Hydrogen Water Testing & Certification

H2 Analytics

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Laboratory Report

Introduction

This report summarizes the analysis of the Rejuvenation tablet manufactured by HRW Natural Health Products Inc., New Westminster, BC as conducted by H2 Analytics, Henderson, NV. The purpose of the analysis was three-fold:

1) Determine the concentration of dissolved hydrogen (H_2) when a single tablet is placed into 500 mL of water and measured using gas chromatography (GC).

2) Determine the concentration of dissolved H_2 when a single tablet is placed into 500 mL of water using GC with acid assist during headspace equilibration.

3) Determine the volume of H_2 gas produced by a single tablet when dissolved in 500 mL of water using gas displacement and acid assist to accelerate the production of hydrogen gas.

Product Description

The client sent one bottle containing 60 tablets for testing. The product name is Rejuvenation, batch # v2 Pilot Batch, expiration date Feb 2023. According to the manufacturer, each tablet contains approximately 80 mg of elemental magnesium (Mg), and produces hydrogen gas through the reaction between magnesium & water according to the reaction equation: $Mg + 2H_2O \Rightarrow Mg(OH)_2 + H_2$. Tablet has a medium gray color, size is approximately 12 mm (D) x 6 mm (H), and weight is approximately 715 mg. In addition to elemental magnesium, the tablet contains other compounds (binders, lubricants & acids).

Note: To ensure representative results, tablets used for testing were randomly selected from the bottle. To prevent contamination of the tablet from moisture or oils, gloves and/or forceps were used to handle each tablet.

Test 1) Determination of dissolved H_2 concentration

Test Equipment (applicable to all tests)

Instrument: SRI 8610C gas chromatograph, Hayesep-D 4M packed column, Tungsten-Rhenium TCD; nitrogen carrier gas (99.999%) used for all measurements; column pressure, 20 mL/min @ 20 psi; Column oven temperature of 80ºC; GC permitted to stabilize for 90 minutes before testing.

GC calibration; 2-point calibration curve @ 3.02 mg/L & 6.04 mg/L using 1000 ppm precision H_2 gas (Gasco).

GC test method: static headspace using VOA septum vial and gastight syringe; headspace equilibration time, 20 min; 5 individual samples were measured and test results averaged.

Syringe: Hamilton #1001, 1000 uL gastight, 1" x 27 ga Luer-Lock

Digital thermometer: Oakton pH 6+ meter w/temperature probe

Headspace equilibrator: H2 Analytics HA-1001, 60 rpm

Headspace vial: Sigma-Aldrich, 40 mL VOA borosilicate w/septum cap

Acetic acid (distilled white vinegar), generic source, 5%

All water samples for GC & gas evolution tests prepared using tap water source; TDS = 250 ± 25, pH = 6.9 ± 0.5, initial temperature = 25ºC ± 1ºC

Laboratory temperature: 25ºC ± 1ºC, elevation 864 meters (914M/0.90 atm). All measurements adjusted to SATP.

Test Description and Methods

The hydrogen water test samples were prepared using water as described above. Prior to testing, the temperature probe was placed into the test water. The initial water temperature for each test was 25ºC ± 1ºC. For each test run, one tablet was placed into 500mL of water contained within an uncovered 500 mL glass beaker. When the tablet had risen to the surface and completely dissolved, the test sample was drawn from the water at a depth of 20 mm below the surface using a gastight syringe. The sample depth was measured using a depth gauge attached to the syringe barrel. The sample was immediately injected into the headspace vial and allowed to equilibrate for 20 minutes using the equilibrator apparatus. The final water temperature was then recorded[1]. After equilibration, the headspace was sampled using a gastight syringe and immediately injected into the GC for analysis.

Test Summary and Results

Molecular hydrogen (H_2) was detected in the tablet water samples. A total of five measurements were performed and the results averaged. The concentration of molecular hydrogen in mg/L is listed below. While other compounds were also present in the water sample (including atmospheric gases such as oxygen and carbon dioxide), their concentrations were not measured.

A total of five tests were performed and the results averaged.

H_2 concentration test result: 7.3 mg/L; H_2 production mass: 3.7 mg

[1] The reaction between Mg and H_2O is exothermic

Test 2) Determination of maximum H_2 concentration and production mass using acid in the headspace vial

Test Note:

This test was requested to determine the hydrogen-gas containing and producing capacity of a tablet added to 500ml of water if consumed when and as instructed by the manufacturer. This test differs from test 1 in that test 1 determines the real peak H_2 concentration, whereas test 2 determines the practical dose of H_2 a consumer will ingest upon consumption of the water post disintegration of the tablet. To simulate the acidic environment of the stomach, acid is added to the headspace vial to accelerate and bring to completion the gas-evolution reaction prior to GC testing.

Test Description and Methods

The hydrogen water test samples were prepared using water as described in Test 1. Before preparing the tablet water, 100 µL of acetic acid was added to the headspace vial using a syringe. In the final calculations, the total headspace vial volume was reduced by 100 µL to compensate for the additional fluid volume in the vial. To ensure representative results, tablets used for testing were randomly selected from the bottle. Prior to testing, the temperature probe was placed into the test water. The initial water temperature for each test was 25ºC ± 1ºC. For each test run, one tablet was placed into 500mL of water contained within an uncovered 500 mL glass beaker. When the tablet rose to the surface and completely dissolved (approximately 60 seconds), the test sample was drawn from the water at a depth of 20 mm below the surface using a gastight syringe. The sample depth was measured using a depth gauge attached to the syringe barrel. The sample was immediately injected into the headspace vial and allowed to equilibrate for 20 minutes using the equilibrator apparatus. The final water temperature was recorded at this time. After equilibration, the headspace was sampled using a gastight syringe and immediately injected into the GC for analysis.

Test Summary and Results

A total of five tests were performed and the results averaged.

H_2 concentration test result: 12.4 mg/L; H_2 production mass: 6.2 mg

3) Determination of H_2 gas production volume

Maximum theoretical H_2 gas production volume

According to the manufacturer, each tablet contains a minimum of approximately 80 milligrams[2] of elemental magnesium (Mg), and produces hydrogen gas from the reaction between magnesium metal & water according to the reaction equation: $Mg + 2H_2O \Rightarrow Mg(OH)_2 + H_2$. Because each mole of magnesium produces 1 mole of H_2 gas, and the molar mass ratio of Mg:H_2 is 12:1, a tablet containing 80 mg of magnesium metal is theoretically capable of producing a maximum of 6.67 mg of H_2 or, in terms of volume, approximately 80 mL (SATP).

[2] The amount of elemental magnesium specified on the bottle label is 80 mg. In order to compensate for normal manufacturing variances and to guarantee that no tablet will contain less than 80 mg, each tablet will contain slightly more than 80 mg. This may result in measured values of hydrogen which are higher than the predicted theoretical maximums.

Test Equipment

Gas displacement apparatus

Digital thermometer: Oakton pH 6+ meter w/temperature probe

Test Description and Methods

The hydrogen gas evolution test sample was prepared using 500 mL of water as described in Test 1. In order to produce, capture, and measure the gas produced by a single tablet, a displacement apparatus was assembled using standard laboratory glassware and equipment. The apparatus included a 500 mL flask filled with 450 mL of water and 50 mL of acetic acid. The flask was sealed with a stopper to which was attached a section of flexible vinyl tubing for transferring the evolved gas to a graduated cylinder which was filled with water and submerged inverted in a reservoir of water. When the gas evolution reaction had finished, the total gas production and temperature were recorded. Because some H_2 gas also dissolved into the reaction water, its level was also measured and added to the total.

Test Summary and Results

A total of five gas evolution tests were performed and the results averaged:

Test results:

H_2 gas evolution (volume): 87.1 mL

H_2 gas evolution (mass): 7.2 mg

Approved By: RSSharpe Title: Director of Testing Report Date: 4/28/20