

Anesthetic Vaporizers

Anesthetic Pearls: The Anesthetic Implications of Vaporizer Designs and Differences

*** **Anesthetic vaporizer output is absolutely dependent on vapor pressure.**

I. Bubble-through design

1. Vapor pressure of agent
2. Temperature
3. Flow rate of carrier gas
4. May be influenced by back pressure on system "pumping effect"

II. Variable bypass vaporizer

- A. Ohmeda TEC 4 & TEC 5; Dräger Vapor 19.1
- B. Variable bypass, flow over, temperature compensated, agent specific, out-of-circuit design

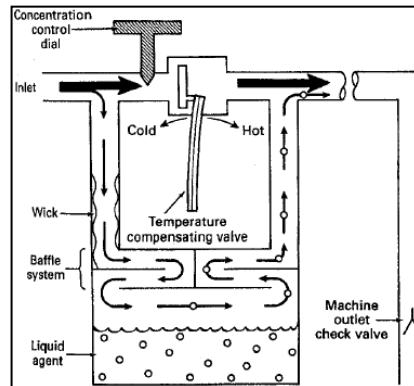


Fig. 9-16. Simplified schematic of the Ohmeda Tec 4 vaporizer. See text for details. (From Andrews,¹⁴³ with permission.)

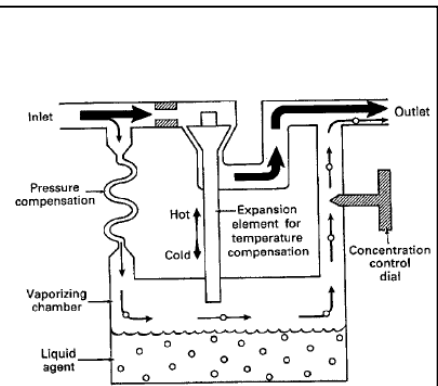


Fig. 9-18. Simplified schematic of the North American Dräger 19.1 vaporizer. See text for details. (From Andrews,¹⁴³ with permission.)

1. **Flow rate:** At extremes (< 250 ml/min or > 15 L/min) the concentration delivered is less than dial setting.
2. **Temperature:** Near linear delivery of set concentration (may have slight increase with high temperatures).
3. **Intermittent back-pressure:** The "pumping effect" is caused by rapid changes in circuit pressure seen with positive pressure ventilation. Compression of gas in vaporizer chamber during inspiration is rapidly released with expiration which causes higher concentration delivery than set on dial (minimal effect with current vaporizers; more pronounced at low flow rates, low dial settings, and low liquid anesthetic levels in vaporizer).
4. **Carrier gas composition:** Likely related to viscosity / density of carrier gases and variable solubility of anesthetic agents in different gases. With current vaporizers, high nitrous oxide concentrations can lead to the delivery of agent that is lower than the dial setting.
5. **Atmospheric pressure:** Current vaporizers deliver the same partial pressure at altitude as at sea level. There is no need to change dial setting for MAC when using current vaporizers at high altitude.
6. **Overdose** can occur if the vaporizer is tipped or overfilled. These conditions lead to liquid agent in the bypass chamber and can thereby lead to delivery of up to 10 times the dial setting (flush vaporizer with high flow gas with vaporizer set at low output for 20-30 minutes if it has been tipped or overfilled).
7. **Wrong agent in vaporizer:** The effect is dependent on the relative vapor pressure of agent put in compared to that of agent for which vaporizer is designed.
 - a. Halothane vaporizer set to 1% (1.25 MAC) but filled with Isoflurane delivers 0.96% (0.84 MAC); but filled with Enflurane delivers 0.62% (0.37 MAC)
 - b. Isoflurane vaporizer set to 1.5% (1.3 MAC) but filled with Halothane delivers 1.56% (1.95 MAC); but filled with Enflurane delivers 0.97% (0.57 MAC)
 - c. Enflurane vaporizer set to 2% (1.19 MAC) but filled with Halothane delivers 3.21% (4 MAC); but filled with Isoflurane delivers 3.1% (2.69 MAC)

III. Electrically heated, pressurized vaporizer (Desflurane TEC-6)

- A. Varied altitude: This vaporizer delivers a concentration based on absolute pressure. Therefore, at altitude, the volume delivered will be less than dial setting.
- B. Carrier gas composition: The vaporizer output is lowered when using air or nitrous oxide instead of 100% oxygen.