

Alcohol Combustion Enthalpy and Soot Production

How does the Molar Enthalpy of Incomplete Combustion of Alcohols (Methanol, Ethanol, Propanol, Butanol, and Octanol) Affect the Mass of Soot Produced per Mole of Alcohol, in the Incomplete Combustion of Alcohol?

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Abstract

This research investigation examined the relationship between the molar enthalpy of incomplete combustion of alcohols and the mass of soot produced per mole of alcohol during incomplete combustion. Five alcohol fuels, methanol, ethanol, propanol, butanol, and octanol, were combusted under oxygen-limited conditions to evaluate how molecular structure and energy release influence soot formation. The molar enthalpy of incomplete combustion was determined through calorimetry, while soot production was measured by quantifying the deposited soot mass and normalizing it by the amount of alcohol combusted. The relationship between combustion energy release and soot production was analyzed using the incomplete combustion model, where insufficient oxygen availability results in the formation of solid carbon alongside carbon monoxide, carbon dioxide, and water. Experimental results showed a strong linear correlation between the magnitude of molar enthalpy of incomplete combustion and soot production, described by the relationship $M = -0.004(\Delta H_c) - 0.478$, where M represents soot mass per mole of alcohol. The fitted model produced a coefficient of determination of $R^2 = 0.986$, indicating that combustion enthalpy strongly predicts soot production within the tested range. Although systematic differences were observed between experimental and theoretical values due to incomplete carbon conversion and measurement limitations, the overall trend supported the hypothesis that higher-carbon alcohols with greater combustion enthalpy produce larger quantities of soot. These findings demonstrate the relationship between fuel energy content and pollutant formation during incomplete combustion.