -872 kJ
1 mol N≡N ... 1 * (-941 kJ) = - 941 kJ
Sum of enthalpies... - 1813 kJ

The overall reaction:

- 86 kJ

Average Bond Enthalpies (kJ/mol)

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