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Convenient Flows Using Flow-Metered Vaporizers

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It is common practice at our institution to use a 5 liters/minute total diluent gas flow (O₂ or N₂O/O₂) when administering halothane via a flow-metered vaporizer (Copper Kettle, Vernitrol, etc.). The oxygen flow through the vaporizer in ml./minute then indicates, without further calculation, the approximate percentage delivered times 100 over the anesthetic range (e.g., 100 ml./minute indicates 1 per cent). It is possible to derive a simple, somewhat general expression for such a diluent gas flow using any applicable agent.

Total diluent gas flow (liters/minute)

$$= \frac{\text{Vapor pressure of agent} \times 10}{\text{Barometric pressure} - \text{Vapor pressure of agent}}$$

Typical values near sea level and room temperature are:

Halothane	5 liters/minute
Fluroxene	6 litres/minute
Chloroform	3 liters/minute
Ether	14 liters/minute

The expression assumes complete equilibrium in the vaporizer and negligible flow through the vaporizer compared to the total gas flow. The error introduced by this latter assumption is negative and directly proportional to the

flow through the vaporizer (e.g., with a 100 ml./minute flow using halothane 0.97 per cent would be delivered, 3 per cent less; with a 500 ml./minute flow 4.25 per cent would be delivered, 15 per cent less). Agents with very low vapor pressures (e.g., trichloroethylene, methoxyflurane) require high flows through the vaporizer and thus introduce excessive errors. Total diluent flows can, when desired, be conveniently changed by multiples if the vaporizer flows are interpreted accordingly.

The expression is derived as follows:

Let: *A* = flow of anesthetic vapor from vaporizer (ml./minute)

P_V = anesthetic vapor pressure at room temperature (mm. Hg)

V = oxygen flow through vaporizer (ml./minute)

D = total diluent gas flow (ml./minute)

P_B = barometric pressure (mm. Hg)

Then the per cent agent from the vaporizer is

$$\frac{A}{A + V} \times 100 = \frac{P_V}{P_B} \times 100$$

(assuming complete equilibrium) (1)

and the final delivered per cent is

$$\frac{A}{A + V + D} \times 100$$

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which should equal the flow through the vaporizer $\times 100$.

$$\frac{A}{A + V + D} \times 100 \times 100 = V \quad (2)$$

Solving (1) for V and substituting in (2) yields

$$\frac{A}{A + V + D} \times 100 \times 100 = \frac{A}{P_V} (P_B - P_V).$$

If $A + V$ is negligible compared to the whole denominator, it can be dropped and simplifica-

tion gives

$$\frac{10^4}{D} = \frac{P_B - P_V}{P_V} \quad \text{or} \quad D = \frac{P_V \times 10^4}{P_B - P_V}.$$

The per cent error in the final delivered gas assuming $A + V$ to be negligible is

$$\left[\frac{A}{A + V + D} - \frac{A}{D} \right] \times 100$$

$$\left[\frac{A}{A + V + D} \right]$$

which simplifies, using the above relations, to

$$\frac{V \times P_B}{100 \times P_V}.$$

GADGETS

Clip-Type Syringe Holder

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Two Gibson † gripper clips, No. 225-L, capacity $\frac{3}{4}$ inch, $1\frac{1}{4}$ inches diameter, fastened together at right angles, either riveted or bolted together with a no. 6-32 by $\frac{1}{4}$ inch screw makes a practical syringe holder. The

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† Gibson Good Tools, Inc., 75 Pearl Street, Sidney, New York.

horizontal gripper clip snaps on to the infusion pole and the vertical one serves to hold firmly a 20-ml. syringe. One may use the sides of the horizontal gripper clip to snap on an aneroid blood pressure gauge.

The cost of this practical syringe holder for continuous administration of intravenous anesthesia is minimal.

