RB-005

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RB-005: Impact of Hood Geometry on Capture Performance

P1 — Core

EXECUTIVE SUMMARY

This paper systematically analyzes each geometric dimension of the outdoor barbecue ventilation hood and its effect on plume capture performance. It delivers minimum and recommended overhang requirements, width-versus-depth asymmetry analysis, hood lip improvement factors, canopy shape comparison, internal volume and baffle effects, geometry-CFM interaction models, and consolidated design guideline tables for every source type at every standard mounting height.

THE CHALLENGE

The hood is the physical interface between the rising **Buoyant Cooking Plume** and the exhaust system. Its geometry defines three critical quantities:

Outdoor Ventilation Standard

Scan for full research paper

Key Quantitative Findings

For a medium gas grill at 30 inches with Q_exhaust = 609 CFM = 0.287 m^3/s:

OH_min: Using the minimum hood width W_min = d_capture (the Heskestad capture diameter, corresponding to 98% time-averaged flux capture in quiescent conditions). This provides no margin for turbulence, wind, or instantaneous plume fluctuation and is the absolute minimum for any capture.

Rear overhang: If the hood is against a wall or backsplash, the wall provides a physical barrier that prevents plume escape to the rear. In wall-mount installations, the rear overhang can be reduced to 6-8 inches (sufficient to prevent thermal damage to the wall surface), because any plume gas that reaches the wall is redirected upward by the wall's blocking effect. The wall acts as a natural extension of the Capture Envelope on the rear side.

For a medium gas grill at 30 inches with Q_exhaust = 609 CFM, Q_plume = 203 CFM, P_hood = 2*(57+53) = 220 inches = 5.59 m:

Key finding: The tapered canopy with baffles is the most effective shape for outdoor capture, achieving eta_uniformity of 0.75-0.85 (75-85% Effective Capture Area)

For the range of exhaust rates in this program (144-1623 CFM):

Beyond approximately 1.5x the required CFM, the improvement per unit of additional CFM becomes small relative to the noise and energy cost.

Design recommendation: Size the blower to provide 1.0x to 1.3x the required CFM from RB-003 Tables 3.8a/b

A blower that provides 150% of the required CFM in a hood that is 80% of the required width will perform worse than a blower at 100% of the required CFM in a hood at 100% of the required width.

For a properly baffled 57" x 53" hood at 609 CFM:

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