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JOB Honda Die Cast
SHEET NO. ________ OF ________
CALCULATED BY ________ DATE ________
CHECKED BY ________ DATE ________
SCALE ________

Duct Opening total open area 8" x 20" x 6 pcs. = 6.6 sq ft

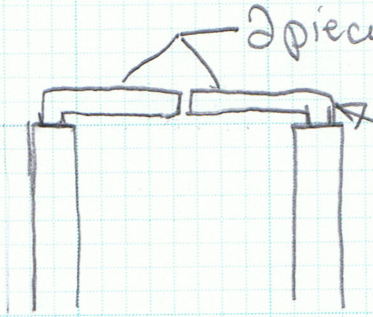
Air Volume at last test (New Plenum) 6970 cfm
(Rating 7,050)

Velocity at each slot 1046 fpm

Adding new plenum to Front Slot opening 84" x 6" = 3.5 sq ft

New Slot Velocity for 6 opening 8" x 20" + 6" x 84" = 10.1 sq ft
690 fpm

2 pieces will maintain more even face velocity



6" x 6" x 6"
84" of Slot

3.1 INTRODUCTION

Local exhaust systems are designed to capture and remove process emissions prior to their escape into the workplace environment. The local exhaust hood is the point of entry into the exhaust system and is defined herein to include all suction openings regardless of their physical configuration. The primary function of the hood is to create an air flow field that will effectively capture the contaminant and transport it into the hood. Figure 3-1 provides nomenclature associated with local exhaust hoods.

3.2 CONTAMINANT CHARACTERISTICS

3.2.1 Inertial Effects. Gases, vapors, and fumes will not exhibit significant inertial effects. Also, fine dust particles, 20 microns or less in diameter (which includes respirable particles), will not exhibit significant inertial effects. These materials will move solely with respect to the air in which they are mixed. In such cases, the hood needs to generate an air flow pattern and capture velocity sufficient to control the motion of the contaminant-laden air plus extraneous air currents caused by room cross-drafts, vehicular traffic, etc.

3.2.2 Effect of Specific Gravity. Frequently, the location of exhaust hoods is mistakenly based on a supposition that the contaminant is "heavier than air" or "lighter than air." In most health hazard applications, this criterion is of little value (see Figure 3-2). Hazardous fine dust particles, fumes, vapors, and gases are truly airborne, following air currents and are not subject to appreciable motion either upward or downward because of their own density. Normal air movement will assure an even mixture of these contaminants. Exception to these observations may occur with very hot or very cold operations or where a contaminant is generated at very high levels and control is achieved before the contaminant becomes diluted.

3.2.3 Wake Effects. As air flows around an object a phenomenon known as "boundary layer separation" occurs. This results in the formation of a turbulent wake on the downstream side of the object similar to what is observed as a ship moves through the water. The wake is a region of vigorous mixing and recirculation. If the object in question is a person who is working with, or close to, a contaminant generating source, recirculation of the contaminant into the breathing zone is likely. An important consideration in the design of ventilation for contaminant control is minimizing this wake around the human body and, to the extent possible, keeping contaminant sources out of these recirculating regions (see also Section 3.4.6).

3.3 HOOD TYPES

Hoods may be of a wide range of physical configurations but can be grouped into two general categories: enclosing and exterior. The type of hood to be used will be dependent on the physical characteristics of the process equipment, the contaminant generation mechanism, and the operator/equipment interface (see Figure 3-3).

3.3.1 Enclosing Hoods. Enclosing hoods are those that completely or partially enclose the process or contaminant generation point. A complete enclosure would be a laboratory glove box or similar type of enclosure where only minimal openings exist. A partial enclosure would be a laboratory hood or paint spray booth. An inward flow of air through the enclosure opening will contain the contaminant within the enclosure and prevents its escape into the work environment.

The enclosing hood is preferred wherever the process configuration and operation will permit. If complete enclosure is not feasible, partial enclosure should be used to the maximum extent possible (see Figure 3-3).

3.3.2 Exterior Hoods. Exterior hoods are those that are located adjacent to an emission source without enclosing it. Examples of exterior hoods are slots along the edge of the tank or a rectangular opening on a welding table.

Where the contaminant is a gas, vapor, or fine particulate and is not emitted with any significant velocity, the hood orientation is not critical. However, if the contaminant contains large particulates that are emitted with a significant velocity, the hood should be located in the path of the emission. An example would be a grinding operation (see VS-80-11).

If the process emits hot contaminated air, it will rise due to thermal buoyancy. Use of a side–draft exterior hood (located horizontally from the hot process) may not provide satisfactory capture due to the inability of the hood induced air flow to overcome the thermally induced air flow. This will be especially true for very high temperature processes such as a melting furnace. In such cases, a canopy hood located over the process may be indicated (see Section 3.8).

A variation of the exterior hood is the push-pull system (See Chapter 10.72). In this case, a jet of air is pushed across a contaminant source into the flow field of a hood. Contaminant control is primarily achieved by the jet. The function of the exhaust hood is to receive the jet and remove it. The advantage of the push-pull system is that the push jet can travel in a controlled manner over much greater distances than air can be drawn by an exhaust hood alone. The push–pull system is used successfully for some plating and open surface vessel operations but has potential application for many other processes. However, the push portion of the system has potential for increasing operator exposure if not properly designed, installed, or operated. Care must be taken to ensure proper design, application, and operation.

3.4 HOOD DESIGN FACTORS

Capture and control of contaminants will be achieved by the inward air flow created by the exhaust hood. Air flow toward the hood opening must be sufficiently high to maintain control of the contaminant until it reaches the hood. External air motion may disturb the hood-induced air flow and require higher air flow rates to overcome the disturbing effects. Elimination of sources of external air motion is an important factor in achieving effective control without the need for excessive air flow and its associated cost. Important sources of air motion are:

- Thermal air currents, especially from hot processes or heat-generating operations.
- Motion of machinery, as by a grinding wheel, belt conveyor, etc.
- Material motion, as in dumping or container filling.
- Movements of the operator.
- Room air currents (which are usually taken at 50 fpm minimum and may be much higher).
- Rapid air movement caused by spot cooling and heating equipment.

The shape of the hood, its size, location, and rate of air flow are important design considerations.

3.4.1 Capture Velocity. The minimum hood-induced air velocity necessary to capture and convey the contaminant into the hood is referred to as capture velocity. This velocity will be a result of the hood air flow rate and hood configuration.

Exceptionally high air flow hoods (example, large foundry side-draft shakeout hoods) may require less air flow than would be indicated by the capture velocity values recommended for small hoods. This phenomenon may be ascribed to:

- The presence of a large air mass moving into the hood.
- The fact that the contaminant is under the influence of the hood for a much longer time than is the case with small hoods.
- The fact that the large air flow rate affords considerable dilution as described above.

Table 3-1 offers capture velocity data. Additional information is found in Chapter 10.

3.4.2 Hood Flow Rate Determination. Within the bounds of flanges, baffles, adjacent walls, etc., air will move into an opening under suction from all directions. For an enclosure, the capture velocity at the enclosed opening(s) will be the exhaust flow rate divided by the opening area. The capture velocity at a given point in front of the exterior hood will be established by the hood air flow through the geometric surface which contains the point.

As an example, for a theoretical unbounded point suction source, the point in question would be on the surface of a sphere whose center is the suction point (Figure 3-4).

The surface area of a sphere is $4\pi X^2$. Using $V = Q/A$ (Equation 1.3), the velocity at point X on the sphere's surface can be given by

$$Q = V(4\pi X^2) = 12.57VX^2 \qquad [3.1]$$

where: Q = air flow into suction point, cfm
V = velocity at distance X, fpm
$A = 4\pi X^2$ = area of sphere, ft^2
X = radius of sphere, ft

Similarly, if an unbounded line source were considered, the surface would be that of a cylinder and the flow rate (neglecting end effects) would be

$$Q = V(2\pi XL) = 6.28\ VXL \qquad [3.2]$$

where: L = length of line source, ft

Equations 3.1 and 3.2 illustrate, on a theoretical basis, the relationship between distance, flow, and capture velocity and can be used for gross estimation purposes. In actual practice, however, suction sources are not points or lines, but rather have physical dimensions that cause the flow surface to deviate from the standard geometric shape. Velocity contours have been determined experimentally. Flow[3.3] for round hoods, and rectangular hoods which are essentially square, can be approximated by

TABLE 3-1. Range of Capture Velocities[3.1,3.2]

Condition of Dispersion of Contaminant	Example	Capture Velocity, fpm
Released with practically no velocity into quiet air.	Evaporation from tanks; degreasing, etc.	50-100
Released at low velocity into moderately still air.	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100-200
Active generation into zone of rapid air motion.	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	200-500
Released at high initial velocity into zone at very rapid air motion.	Grinding; abrasive blasting; tumbling	500-2000

In each category above, a range of capture velocity is shown. The proper choice of values depends on several factors:

Lower End of Range	*Upper End of Range*
1. Room air currents minimal or favorable to capture.	1. Disturbing room air currents.
2. Contaminants of low toxicity or of nuisance value only.	2. Contaminants of high toxicity.
3. Intermittent, low production.	3. High production, heavy use.
4. Large hood-large air mass in motion.	4. Small hood-local control only.

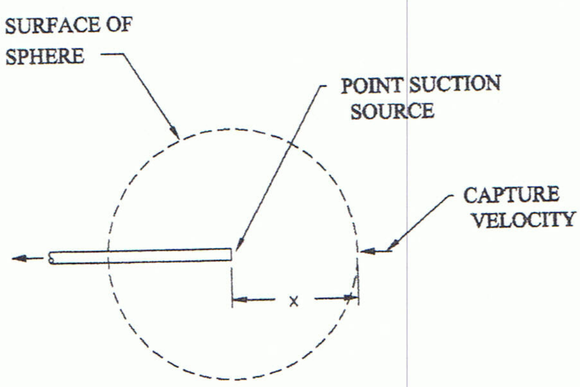


FIGURE 3-4. Point suction source

$$Q = V(10X^2 + A) \quad [3.3]$$

where: Q = air flow, cfm

V = centerline velocity at X distance from hood, fpm

X = distance outward along axis in ft. (NOTE: equation is accurate only for limited distance of X, where X is within 1.5 D)

A = area of hood opening, ft^2

D = diameter of round hoods or side of essentially square hoods, ft

Where distances of X are greater than 1.5 D, the flow rate increases less rapidly with distance than Equation 3.3 indicates.[3.4-3.5]

It can be seen from Equation 3.3 that velocity decreases inversely with the square of the distance from the hood (see Figure 3-5.)

Figures 3-6 and 3-7 show flow contours and streamlines for plane and flanged circular hood openings. Flow contours are lines of equal velocity in front of a hood. Similarly, streamlines are lines perpendicular to velocity contours. (The tangent to a streamline at any point indicates the direction of air flow at that point.)

Flow capture velocity equations for various hood configurations are provided in Figures 3-8, 3-9, 3-10, and 3-11.

3.4.3 Effects of Flanges and Baffles. A flange is a surface at and parallel to the hood face that provides a barrier to unwanted air flow from behind the hood. A baffle is a surface that provides a barrier to unwanted air flow from the front or sides of the hood.

If the suction source were located on a plane, the flow area would be reduced (1/2 in both cases), thereby decreasing the flow rate required to achieve the same velocity. A flange around a hood opening has the same effect of decreasing the required flow rate to achieve a given capture velocity. In practice, flanging can decrease flow rate (or increase velocity) by approximately 25% (see Figures 3-6, 3-7, and 3-11). For most applications, the flange width should be equal to the square root of the hood area $(\sqrt{A})$.

Baffles can provide a similar effect. The magnitude of the effort will depend on the baffle location and size.

Figure 3-11 illustrates several hood types and gives the velocity/flow formulas that apply.

A summary of other equations for hood velocity and the impact of cross-drafts on hood performance can be found in Reference 3.23.

3.4.4 Air Distribution. Slot hoods are defined as hoods with an opening width to length ratio (W/L) of 0.2 or less. Slot hoods are most commonly used to provide uniform exhaust air flow and an adequate capture velocity over a finite length of contaminant generation, e.g., an open tank or over the face of a large hood such as a side-draft design. The function of the slot is solely to provide uniform air distribution. Slot velocity does not contribute toward capture velocity. A high slot velocity simply generates high pressure losses. Note that the capture velocity equation (Figure 3-11) shows that capture velocity is related to the exhaust volume and the slot length, not to the slot velocity.

Slot hoods usually consist of a narrow exhaust opening and a plenum chamber. Uniform exhaust air distribution across the slot is obtained by sizing slot width and plenum depth so that velocity through the slot is much higher than in the plenum. Splitter vanes may be used in the plenum; however, in most

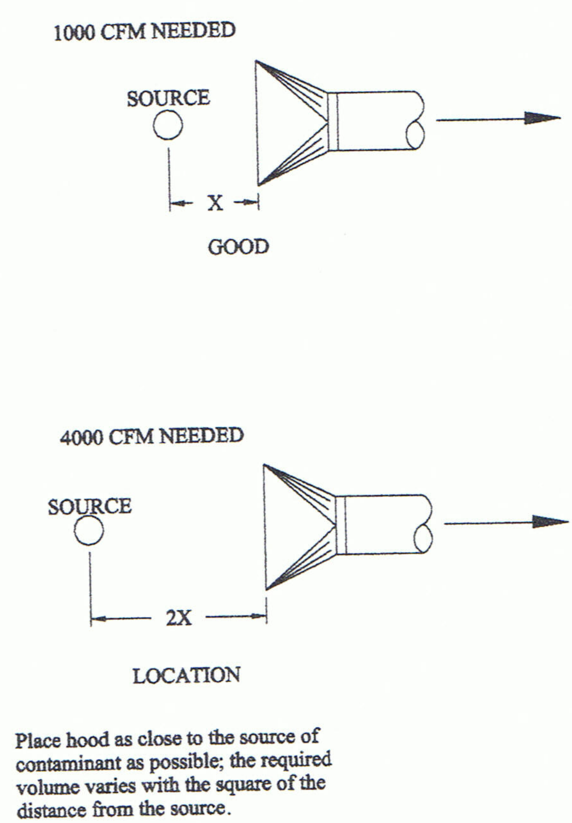


FIGURE 3-5. Flow rate as distance from hood