

**SUBJECT: Turbine Powered Portable Ventilators Generate Elevated Temperature Gas that Can Adversely Impact Humidifier Performance**

A recent report in the Journal of Aerosol Medicine (J Aerosol Med 2002;15:7-13) documented that humidifier performance is adversely effected by elevated temperature of gas entering the humidifier. The higher the temperature, the lower the water content in the gas exiting the humidifier. According to the report, "Inlet gas temperatures above 26 degrees C may result in inadequate humidification."

Branson, Johannigman, Campbell and Davis of the Division of Trauma/Critical Care, University of Cincinnati produced a poster for the recent SCCM meeting that documents the gas outlet temperatures of six portable ventilators including: HT50, Newport – Dual piston, Achieva, Puritan Bennett – Piston, LTV 1000, Pulmonetic Systems – Turbine, Quantum, Respironics – Blower, Tbird, Viasys – Turbine, Eagle 754, Impact – Diaphragm pump.

According to Branson's poster, "As airway pressures and load increase, operating temperature of these driving systems increase. ...Turbine powered PV generate the highest temperatures due to high speeds and relative inefficiency."

The HT50, with its dual micro pistons, had one of the lowest and most stable output gas temperatures of the 6 ventilators tested. The output temperature remained at or very near to room temperature, regardless of PEEP level or mode of ventilation.

According to the results found by Branson's group, the gas temperatures found leaving the Viasys Tbird and Pulmonetic LTV are elevated and return to room temperature after about 48" of circuit tubing. This means that if the circuit tubing between the ventilator and the humidifier is not long enough (~48"), the gas entering the humidifier will be elevated. And according to the test results published in the Journal of Aerosol Medicine, the impact of putting heated air into a heated humidifier is that the humidifier will put less water into the gas before it is delivered to the patient.

In other words, if you don't use a long enough piece of circuit tubing between the ventilator outlet and the inlet to the humidifier, the Tbird and LTV will put warm air INTO a heated humidifier and compromise the humidity output of the heated humidifier. So at the same temperature setting on the humidifier, the patient receives less water content in the gas delivered to their airway.

The HT50 has a very low, stable gas outlet temperature and therefore has NO need for an extra long piece (48") of circuit tubing between the ventilator outlet and humidifier inlet to allow for gas cooling for the purpose of preserving humidifier efficiency.

If you have any questions about this information please contact Newport Clinical Marketing: 1.949.642.3910 ext. 218 or email: [clinical@newportnmi.com](mailto:clinical@newportnmi.com).



# Gas Temperature of Portable Ventilators

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## INTRODUCTION

New technology has allowed introduction of small, light weight portable ventilators (PV) capable of powerful performance. Key to the success of these devices has been the development of systems to create compressed air. PV compress air using pistons or turbines. As airway pressures and load increase, operating temperature of these driving systems increase. Heat is dissipated through the case of the PV and lost to the inspired gas. We measured the gas temperature at several intervals along the ventilator circuit from ventilator outlet to the y-piece using six PV at varying levels of PEEP and in both volume and pressure control.

## METHODS

Six ventilators were studied

- Achieva, Puritan Bennett – Piston (Fig #1)
- Eagle 754, Impact, - Diaphragm pump (Fig #2)
- HT-50, Newport Medical - Dual pistons (Fig #3)
- LTV 1000, Pulmonetic Systems – Turbine (Fig #4)
- Quantum, Respironics – Blower (Fig #5)
- Tbird, Viasys – Turbine (Fig #6)

All ventilators were connected to a test lung (TTL, Michigan Instruments) by the required 48" circuit. Tidal volume was set at 500 mL and respiratory rate at 20 breaths/min. Lung compliance was set at 0.1L/cm H2O and at 0.02 L/cm H2O and PEEP was varied from 0 to 20 cm H2O. Gas temperature was measured at the ventilator outlet, and 6, 12, 24, and 48" from the outlet. Gas temperature was measured using a Gibeck Temperature Humidity Sensor. The temperature sensor has a 90% response time less than 150 ms. The sampling rate of the device is 21 Hz. All signals were captured to a PC for later analysis.



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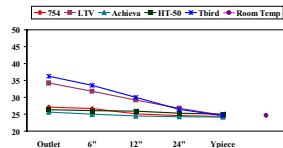


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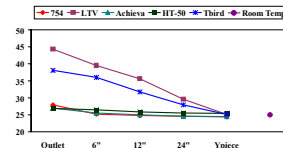


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## RESULTS

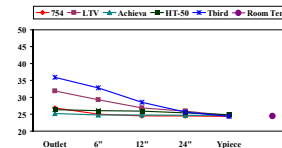


PEEP – 0 cm, CL – 0.02 L/cm  
Volume Control 500 mL x 20 bpm

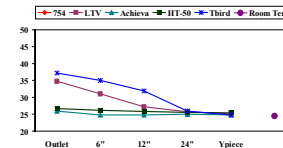


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Volume Control 500 mL x 20 bpm

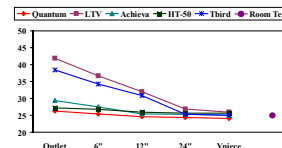
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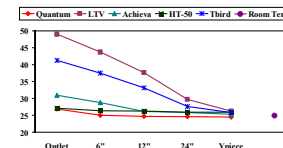
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Volume Control 500 mL x 20 bpm



PEEP – 20 cm, CL – 0.1 L/cm  
Volume Control 500 mL x 20 bpm



PEEP – 0 cm, CL – 0.1 L/cm  
Pressure control 45 x 20 bpm



PEEP – 20 cm, CL – 0.1 L/cm  
Pressure Control 45 x 20 bpm

## DISCUSSION/CONCLUSION

The development of powerful PV capable of generating compressed air via the driving mechanism has improved portability and flexibility. This study was undertaken after home care complaints that humidifier failure occurs with turbine based ventilators. A recent report documented that humidifier performance is adversely effected by elevated temperature of inspired gas. (*J Aerosol Med 2002;15:7-13*). Increasing the length from the ventilator outlet to the humidifier may help alleviate this problem. Turbine powered PV generate the highest temperatures due to high speeds and relative inefficiency. Gas temperatures dissipate quickly as humidity is low and over 48" inspired gases equilibrate closely with room temperature. The effects on humidifier performance should be carefully elucidated.