Flame spectra of hydrogen combusting flames and energy input into glass melt

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Abstract

Hydrogen combustion is one of the most promising abilities to reduce the carbon footprint of glass production. As hydrogen containing flames get more and more invisible for human eyes with increasing hydrogen content in the fuel gas, one big question is, whether the heat transfer into glass melt is sufficient for high melting temperature and good glass quality.
Industrial combustion in high temperature furnaces lives on the heat exchange of the gas radiation of flames with surrounding components. These components are gaseous media (waste gas), refractory lining and the glass melt. The refractory linings are surface radiators whereas waste gases are semi-transparent media just as glass melts. The resulting total radiation and the heat radiation exchange with the melt can be used to determine the differences of heat input into the melt when comparing different fuel gas compositions. The optical properties (transition, absorbance, reflection and emission) of the different ingredients of the total radiation needs to be known as function of the wavelength (UV-VIS-IR) to calculate the heat transfer into the melt.

A two-dimensional model is used to calculate the heat radiation between the glass melt and the crown. The combustion room was filled with hot waste gases of different temperatures and the flame as the component with the highest temperature. Interreflection of the single radiation sources at the boundaries is taken into account. The adiabatic flame temperature is used to estimate the temperature of the flame and of the waste gases.
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Keywords: flame spectrum, hydrogen combustion, heat radiation

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