RB-011

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RB-011: Grease Aerosol Transport and Deposition in Open Environments

P3 — Frontier

EXECUTIVE SUMMARY

This paper characterizes the generation, transport, and deposition of grease aerosol produced during outdoor barbecue cooking. Drawing on aerosol physics, Stokes settling law, and the buoyant plume framework established in RB-001, it models the particle size distribution of cooking-generated grease aerosol (0.01 to 100 micrometers), quantifies gravitational settling velocities and transport distances under wind conditions analyzed in RB-006, and characterizes deposition patterns in the missed plume region identified in RB-007. The paper establishes that fine grease aerosol (less than 2.5 micrometers) can travel tens to hundreds of meters downwind, while coarse droplets (greater than 10 micrometers) deposit within 1 to 5 meters of the source. Fire risk implications of grease deposition on adjacent combustible surfaces are analyzed, with accumulation rate estimates for surfaces at various distances from the cooking source.

THE CHALLENGE

When an outdoor barbecue hood achieves complete capture of the **Buoyant Cooking Plume**, grease aerosol is intercepted at the **Plume Interception Plane**, passes through the hood's grease filters, and is either collected in the filter system or exhausted through the duct. In this scenario, grease deposition on surrounding surfaces is minimal and fire risk from grease accumulation is confined to the hood and duct interior.

Outdoor Ventilation Standard

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Key Quantitative Findings

Mass contribution: less than 5% of total aerosol mass (despite dominating particle count)

Mass contribution: 20 to 50% of total aerosol mass

Mass contribution: 50 to 80% of total aerosol mass (a small number of large droplets carry the majority of the grease mass)

Behavior: settling velocity is significant (10^(-3) to 0.3 m/s); particles above 20 micrometers settle rapidly and deposit within meters of the source; particles between 2.5 and 10 micrometers can travel tens of meters

g = gravitational acceleration = 9.81 m/s^2

Ultrafine mode (less than 0.1 micrometers): 3% = 3 mg/min

Accumulation mode (0.1 to 2.5 micrometers): 30% = 30 mg/min

Coarse mode (greater than 2.5 micrometers): 67% = 67 mg/min

The critical particle diameter at which the settling velocity equals 1% of the weakest plume centerline velocity (approximately 1.0 m/s at 48 inches for the charcoal kettle) is:

40% of the mass is in droplets larger than 50 micrometers (approximately 12 mg/min). These deposit within 1 meter of the escape point — on the hood exterior, adjacent countertop, and the immediate deck area directly downwind.

Why This Research Matters

This research provides the first physics-based, quantitative methodology for outdoor cooking ventilation design. These findings enable proper hood sizing, CFM specification, and mounting height selection — preventing the common failures that occur when indoor assumptions are applied outdoors.

The Full Research Paper Includes:

✓ Complete derivations and governing equations
✓ Quantitative design tables and correction factors
✓ Engineering methodology with worked examples

✓ Interactive calculation tools and diagrams
✓ Full reference bibliography and validation data