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Predicting the visibility of a chemical vapor plume using schlieren optics RORY BIGGER, GARY SETTLES, Penn State — Chemicals plumes from a freely-evaporating liquid surface and from the exit of a circular pipe are considered. For the freely-evaporating case, the visibility of fourteen chemicals was tested in two schlieren optical systems. One system was a modest bench-top system and the other was a lard system of extraordinary sensitivity. Plume visibility was found to be a function of the vapor pressure and vapor refractive index. An empirical fit to the plume-visibility data, compared with the sensitivities of these systems (measured using a standard-lens method), suggests guidelines for predicting the visibility of plumes of other chemicals using other schlieren equipment. For the circular opening case, plume visibility of the same chemicals was found to be a function of plume geometry and refractive index. The peak light-ray deflections (also measured with a standard lens) caused by plumes of two different sizes were found to scale based on plume geometry. This scaling information and plume refractive index can be used to predict plume visibility for arbitrary chemicals in arbitrary systems, if the system sensitivity is known. One application of this work lies in the optical detection of plumes emitted by contraband material.

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