Letters to the Editor

A Method to Quickly Estimate Remaining Time for an Oxygen E-Cylinder

To the Editor:

With the growing use of out-of-hospital resuscitation, as well as office practice anesthesia, and hospital-based anesthesia in suites other than the operating room, the dependence on oxygen delivery from E-cylinders will continue to increase. Therefore, it is paramount that practitioners have a simple means of determining the remaining time of pressurized oxygen supplied in this manner.

The remaining time, for oxygen delivery from an E-cylinder, can be readily estimated using the following formula:

$$t = \text{Remaining Time} \approx \frac{\text{Remaining Pressure}}{200 \times \text{Flow Rate}} \quad (1)$$

where remaining time, t, is expressed in hours, remaining pressure is in pounds per square inch or PSI, and flow rate is in liters per minute. This formula slightly underestimates the available time and thus provides a "safety margin." The derivation of equation 1 and the formula to determine a "more exact" remaining time are both shown in the Appendix.

Example 1: If 1000 PSI is remaining in an E-cylinder and the flow rate is 5 L/min, the remaining time is readily estimated to be 1 h:

$$\frac{1000}{200 \times 5} = \frac{1000}{1000} = 1 \text{ hour} \quad (2)$$

Using the "more exact" method, from the Appendix, the remaining time is found to be 1.16 h.

Example 2: With 300 PSI in an E-cylinder and a flow rate of 2 L/min, the remaining time can be approximated as:

$$\frac{300}{200 \times 2} = \frac{300}{400} = 0.75 \text{ hours} \quad (3)$$

whereas the "more exact" method yields a calculated remaining time of 0.87 h.

Thus, this approximate formula should be helpful for quickly estimating the remaining time of available oxygen in those situations that depend on E-cylinders.

Appendix: The pressure-volume relationship for oxygen stored in an E-cylinder is characterized by Boyle's law where the product of pressure and volume remain constant:

$$P_i \times V_i = P_r \times V_r \quad (1A)$$

where P and V refer to pressure and volume, respectively. The subscripts i and r denote initial and remaining conditions. Substituting the product of flow rate, Q, and remaining time, t, for V_i yields:

$$P_i \times Q \cdot t = P_r \times V_r \quad (2A)$$

Solving for t yields the "more exact" method of determining remaining time:

$$t = \frac{P_r \times V_r}{P_i \times Q \times 60} \quad (3A)$$

This formula uses typical units for pressure of pounds per square inch, volume in liters, and flow rate in liters per minute. The 60 in the denominator converts minutes into hours. It should be noted that V_r is the volume of the E-cylinder. The usual values for P_i and V_r are 1900 PSI and 660 L, respectively.

The approximate formula is based on rounding V_r down to 600 L and using a value of 2000 PSI for P_i. This also creates a "margin of safety" for the estimated remaining time:

$$t = \frac{P_r \times 600}{2000 \times Q \times 60} = \frac{P_r}{200 \times Q} \quad (4A)$$

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