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H_2HUBB Official Test Report

Evaluation Introduction

This report provides a comprehensive analysis of the 4500PRO Hydrogen inhalation therapy device from HYDRO 4 HEALTH®, a company based in Europe. H_2HUBB classifies this device as a Professional-Grade, high-flow-rate hydrogen inhalation system. It is equipped with hydrogen electrolytic cells utilizing a PEM/SPE membrane, ensuring the production of pure hydrogen gas with only deionized or distilled water required for operation. The device supports continuous hydrogen gas production, allowing users to extend inhalation sessions up to 8 hours. We thoroughly evaluated the system's hydrogen gas output in mL/min to verify its performance. Additionally, we assessed its safety features and operations to confirm the presence of appropriate mechanisms for safe and reliable usage. Our investigation determines whether the 4500PRO device meets our H_2 product performance standards required for approval and recommendation by H_2HUBB. For more information about our performance standards for hydrogen inhalation systems, please visit **H_2HUBB.**

H_2 Products

- Company: HYDRO 4 HEALTH®
- Product Name: 4500PRO
- Type: Pure H_2 Inhalation Device (>99.9%/3N)
  - PEM/SPE
  - High Flow Rate
- Mfgr rated H_2 Output: 3000 mL/min
- URL Link: https://hydro4health.com

Method and Procedure

- Distilled Water (used for testing): 6.0 pH
- Water Temperature: 65~70F/ 18~21C
- Reservoir Vol Size: 4 L/4000 mL (1.05 gals)
- H_2 Output: up to 3000 mL/min or 247.34 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 H_2 Mass Flow Meter
- All measurements converted to SATP where applicable

Test Results

To evaluate the hydrogen gas flow rate, the system was assembled according to protocol and filled with distilled water to the manufacturer's recommended level. The device was tested at each designated output mode—1500, 3000, and 4500 mL/min of H_2/O_2—and operated for a 1-hour session per setting. A 10-minute warm-up period preceded each measurement to allow for system stabilization. During operation, the produced hydrogen gas was routed through a drying column, followed by a humidity and temperature sensor, before entering an Alicat Mass Flow Meter for precise measurement of molecular hydrogen output. To ensure measurement accuracy, a 5–10 minute stabilization period was observed to eliminate ambient air interference. Minor flow corrections were made to compensate for resistance or moisture-induced losses in the system. Each output mode was tested a minimum of three times, and the flow rate values reported herein represent the average of these measurements.

H_2 Flow Rate Test Results at SATP:

Mode: 1500 mL/min Setting

- Device H_2 Flow Rate (mL/min) (mg/min) avg:≅ 1513.00 mL/min H_2 (≈124.74 mg/min)
- Device O_2 Flow Rate (mL/min) avg: ≅ 756.52 mL/min
- Total H_2/O_2 Flow Rate (mL/min) avg:≅ 2269.50 mL/min

Mode: 3000 mL/min Setting

- Device H_2 Flow Rate (mL/min) (mg/min) avg: ≅ 2303.43 mL/min H_2 (≈190 mg/min)
- Device O_2 Flow Rate (mL/min) avg: ≅ 1151.74 mL/min
- Total H_2/O_2 Flow Rate (mL/min) avg: ≅ 3455.15 mL/min

Mode: 4500 mL/min Setting

- Device H_2 Flow Rate (mL/min) (mg/min) avg: ≅ 3193.17 mL/min H_2 (≈263.27mg/min)
- Device O_2 Flow Rate (mL/min) avg:≅ 1596.62 mL/min
- Total H_2/O_2 Flow Rate (mL/min) avg: ≅ 4789.76 mL/min

Claimed Mfgr's H_2 mL/min (mg/min) confirmed: Yes

H_2HUBB Hydrogen Flow Rate Assessment

- H_2HUBB's hydrogen gas flow rate test results confirm and exceed the manufacturer's performance claims for the 4500PRO. At standard atmospheric pressure (SATP), the device produced an average of 3193.17 mL/min of hydrogen gas on the 4500 mL/min setting, aligning with and slightly surpassing the expected output. This demonstrates that the manufacturer's stated values are conservative, reinforcing the device's reliability and consistent performance under real-use conditions. Notably, when operated at the 4500 mL/min setting with a single-user nasal cannula, the device delivers an estimated inhaled hydrogen concentration of 17–20%, which exceeds safe levels used in most human clinical studies. Therefore, this setting is best reserved for dual-user inhalation, while the 1500 mL/min and 3000 mL/min modes are more appropriate and safer for single-user applications. These results exceed **H_2HUBB's minimum performance standards** and qualify the 4500PRO as a **Level 5 hydrogen inhalation device** within our performance ranking system.

INTERNAL BREAKDOWN AND PERFORMANCE:

Manufacturer's Rated Electrical Values:

Type of Device / Electrolytic Cell:

- Pure H_2: PEM/SPE Membrane

Power Supply Rating (per label):

- Voltage Output Rating: 40 V
- Current Output Rating: 13.4 A
- Rated Power: 536 Watts

Confirmed Electrical Values:

- Applied Voltage at Stack: 9.4 V DC
- Total Measured Current: 36 A DC
- Total Electrical Power: 338.4 Watts (9.4 V × 36 A)

Cell Configuration:

- Number of Stacks: 3 (wired in parallel)
- Cells per Stack: 4 (wired in series)
- Total Number of Electrolytic Cells: 12 PEM cells

Electrolytic Cell Stack Characteristics:

- Voltage per Stack: 9.4 V
- Voltage per Cell: 2.35 V (9.4 ÷ 4)
- Current per Stack: 12 A (36 A ÷ 3)
- Current per Cell: 12 A (same across all cells in series)
- Effective Electrochemical Current per Stack: 144 A (12 A × 4 cells)
- Total Effective Electrochemical Current: 432 A (144 A × 3 stacks)
- Power per Stack: 112.8 W (9.4 × 12 A)
- Total System Power: 338.4 W (112.8 × 3)

H_2 Production: (Based on measured amperage @SATP)

- Total Theoretical Max H_2 production (@ 100% cell efficiency)
  - Total: 3287.92 mL/min (271 mg/min)
- Measured H_2 production
  - 3193.17 mL/min (263.27 mg/min)
- Electrolytic cell efficiency
  - 97.12%

Product Assessment

Functionality:

- **Power input/Power cord:**
  - Located on the back of the system; supplies power to the device.
- **Digital Display and Control Panel**
  - Displays the session duration
  - Shows the combined hydrogen and oxygen gas production in mL/min
  - Allows the user to select hydrogen/oxygen gas production settings: 1500, 3000, 4500 mL/min
  - Allows the user to select and adjusts session time in 1-hour increments, up to 8 hours
  - Allows the user to refill the device with distilled water using the “Add Water” function on the display control panel.
  - Allows the user to drain the internal distilled water using the “Drain Water” function on the display control panel.
- **Power Start/Stop Button:**
  - Initiates electrolysis for hydrogen inhalation
  - Pressing the button while the device is running will stop gas production
- **Water Collection/Humidifier**
  - Collect water moisture from the hydrogen and oxygen gas production
- **Reservoir (4.0 L or 1.05 gal):**
  - Requires 4.0 liter of distilled water
- **H_2 Port (1x):**
  - Outputs hydrogen gas for single-user inhalation
- **O_2 Vent (1x):**
  - Vents oxygen gas produced during electrolysis
- **Drain Port:**
  - Allows the user to empty the distilled water reservoir using a special drain port and tubing located on the back of the system.

Product Safety

Safety Components:

- The system has 7 fundamental safety mechanisms for ensuring the device's safety.
  - Low-water protection
    - Protects cells from excessive heat
  - Large distilled water reservoir
    - Protects cells from excessive heat
  - Internal Fans
    - Prevents hydrogen gas build-up in case of leaks and may also aid in preventing overheating
  - Reservoir water cooler
    - Prevents reservoir water from overheating and protects the H_2 cells from thermal damage
  - Internal gas separator
    - The apparatus helps to improve H_2 gas purity.
  - Internal deionization resin filters
    - Improves gas purity and reduces ions (mineral, metal, etc.)
  - Heat Vents
    - 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.

Overall Opinion

The 4500PRO Hydrogen Inhalation Device has been confirmed through H_2HUBB testing to be a well-engineered and high-performing system for hydrogen inhalation. The manufacturer specifies a hydrogen gas output of 3000 mL/min at >99.9% purity under standard operating conditions. Our independent testing verified these claims, demonstrating that the device consistently achieves and slightly exceeds the stated hydrogen output. Notably, the device exhibited overperformance ranging from 6.44% to 51.3% across multiple flow settings, indicating that the manufacturer has taken a conservative approach in its performance claims. This suggests an emphasis on reliability and consistency in the device's design and manufacturing, reinforcing its credibility as a therapeutic hydrogen inhalation system.

Hydrogen gas output flow rates are a critical performance parameter for inhalation devices. At H_2HUBB, the minimum standard for hydrogen generators or inhalation units (whether pure hydrogen, oxyhydrogen, or H_2 mixed with air) is 120 mL/min of H_2. This rate corresponds to approximately 0.7-1.3% H_2 at typical resting breathing rates (4-6 L/min) when using a nasal cannula for an average adult. Scientific studies on molecular hydrogen inhalation therapy generally utilize concentrations between 0.5% and 4% or more at resting breathing rates, a range that has been shown to provide therapeutic benefits. Given these findings, H_2HUBB establishes 120 mL/min of H_2 as the baseline requirement for hydrogen inhalation devices to ensure effectiveness. The 4500PRO H_2 inhalation device significantly exceeds this minimum standard, delivering performance well within the therapeutic range.

The 4500PRO is equipped with an advanced PEM/SPE electrolytic cell system, configured with three parallel stacks, each consisting of four cells in series, totaling 12 PEM cells. This engineering enables the device to consistently produce high-purity hydrogen gas (>99.9%). During H_2HUBB's performance testing, the system's electrical values were confirmed at 9.4 V DC and 36 A DC, yielding a total power draw of 338.4 watts. Each stack operated at 9.4 V and 12 A, delivering 112.8 watts per stack. Based on these confirmed values, the measured hydrogen gas output averaged 3193.17 mL/min (263.27 mg/min) at standard atmospheric pressure (SATP), closely aligning with the theoretical maximum of 3287.92 mL/min (271 mg/min)—assuming 100% cell efficiency. This indicates an excellent electrolytic cell efficiency of 97.12%, which is highly efficient for a PEM/SPE-based hydrogen inhalation system. The 4500PRO's hydrogen flow rate is more than sufficient to deliver therapeutic hydrogen concentrations of approximately 17–20% when used by a single adult with a nasal cannula at the highest setting—levels that exceed most clinically studied concentrations. As such, the 4500PRO is best utilized in dual-user mode at the highest setting, while its 1500 and 3000 mL/min modes are more appropriate for single-user inhalation. **According to our flow-rate test results, the product will be featured on our website as a Level 5 hydrogen inhalation device.**

You can view the meaning of this ranking **here**.

The 4500PRO Hydrogen Inhalation Device provides a substantial flow rate of hydrogen gas, making it essential to assess whether its output exceeds hydrogen's detonability concentrations in air when delivered through a nasal cannula. According to NASA **[1]** and other sources **[2][3]**, the detonability concentration of hydrogen in ambient air ranges from 18% to 59% (vol/vol). Furthermore, several studies have indicated that hydrogen inhalation concentrations for humans should remain below 10% **[4][5][6][7]** to ensure safety. Other sources suggest that 15% H_2 concentration may cause a small, non-harmful combustion event (a "pop") **[8]**. Taking into account both the lower detonability threshold of 18% and the recommended safety range of 10–15%, we identify a hydrogen concentration caution zone between 11–18%, which warrants special attention.

H_2HUBB maintains a conservative safety approach and advises restricting hydrogen inhalation concentrations to no more than 15% in residential or uncontrolled environments. This recommendation mitigates risk, though it is important to note that the gas remains flammable at the nasal cannula tip.

To assess the real-world hydrogen concentration delivered by high-output systems like the 4500PRO, it is important to understand how nasal cannula delivery and human physiology influence administered dose. Based on hydrogen's physical properties—including its small molecular size **[9]**, high diffusivity **[10]**, and the dynamics of tidal breathing **[11]**—a significant portion of gas is lost to the atmosphere during use, specifically during exhalation. At H_2HUBB, we estimate an average hydrogen loss of 66-67% when delivered via nasal cannula.

At its maximum setting, the 4500PRO produces 3193.17 mL/min of pure hydrogen gas. After accounting for a 66% loss, the actual administered hydrogen flow rate becomes:

- 3193.17 × 0.334 = 1064.58 mL/min

Assuming an average minute ventilation of 6 L/min (6000 mL/min), the estimated inhaled hydrogen concentration is:

- 1064.58 ÷ 6000 = 0.1774 → 17.74%

This exceeds the lower detonability threshold of hydrogen in air, indicating that this setting is not recommended for single-user nasal cannula use in non-clinical environments. H_2HUBB strongly recommends reserving the 4500 mL/min setting for dual-user inhalation or supervised clinical settings with appropriate safety protocols.

The 4500PRO's 3000 and 1500 mL/min modes, however, are more appropriate for single-user applications:

- 3000 mode (2303.43 mL/min H_2 output):
  - Adjusted for loss → 767.81 mL/min, resulting in 12.80% inhaled H_2 concentration

- 1500 mode (1513.00 mL/min H_2 output):
  - Adjusted for loss → 504.33 mL/min, resulting in 8.41% inhaled H_2 concentration

Both settings remain below the recommended 15% threshold and are suitable for home or therapeutic use by a single user via nasal cannula.

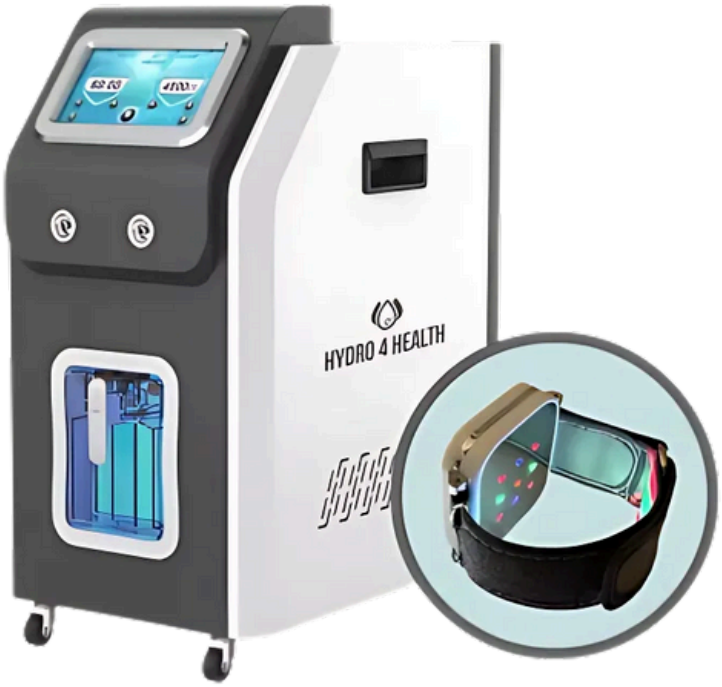
Each flow mode on the 4500PRO—1500, 3000, and 4500 mL/min—delivers a unique therapeutic dose of hydrogen based on its corresponding inhaled concentration, and these doses are not interchangeable simply by extending the duration of inhalation. While it may seem intuitive to assume that breathing from a lower flow rate (e.g., 3000 mL/min) for a longer period could match the effects of a higher flow rate (e.g., 4500 mL/min), this is not supported by the physiological data or Henry's Law. The concentration of hydrogen that dissolves into the blood (expressed in µmol/L) is a function of inhaled partial pressure—not time alone. For example, a 4% H_2 inhalation will never reach the same tissue saturation or blood concentration as a 6% or 10% H_2 concentration, regardless of how long it is inhaled. As shown in validated models and studies, each concentration reaches a distinct equilibrium level in tissues and blood **[12]**.

Therefore, the 4500 mL/min setting does provide the highest potential for systemic saturation and cellular delivery—but this does not override the importance of safety. Due to the resulting 17–20% inhaled H_2 concentration at this mode, it is recommended only for dual-user inhalation or supervised clinical use. Importantly, the 1500 and 3000 mL/min settings still deliver far more hydrogen to the human body than most H_2 inhalation units currently on the market and already approach or exceed the upper end of therapeutic ranges commonly used in both clinical research and safety guidelines. Users should not feel they are missing out by using these lower settings—they provide potent therapeutic dosing while remaining within safe and appropriate inhalation concentration thresholds for single users.

Ensuring the safety of high-flow hydrogen inhalation systems is critical. Several devices delivering comparable flow rates have been used in clinical research, demonstrating a strong safety record when operated under proper conditions. Inhaled H_2 concentrations can consistently remain below the 15% safety threshold when nasal cannulas are used correctly. For instance, the Asclepius Meditec Co. AMS-H-03 hydrogen-oxygen nebulizer (3 L/min oxyhydrogen inhalation unit) has been utilized in several major clinical trials **[13]** and is classified as a Class III medical device **[14]**. Despite producing approximately 2000 mL/min of hydrogen gas, its actual inhaled hydrogen concentration—when delivered via nasal cannula—remains safely below 15% for most males and many females. This supports the idea that high therapeutic dosing can be achieved safely with appropriate equipment, usage, and precautions.

In conclusion, the 4500PRO delivers a highly therapeutic and efficient hydrogen flow, but due to the elevated hydrogen concentrations possible at its highest setting, proper usage context is critical. Users should adhere to safe guidelines and utilize lower flow settings for single-user use to remain within recommended hydrogen concentration limits. The 4500PRO's performance confirms its status as a high-level hydrogen inhalation system, provided it is used with informed safety practices.

The manufacturer's claims regarding the molecular hydrogen output flow rate have been validated by our tests, and the device's performance aligns well with the product's marketing materials. No safety concerns were identified, as the system appears to incorporate adequate safety measures. Overall, we are satisfied with the device's performance. The 4500PRO device exceeded H_2HUBB's minimum performance standards, and in our assessment, it is both safe and effective for in-home hydrogen inhalation. Based on these findings, we are confident in recommending this product to the public.



Approved by:

Tywon Hubbard

CEO, H_2HUBB LLC

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