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Objective

Quantitative chemical analysis of pH, oxidation-reduction potential (ORP) and molecular hydrogen gas concentration were performed on the Leveluk SD501 from Enagic and the UltraStream from AlkaWay. Results are shown in tables 1-3.

Methods and Conditions

The pH of source water was ≈ 7.50, ORP ≈ 265 mV, temperature ≈ 19 °C and pressure 0.83 atm. Each machine was given a minimum of 3 hours of "non-use" before tests were conducted in order to verify complete cooling and or/ media to achieve equilibrium. (It was determined that ≈ 2 hours is needed for complete restoration of absolute capabilities for the UltraStream, but not for the SD501).

Hydrogen gas concentration was measured immediately after obtaining aliquots in order to minimize hydrogen exsolution from samples. Molecular hydrogen detection limit was 0.05 ppm. Saturation of hydrogen is 1.6 ppm (0.8 mM) at STP. Hydrogen gas was determined via a novel redox titration method using methylene blue as reagent and colloidal-platinum particles as catalyst. This method has previously been demonstrated effective and accurate with great precision compared to the standard electrochemical method (Seo, Tomoki, et al. Med Gas Res. 2, (2012)).

The values reported represent the averages that where obtained following appropriate analytical procedure. These averages also show the ranges (low to high) that were observed during this study. The values that do not have a corresponding range are the results of only one test; nevertheless, this is merely due to confidence in the values reported. Indeed, they correlate well with the known data and coincide with basic scientific knowledge.

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Results

Table1. Results for the Enagic Leveluk SD501

Type	pH	ORP (mV)	[H_2] ppm	% saturation
With saline solution, "increase flow" (5 mL/s)	11.60 (11.51-11.71)	-875 (-865 to -885)	1.48 (1.0-2.0)	92.5% (62.5-125.0)
No saline solution, 9.5 setting, "increase flow" (5 mL/s)	10.75 (10.6-11.0)	-838 (-835 to -840)	1.2 (0.9-1.3)	68.8 % (56.3-81.3)
No saline solution, 9.5 setting, "normal flow" (30 mL/s)	9.50 (9.31-9.61)	-650 (-480 to -732)	0.35 (0.3-0.5)	21.9 % (18.8-31.0)
After 10 liter 9.5 setting, "normal flow" (30 mL/s)	9.5	-720	0.35	18.8%
10 liters produced at 9.5 setting, "normal flow (30 mL/S)	9.5	-720	0.35	18.8 %

At a low flow rate (5 mL/sec), with the saline solution, the SD501 was able to produce a supersaturated hydrogen gas solution (2.0 ppm) with extremely low redox potential; however, other times only half of that concentration was achieved.

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Notably, when on normal flow, the machine produced a consistent hydrogen gas concentration (≈0.35 ppm) even after 10 liters, fluctuating between 0.3 and 0.45 ppm.

Table 2. Results for the AlkaWay UltraStream

UltraStream	pH	ORP (mV)	[H_2] ppm	% of saturation
Water off, captured leaking drops	9.71 (9.62-9.80)	-775 (-761 to -780)	1.2 (0.9-1.3)	75% (56.3-81.3)
Very slow 5 mL/S	9.61 (9.49-9.65)	-770 (-758 to --778)	1.1 (0.9-1.2)	68.8% (56.3-75)
"normal flow" (30 mL/s)	9.30 (9.31-9.61)	-710 (-670 to -767)	1.1 (0.9-1.2)	68.8% (56.3-75)
After 1 liter, "normal flow" (30 mL/s)	8.10 (8.02-8.20	-663 (-610 to -715)	0.8 (0.7-0.9)	50% (43.8-56.3)
1 liter produced at "normal flow" 30 mL/s)	8.61	-700	0.9	56.3%

Table 3. Results for the AlkaWay UltraStream. Values were determined after each presented volume. The flow was continuous at ≈ 30 mL/s.

UltraStream	pH	ORP (mV)	[H_2] ppm	% of saturation
0.25 L	9.1	-741	1.1	68.8%
0.50L	8.6	-705	0.8	50%
0.75L	8.1	-670	0.8	50%
1.00 L	8.0	-663	0.8	50%
After 6-8 liters	7.8	-600	0.2	13%
After 8-12 liters	7.6	-50 mV	< 0.05	< 3%

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Results from Tables 2-3 indicate that the UltraStream can produce ≥ a 50% H_2 (g) concentration for a liter, and readily decreases to only a 13% concentration after 6-8 liters. After 8-12 liters the concentration was below detection limit (0.05 ppm).

Discussion

In testing the SD501, the "normal flow" rate used in this work was more than twice as slow as recommended by the manufacture (0.5 gallons per minute vs. 1-2 gallons per minute). This flow rate (8+ seconds/cup) was used in order to obtain a pH ≈ 9.5 thus also assuring a greater hydrogen gas concentration. Indeed, at the faster flow rate (63 mL/s or 1 gallon/min) the SD501 only produced a hydrogen gas concentration of ≈ 0.1 ppm (data not shown).

The pH of source water is a critical factor in performing these types of analysis. A low pH, by definition, has a greater hydrogen ion concentration, which facilitates the redox reaction [$2H^+ + 2e^- \rightarrow H_2$ (g)] at the cathode. Furthermore, if the pH of the source water is relatively high (≈ pH 8.5), then running water at the same flow rate used in this work would produce a pH closer to 10.5—which is considered unpalatable.

A lower pH also facilitates the production of hydrogen gas via the magnesium media found in the UltraStream—for the same reasons as given above. In this work it is seen that at normal flow rate the UltraStream produces an initial higher hydrogen gas concentration (68.8% vs. 21.9%) compared to the SD501, but was unable to maintain the concentration for an extended period of time (i.e. more than a few liters).