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Environmental Engineering Air Pollution and Control

Study of Visible Exhaust Smoke from Aircraft Jet Engines

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Abstract: The objective of this study was to relate the visibility of inflight jet exhaust to the SAE smoke number. A method based on photographic photometry was developed for measuring the optical density of smoke plumes. This method was related to visibility and to the smoke number through transmissometer measurements and visibility theory. A portable transmissometer, capable of operating over a wide range of optical path lengths and under varying ambient light conditions was fabricated for use on this study. The mathematical expression relating the transmission measurements to the smoke number was derived. Liminal visibility requirements of smoke trails, developed from light scattering theory, correlated with actual visual observations and the transmissometer and photometry measurements. Test results, with the engines investigated, indicate that SAE smoke numbers below 23 were associated with invisible exhaust plumes. Samples of the exhaust smoke showed the particles to be composed of lacy agglomerates. At the nozzle, the geometric median particle diameter was 0.052 micrometers. At a distance of 10 nozzle diameters the geometric median particle diameter was 0.13 micrometer at cruise condition.

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