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Effect of Pressure on the Heat Transfer and Flame Characteristics of Small-Scale Ethanol Pool Fires

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Abstract

Fire research with regard to high pressure is important for safety design and fire prevention under a high-pressure environment, such as nuclear containment shells during a pressurized period and deep-sea submersibles. To investigate the effect of high pressure on fire behavior, studies on ethanol pool fires using 1.5-cm- and 2.0-cm-diameter glass vessels were conducted under a wide pressure range of 1-5 atm. Results show that high pressure significantly impacts the heat transfer and flame characteristics of small-scale ethanol pool fires. As pressure increases, the fuel burning rate decreases slightly and then increases considerably, which is attributed to the effect of pressure on heat transfers. As pressure increases, the flame becomes unstable with the color changing from blue to yellow. Moreover, the flame height of the 1.5-cm-diameter pool fire increases over the entire pressure range whereas the flame height of the 2.0-cm-diameter pool fire increases until its peak value is reached at 2 atm and then decreases gradually. Then, a global correlation of flame height for small-scale ethanol pool fires is analyzed and verified using the experimental results. Flame puffing frequency increases with pressure for both pool sizes; hence, the Strouhal number correlates well with the Froude number.