VENTILATOR PROBLEMS CAUSED BY HUMIDITY IN THE AIR SUPPLIED FROM SIMPLE COMPRESSORS

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SUMMARY

Relative humidity of air produced by simple compressors used to drive ventilators was measured at different working pressures. At normal working pressures, a relative humidity of 100% was found and condensation occurred, mainly at the high pressure air/oxygen mixer valve. This resulted in blockages and loss of accuracy which could have serious consequences for patients. It was concluded that simple compressors are unsuitable and that medical air must be used.

The Siemens Servo-900B ventilator is driven by gas derived from a high pressure air/oxygen mixer unit and requires a minimum operating pressure of 200 kPa. When medical air is not available, the ventilators are supplied with compressors which are of the reciprocating piston, oil-free type, without air drying facilities but fitted with cooling coils. Difficulties were encountered because of condensation and water collection in the mixer unit which affected the performance and reliability of the ventilator system. This particular problem has not been reported and prompted our investigation of the characteristics of air produced by simple compressors.

METHODS

A test circuit consisting of a compressor, a cooling coil, a water trap, 2 m of flexible tubing and a mixer unit was set up and the temperature of the air measured at various points (fig. 1). The relative humidity before the mixer was measured by dew point estimation and values derived for the other points indicated. Measurements of relative humidity were made for working pressures between 0 and 207 kPa.

RESULTS

The measured values of temperature and relative humidity for a working pressure of 150 kPa are shown in figure 1. The measured data of relative humidity at various pressures are shown in figure 2 with a series of theoretical curves of relative humidity at various pressures indicated by dashed line. The solid lines represent the theoretical relationship of relative humidity with working pressure for initial values of relative humidity of 30%, 43% and 60%. (N.B. The theoretical values were consistently greater than experimental.)

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humidity \( v. \) pressure derived from the application of the Ideal Gas Laws.

**DISCUSSION**

The relative humidity of air delivered from a compressor is directly proportional to the working pressure. It is apparent from figure 2 that air delivered to the mixer at a pressure of 170 kPa is fully saturated. Condensation must occur with air delivered at greater pressures, since the relative humidity cannot increase. The degree of condensation is proportional to the difference between the working pressure and the saturation pressure.

The relative humidity of room air which is drawn in by the compressor also affects the humidity of the output gas. If air is compressed to three times atmospheric pressure, then the relative humidity of the output gas will be approximately three times the relative humidity in the room at the same temperature. Thus room air with a relative humidity greater than 33% will produce problems of condensation.

High pressure air/oxygen mixer units provide an accurate method of controlling the oxygen concentration which is important for the proper management of patients. Although water in these units can prevent ventilation of the lungs by creating a blockage, we have found that water vapour also causes corrosion which affects the accuracy of the unit. This hazard has been reported in the literature (Report, 1979). Alternative low pressure mixing systems are normally incorporated within the ventilator and are driven by the cycling mechanism. Condensation is unlikely at the working pressures used (10 kPa). However, this method of mixing cannot be added easily to a ventilator designed to function from high pressure sources.

In conclusion, it is imperative to establish if a ventilator requires high pressure medical air (Memorandum, 1977) and, if so, simple compressors should not be used. Medical air is available from air cylinders, use of which is impractical in a busy I.C.U., from a pipe-line or from a special compressor incorporating desiccators.

**REFERENCES**
