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Smoke Chemistry and Chemical Composition

Chemical Composition of Smoke

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Smoke is something that we will deal with all throughout our lives, in everyday situations as well as in emergencies. But not all smoke is the same -- in fact, the smoke will vary depending upon what is being burned. So then what, exactly, is smoke made of?

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Chemicals in Smoke

In addition to the chemicals listed in the table, wood smoke also contains a large amount of unreacted air, carbon dioxide, and water. It contains a variable amount of mold spores.

VOCs are volatile organic compounds. Aldehydes found in wood smoke include formaldehyde, acrolein, propionaldehyde, butyraldehyde, acetaldehyde, and furfural. Alkyl benzenes found in wood smoke include toluene. Oxygenated monoaromatics include guaiacol, phenol, syringol and catechol. Numerous PAHs or polycyclic aromatic hydrocarbons are found in smoke. Many trace elements are released.

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Chemical Composition of Wood Smoke

| Chemical | g/kg Wood |
|--------------------|-----------|
| carbon monoxide | 80-370 |
| methane | 14-25 |
| VOCs* (C2-C7) | 7-27 |
| aldehydes | 0.6-5.4 |
| substituted furans | 0.15-1.7 |
| benzene | 0.6-4.0 |
| alkyl benzenes | 1-6 |

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| | |
|--|---|
| sulfur dioxide | 0.16-0.24 |
| methyl chloride | 0.01-0.04 |
| naphthalene | 0.24-1.6 |
| substituted naphthalenes | 0.3-2.1 |
| oxygenated monoaromatics | 1-7 |
| total particle mass | 7-30 |
| particulate organic carbon <small>Advertisement</small> | 2-20 |
| oxygenated PAHs | 0.15-1 |
| Individual PAHs | 10^{-5} - 10^{-2} |
| chlorinated dioxins | 1×10^{-5} - 4×10^{-5} |
| normal alkanes (C ₂₄ -C ₃₀) | 1×10^{-3} - 6×10^{-3} |
| sodium | 3×10^{-3} - 2.8×10^{-2} |
| magnesium | 2×10^{-4} - 3×10^{-3} |
| aluminum | 1×10^{-4} - 2.4×10^{-2} |
| silicon | 3×10^{-4} - 3.1×10^{-2} |
| | $^{-3} \quad 9 \times 10^{-2}$ |
| | $^{-4} \quad 1 \times 10^{-2}$ |
| | $^{-3} \quad .6 \times 10^{-2}$ |
| | $^{-4} \quad 8 \times 10^{-2}$ |
| | $^{-5} \quad \times 10^{-3}$ |

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-6 $\times 10^{-3}$

-4 $\times 10^{-4}$

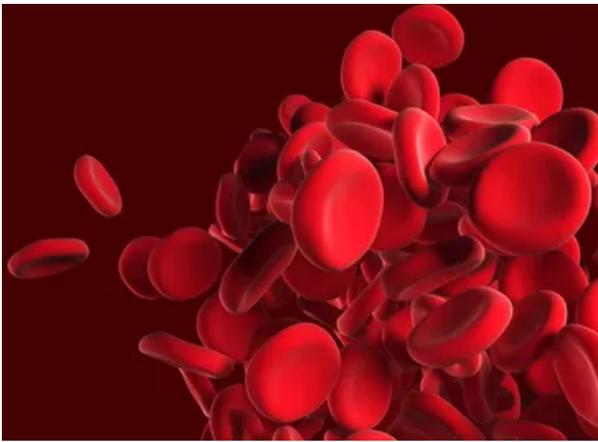
-4 $\times 10^{-3}$

-5 $\times 10^{-4}$

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1×10^{-4} - 3×10^{-3}

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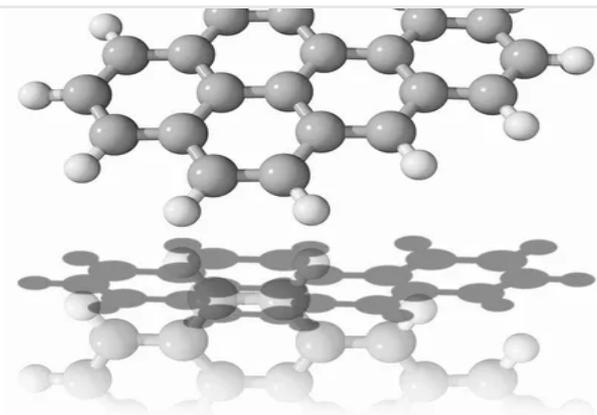


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Why Fire Is Hot

The energy required to start and sustain the combustion reaction is much less than the energy released by the combustion reaction.

- Requires activation energy to be ignited
- Breaking oxygen molecule bonds absorbs energy
- Requires little energy to keep burning
- Forming carbon dioxide and water bonds releases heat energy

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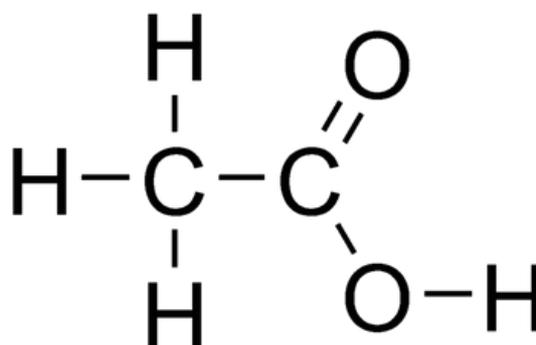
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Why Fire Is Hot (and How Hot It Is)

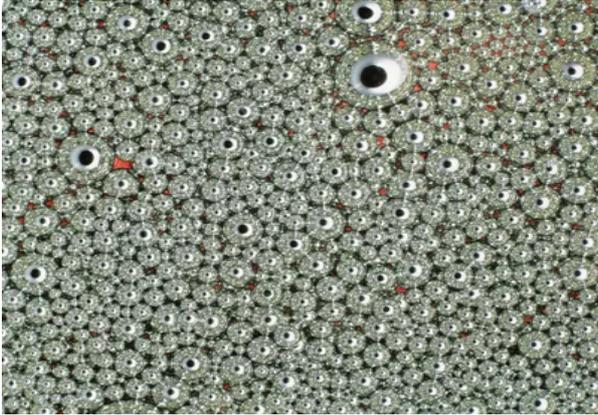


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