

# Performance of a Novel Humidification Device in Continuous Flow of Dry Gas

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PERFORMANCE OF A NOVEL HUMIDIFICATION DEVICE IN CONTINUOUS FLOW OF DRY GAS

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**Background:** A novel active humidification system has been developed which can heat and humidify dry therapeutic gases. This study measures the ability of this in-line humidification device (Pari Hydrate™, Pari Respiratory Equipment, Midlothian, VA) to heat and humidify dry therapeutic gas at high flows. The new technology (C-Force™, Pari Respiratory Equipment) produces water vapor in a pressurized stream from an in-line, small device placed proximal to the patient. A controller allows precise water introduction into the bottom of a ceramic disk. A heating plate on the top of the disk vaporizes the water inside the ceramic and the resultant vapor stream is directed into the gas flow. Energy efficiency is over 90% and there are no moving parts in the disk.

**Method:** The device housing the vaporizing disk was connected to a flowmeter by 1/8" oxygen tubing. Dry oxygen source gas was used at flows of 10, 20 and 40 L/min. Temperature and relative humidity (RH) were recorded 6" from the device output in large bore corrugated tubing. Source gas humidity was measured at less than 3% RH and temperature at 20°C. RH was measured using a hygrometer calibrated as per manufacturer's instructions.

**Results:**

Relative Humidity and Temperature of AirFlow		
	RH (%)	Temp (C)
source gas	3.0	20.0
10 L/min	95.9	35.9
20 L/min	90.7	36.6
40 L/min	95.0	36.0

**Conclusions:** This device is capable of heating and humidifying dry gas flows of up to at least 40 L/min to over 35°C and over 90% relative humidity. Application to high oxygen flow therapy is possible.

## Introduction

- A novel humidification technology (Hydrate™; Pari Respiratory Equipment, Midlothian, Virginia) is capable of vaporizing water to heat and humidify therapeutic gases. This technology is based on a porous, multi-layered ceramic disk that draws water in through the bottom and, using a heating element on the top surface, vaporizes the water; ejecting it out of the top of the disk. (Figure 1) It has the potential to be used as a humidifier for high flow oxygen therapy.

## Objectives

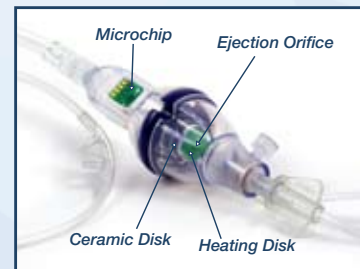
- To test the ability of the in-line novel humidification device (Pari Hydrate™; Pari Respiratory Equipment, Midlothian, Virginia) to use the C-Force™ technology to heat and humidify dry, therapeutic gas at high flows.



Figure 1. The capillary force generator's jet stream of vapor.

## Technology

- The C-Force™ (Figure 2) is fed water by a peristaltic pump and electronically controlled by the Pari Hydrate™ (Figure 3). Water is drawn into the disk by capillary forces, is vaporized, then ejected out the top due to expansion from the phase transition to a gas. (Figure 1) The heating element on the top of the disk creates a thermal balance between the top of the disk and the cooling water entering the bottom. (Figure 4) Temperature of the heating element is controlled by the Pari Hydrate™ so the operator can increase the temperature and humidity (via the water feed) independently within a range of operating temperatures in the prototype model.



The C-Force™ housing containing the disk which is the vaporizer. The housing is placed in-line and the vapor jet is directed toward the incoming gas flow for better mixing. A microchip is contained in the C-Force™ housing to measure and control temperature of heating element and gas.

- The C-Force™ (Figure 2) houses the ceramic disk which is fed water by a peristaltic pump and is electronically controlled by the Pari Hydrate™ (Figure 3). Water is drawn into the disk by capillary forces, is vaporized, then ejected out the top due to pressure from expansion from the phase transition to a gas. A heating element on the top of the disk, which is controlled by the Hydrate™, creates the heat to provide vaporization. There is a thermal balance between the top of the disk and the cooling water entering the bottom. Because the water (via the peristaltic pump) and the heat (via the heating element) are controlled separately by the Hydrate™ there can be independent variations in the temperature and humidity of the gas within a range of operating temperatures.

\*Results reported are for early software versions of the Hydrate™.



Figure 3. The Pari Hydrate™ controls the function of the C-Force™ (temperature and vapor) and contains the peristaltic pump for precise water flow to the C-Force™.

## Method

- The C-Force™ inflow was connected to 1/8" oxygen tubing and outflow was connected to large bore corrugated tubing.
- Dry source gas was oxygen from a cylinder regulated at 50 psi.
- Temperature and relative humidity (RH) were measured 6" from the C-Force™ using a hygrometer (Rotronic Instrument Corp, Huntington, NY) and calibrated as per manufacturer's instructions.
- Source gas humidity and temperature were measured proximal to the C-Force™.
- Results were measured at 10, 20 and 40 L/min. of gas flow measured by a thorpe tube flowmeter.

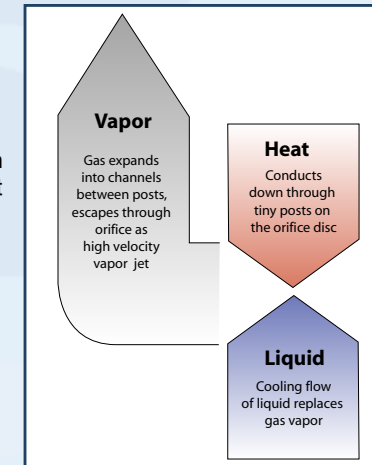


Figure 4. Heat generated by the heating element and the cooling influx of water allow thermal equilibration.

## Results

Relative Humidity and Temperature of Air Flow		
	RH (%)	Temp (C)
source gas	3.0	20.0
10 L/min	95.9	35.9
20 L/min	90.7	36.6
40 L/min	95.0	36.0

Table 1. Relative humidity (RH) and temperature of source gas and heated and humidified high flow oxygen by the Pari Hydrate™

## Conclusions

- The Pari Hydrate™ delivers absolute humidity of 39.9 mg/L, 39.1 mg/L and 39.7 mg/L at flows of 10 L/min, 20 L/min and 40 L/min, respectively. These levels were well over the recommended minimum absolute humidity levels of 30 mg H<sub>2</sub>O/L at 30°C and within recommended levels of absolute humidity between 36 mg/L to 40 mg/L.<sup>2</sup>
- The Pari Hydrate™ is capable of heating and humidifying dry oxygen flow up to 40 L/min to over 35°C and over 90% relative humidity. Application to high flow oxygen therapy is possible.

## References

- AARC Clinical Practice Guideline: Humidification during Mechanical Ventilation Respir Care 1992;37:887-890
- Respiratory Care: Principles & Practice. Dean R. Hess et al. W.B. Saunders Company, Philadelphia, PA 2002, pp 635