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H_2 HUBB Official Test Report

Product:

Name: HX3000 Clinical Hydrogen Inhalation System
Company: Hydrogen For Health
Mfgr rated H_2 Output: 2000 mL/min
Type: Pure H_2 Inhalation Device (99.99%/4N)

- PEM/SPE
- O_2 port supplied as well.

Tester: Tywon Hubbard (TH)
Testing start date: 12/22/23
Completion date: 1/25/24

PERFORMANCE:

H_2 mL/min Confirmation Test: HX3000

- **METHODOLOGY:**
- Distilled Water (used for testing): 6.0 pH
- Water Temperature: 65~70F/ 18~21C
- Reservoir Vol Size: 8.0 L/8000 mL (2.11 gals)
- H_2 output: 2000 mL/min or 165 mg/min (@ SATP)
- Test Location: 277 meters (909 ft elevation)
- H_2 Flow Test: mL/min, normal timing for a breathing session (1 hr)
    - Test methodology: Alicat Mass Flow Meter
    - All measurements converted to SATP where applicable

H_2 Flow Rate Test Results at SATP:

- **Device H_2 mL/min (mg/min) avg:** ≅ 2100 mL/min (173.14 mg/min)
- **Device O_2 mL/min (mg/min) avg:** ≅ 1050 mL/min
- **Device Total H_2/O_2 mL/min (mg/min) avg:** ≅ 3150 mL/min
- **Claimed Mfgr's H_2 mL/min (mg/min) confirmed:** Yes
    - In this report, we are exclusively presenting the test results for the 3000 mL/min H_2/O_2 setting, which is essential to meet our H_2HUBB recommendation standards. If clients wish to examine the results for the lower gas output settings tested by H_2HUBB, please feel free to contact us.

INTERNAL BREAKDOWN AND PERFORMANCE:

Manufacturer's Rated Electrical Values: (as stated on the both power supplies)

- **Type of device/electrolytic cell**
    - Pure H_2: PEM/SPE membrane
- **Applied volts:**
    - 18 volts
- **Total Amps:**
    - 25 amps
- **Total watts:**
    - 450 watts

Confirmed Electrical Values (@ 2X: 6 electrolytic cells in series configuration)

- **Cell Configuration**
  - 2 separate electrolytic cells
  - 6 cells in series with each stack
- **Electrolysis amps at each cell (cell 1 & cell 2):**
  - 23.60 amps (DC) per cell
  - 141.60 effective amps (DC)
- **Electrolysis volts at each cell (cell 1 & cell 2):**
  - 11.25 volts (DC)
  - 1.87 volts (DC) per cell
- **Electrolysis watts at each cell (cell 1 & cell 2):**
  - 265.50 watts

H_2 Production: (Based on measured amperage @SATP)

- **Total Theoretical Max H_2 production (@ 100% cell efficiency)**
  - Cell 1: 1077.71 mL/min (88.85 mg/min)
  - Cell 2: 1077.71 mL/min (88.85 mg/min)
  - Total: 2155.42 mL/min (177.71 mg/min)
- **Measured H_2 production**
  - 2100 mL/min (173.14 mg/min)
- **Electrolytic cell efficiency**
  - 97.50%

PRODUCT ASSESSMENT:

Functionality:

- **Power**
  - **Power input/Power cord:** Located on the back of the system and provides power to the device.
  - **Master switch:** Located on the back of the system.
- **LED Digital Display and control panel**
  - Displays the session time-frame
  - Displays the combined hydrogen gas and oxygen gas production in mL/min
  - Displays hydrogen gas purity
  - Displays the total hours the device has been in use.
  - **Flow Control:**
  - Allows the user to change the combined hydrogen/oxygen gas production in mL/min (1500, 2250, 3000)
  - **Power/ON OFF**
  - Turns on the display
  - **Times setting**
  - Increases the session time by 1-hr intervals up to 4 hrs.
  - Initiates electrolysis for hydrogen/oxygen gas inhalation.
  - **Gas display window:**
  - Shows the hydrogen/oxygen gas flow
- **Reservoir (1.8L or 2.11 gals)**
  - Requires 8.0L liters of distilled water.
- **H_2 ports (2X)**
  - Delivers the H_2 gas production for H_2 inhalation for single or dual users.
- **O_2 port (1X)**
  - Delivers the O_2 gas production for H_2/O_2 inhalation for single or dual users.
- **Drain port**
  - Allows you to drain the distilled water reservoir with a special fitting.

Reliability:

- **New: No**
  - Initial test results and evaluation are currently on the report. (see Overall Opinion)
- **3 months:** N/A
- **6 months:** N/A
- **1 year:** N/A
- **Reliability Summary**: N/A

PRODUCT SAFETY:

Safety Components:

- The system has 5 fundamental safety mechanisms for ensuring the device's safety.
    - Low-water protection
        - Protects cells from excessive heat (two cells)
    - Large distilled water reservoir
        - Protects cells from excessive heat (two cells)
    - Internal Fans (2X)
        - Prevents hydrogen gas build-up in case of leaks and may also aid in preventing overheating
    - Internal gas separator (4X)
        - The apparatus helps to improve H_2 gas purity.
    - Internal deionization resin filters (3X)
        - Improves gas purity and reduces ions (mineral, metal, etc.)
    - Heat Vents (2X)
        - Prevents excessive heat in the system

The system theoretically should only be combustible at the tip of the nasal cannula as the system produces >99% pure hydrogen gas.
As with all inhalation devices that produce pure hydrogen gas, care should be taken to avoid exposing the cannula tip to any source of ignition (such as an open flame or a spark) which could result in the combustion of the gas.

Cost:

- **Hydrogen For Health (HX3000™):** $4,300.00
- **H_2 Hubb discount:** TBA
- **H_2 Hubb recommendation cost:** TBA

Overall Opinion:

Hydrogen For Health HX3000 Clinical Hydrogen Inhalation System is a well-engineered hydrogen inhalation device based on our testing. The unit is rated by the manufacturer to supply 2000 mL/min of pure hydrogen gas (99.99%) at 100% production capacity. We were able to confirm the manufacturer's claims of the HX3000. In addition, the system is claimed to provide 1000 mL/min of pure O_2, which we also confirmed.

Hydrogen gas output flow rates are a critical performance parameter for inhalation devices. H_2HUBB's minimum standard for hydrogen generators or inhalation units (pure H_2, mixed with air, etc.) is 120 mL/min of H_2 (120 mL/min ≅ 2% H_2 at resting breathing rates (4-6 L/min)). This is based on preliminary observations and/or studies demonstrating that 1~1.3% (vol/vol) of H_2 may offer therapeutic potential. For these reasons, 120 mL/min of H_2 is our minimum standard for hydrogen generators and the HX3000 device easily surpasses this standard.

The system utilizes two separate electrolytic cells each containing six cells in a series configuration. We confirmed the system electrical values at 11.25 V/23.60 A at the device's 100% production capacity measured at each electrolytic cell. That means each individual cell (6X) within both cells will draw 23.60 amps at 1.87V. Given these measured electrical values, our measurement of ≅ 2100 mL/min (173.14 mg/min) not only confirms the flow rate but surpasses the manufacturer's claims of 2000 mL/min, correlating well with our findings. The total H_2 gas output for the device based on the theoretical maximum (100% cell efficiency) would be ≅ 3233.13 mL/min at SATP. Therefore, it appears that the H_2 inhalation system electrolytic cell is operating at a cell efficiency of 97.50%. This means that the O2 production of the system was calculated to be ≅ 1050 mL/min (@ SATP). Our findings confirmed the claims that the device can provide ≅ 3000 mL/min of oxyhydrogen (H_2/O_2). The measured oxyhydrogen production of the system based on our analysis was ≅ 3150 mL/min. This represents a 5% increase in hydrogen production compared to the advertised claim, which is great. **Based on these results, the product will be featured on our website as a Level 5 Inhalation device.** You can view the meaning of this ranking **here**. We are satisfied with the device's performance characteristics as indicated by our gas output measurements.

The HX3000 provides a substantial flow rate of hydrogen gas, making it imperative for H_2HUBB to assess whether this flow surpasses hydrogen's flammability concentrations in air when delivered through a nasal cannula during inhalation. According to NASA [1] and other sources [2][3], the flammability concentration of hydrogen in the presence of ambient air ranges from 18% to 59% (vol/vol).

Furthermore, some studies on hydrogen have indicated that H_2 inhalation concentration for humans should stay below 10%[4] to ensure safety. Other studies suggest that a 15% H_2 concentration may cause a relatively small combustion (pop) that will not harm individuals [5]. Considering the fundamental fact that the lower limit concentration of hydrogen gas for flammability in air is 18%, and correlating studies recommend a lower limit H_2 concentration of 10-15%, we have a hydrogen flammability concentration range of 10~18%, warranting our attention and concern. H_2HUBB prioritizes safety, advocating for conservative figures. Therefore, H_2 inhalation flow rates should not exceed a 15% H_2 concentration when using an H_2 inhalation device based on our understanding of the data.

To investigate the relationship between hydrogen inhalation systems' output flow rates and the resulting inhalation concentration of H_2, it's crucial to understand the fundamental characteristics of H_2 inhalation devices and the physiological processes involved in H_2 inhalation. Firstly, losses occur because hydrogen gas rapidly diffuses into the atmosphere when using nasal cannulas with H_2 inhalation units, typically ranging from 50-70%. At H_2HUBB, our current estimate, guided by researchers, indicates an approx 60-66% loss in hydrogen flow rate from an H_2 inhalation device to the atmosphere when utilizing nasal cannulas. This loss is influenced by three key factors: hydrogen's status as the smallest and lightest gas [6], its high diffusibility in air [7], and the substantial gas exchange that occurs during human breathing (both inhalation and exhalation)[8].

For example, if we consider a pure H_2 inhalation system (e.g. 99% H_2 @ 100-1000 mL/min) the delivered hydrogen gas to the nasal passage will fall from the 100% H_2 concentration being delivered by the cannula to a significantly lower % when combined with the surrounding air that also enters the nasal cavity around the tip of the cannula when breathing. The precise H_2% after mixing with the air in the nasal passage depends on the relative flow rates of the H_2 (100-1000 + mL/min) and air as determined by the tidal volume and respiration rate (E.g. 250-500 Vt/4-6 Vm).

Considering the tidal volume (400-500 mL) and ventilation rate (4-6 L/min) for males and females (indicating how much air is inhaled per breath and exchanged in a minute), we can calculate the H_2 concentration in the nasal cavity. This calculation is based on the delivered flow rates of hydrogen gas (e.g., 150-1000 mL/min) and inhalation dynamics, including average tidal volumes and minute ventilations.

Based on average male inhalation dynamics, at its highest production capacity (≅ 2100 mL/min (173.14 mg/min) the HX3000 will generate a 12.73% H_2 concentration in the nasal cavity during inhalation. Here is how we calculated these results. After factoring in the losses, the actual administration flow rate at 2100 mL/min would be approximately 700.00 mL/min. We calculated this by dividing the provided flow rate of 2100 mL/min by 60 to obtain the mL/sec, resulting in 35 mL/sec. Then, by multiplying 35 mL/min by 20 secs (the time spent inhaling during a minute), we determined the actual administered flow rate to be 700 mL/min (35 x 20 = 700 mL/min). This accounts for a 65% loss of the H_2 flow rate, given that we spend about 20 seconds inhaling and 40 seconds exhaling per minute. The primary loss of hydrogen gas occurs during exhalation. Given that the ventilation minute for an average male at rest is 5-6 L, we can determine the H_2 concentration by dividing the actual administered flow rate of H_2 (700 mL/min) by 5.5 L (5500 mL/min), resulting in a concentration of 12.73%.

The math:

Actual administered flow rate 700 mL of H_2/5500 mL ventilation minute = 0.1272

0.1272 x 100 = 12.72%

The final hydrogen concentration of this device remains under our target of 15% for the average male or female. That being said, modifying the respiratory dynamics and capacities, such as adjusting tidal volume (Vt) within the range of 250-500 mL and ventilation minutes (Vm) between 4-7 L/min, would alter our results.

Ensuring the safety of high flow rate H_2 inhalation systems is crucial. Several devices administering these hydrogen gas levels have been utilized in clinical research, increasing their likelihood of being used safely and considered secure. Final concentrations can consistently remain under the lower limit threshold of 15%. For instance, the Asclepius Meditec Co. AMS-H-03 hydrogen-oxygen nebulizer (3L/min oxyhydrogen inhalation unit) used in several major clinical studies [9] is a Class III Medical Device [10]. The levels of H_2 for that unit are high (2000 mL/min of H_2) but if a nasal cannula is used then, as we have already demonstrated, its delivered H_2 concentration is still way under approx 15% for most males and some females.

Based on our analysis, the HX3000 should deliver a highly therapeutic flow rate of hydrogen gas at a safe concentration. It's crucial to recognize that hydrogen inhalation comes with safety risks, but understanding these facts is essential for contextualizing and managing those risks appropriately.

Finally, the HX3000 boasts exceptional build quality and an appealing design. Given its substantial size (23" x 12" x 34"), it is more likely suited for medical clinics or individuals facing serious health challenges. Despite its size, the unit remains easy to maneuver, thanks to its wheels, and simple to set up due to its straightforward functionality. The LED control panel has great lighting and displays the device's key features and functions well. Overall, the design is elegant and is highly therapeutic based on our analysis and knowledge of human studies.

The validity of the manufacturer's claims regarding molecular hydrogen output flow rate is not in question and the device's performance agrees with the product's marketing materials. We have no safety concerns with the system as it seems to implement sufficient safety measures. We are generally pleased with the performance of the device. The HX3000 device performed above our minimum performance standards and, in the opinion of H_2HUBB, the system appears to be safe and suitable for in-home H_2 inhalation. We desire to move forward with recommending the product to the public.

H_2 Hubb LLC disclaimer: All tests conducted and test results produced by H_2 Hubb LLC have been done according to industry-accepted practices and standards. Nevertheless, these results may not necessarily reflect test results performed by manufacturers, suppliers, or third-party labs. Our test results are independent of all other parties, and testing by other parties may produce different results. We understand that many variables are involved in testing, some of which are extremely difficult to control. These reports are not meant or intended for any other purpose but to uphold H_2 Hubb LLC's business practices and to validate the reasons for our recommendations.

Approved by:

Tywon Hubbard CEO of H_2HUBB