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Experimental confirmations of the new chemical species of Santilli MagneHydrogen

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ABSTRACT

In this note, we report two different experimental confirmations of the new chemical species of MagneHydrogen (MH discovered by R. M. Santilli in 2003 [1]) with 99% Hydrogen content, but also having a multiple of the specific weight of conventional molecular Hydrogen. A number of features of the new species MH are pointed out, such as the increased energy content and the lack of seepage through the walls of a container. These features appear to be relevant for the Hydrogen industry. Samples of the new species of MH are made available at no cost to qualified chemists for independent verifications.

In a paper from 2003, R. M. Santilli [1] presented theoretical and experimental evidence on the existence of a new species of Hydrogen he called *MagneHydrogen*, which consists of 99% Hydrogen (see Fig. 1), yet its specific weight (or, equivalently, molecular weight) is 7.47 times that of conventional Hydrogen (see Fig. 2). The original signed reports from independent analytic laboratories are appended at the end of the pdf file [1]. The new species is generically denoted MH and its individual clusters are denoted MH_n, $n = 2,3,4,\ldots$ to specify the number of hydrogen atoms per cluster.

Since the U.S. publicly traded company Magnegas Corporation [6] is in the process of organizing industrial production of Santilli MagneHydrogen, it appeared advisable to present for the scientific community two experimental verifications of MH as identified in Ref. [1], and offer at no cost samples of the new chemical species to qualified chemists for independent verifications.

To our best understanding, the most plausible interpretation of the new species of MH is that originally presented by Santilli in Ref. [1], namely, a multiple of the specific weight under a high Hydrogen percentage is evidence of a new clustering of *H*-atoms which cannot possibly be of valence type due to the evident absence of the valence electrons necessary for a quantitative representation of the clustering of many different atoms. Therefore, Santilli presented the new species of MH as additional evidence on the existence of the new species of *magnecules* (see Ref. [7] for Santilli's original presentations and Ref. [3] for recent experimental confirmations as well as to update the rapidly growing literature in the field).

In essence, the new chemical species of magnecules [1,2] can be defined as *clusters of individual atoms (H, O, C, etc.), dimers (HO, CH, etc.) and ordinary molecules (H_2, CO, H_2O, etc.) bonded together by attractive forces between opposing magnetic polarities of toroidal polarizations of atomic orbitals, as well as the*

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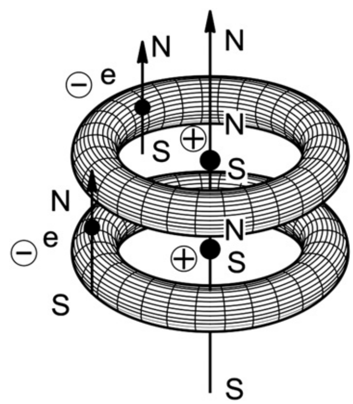


Fig. 1 – Conceptual rendering of Santilli magnecules, here referred to the species H × H assumed at absolute zero degree temperature. Note that [1,2]: the toroidal polarization of the electron orbitals creates a new magnetic field not existing for spherical distributions; all magnetic forces between said toroids as well as between the magnetic polarities of nuclei and electrons, are attractive; and the repulsive forces between nuclear and electron charges can be averaged to zero in first approximation since the atoms are individually neutral, thus resulting in the dominance of the new Santilli magnecular bond which is predominantly magnetic, rather than of a valence type.

polarization of the magnetic moments of nuclei and electrons (see a conceptual rendering in Fig. 1).

To derive the new species of MH, Santilli first developed the so-called *PlasmaArcFlow™ Reactor* for the conversion of various liquids into a combustible gaseous fuel known as *MagneGas™* (MG). The gasification is achieved via a submerged DC electric arc between carbon electrodes that, under sufficient powers (of the order of 300 kW or more) is capable of producing at atomic distances the high values of the magnetic field necessary for the polarization of electron orbitals into toroids (estimated as being of the order of 10^{12} Gauss).

By remembering that the electrodes are given by graphite and that they consume during the gasification process, MagneGas produced from water as liquid feedstock contains at least 60% Hydrogen in mixture with other combustible gases expected to be given by 30% Carbon Monoxides and 10% of various HydroCarbons. MagneGas produced from other liquid feedstock maintains its characteristics of being a “hydrogen-based gaseous fuel”, namely, a gas containing more than 50% Hydrogen [2].

Santilli obtained the new species MH via the use of conventional *Pressure Swing Adsorption* (PSA) equipment for the separation of Hydrogen from MG. It soon became clear that the purity and increased specific weight of MH depends on various factors, including the selected zeolites, the operating pressure, etc. As an example, the specific weight of 7.47 times that of H_2 was achieved by passing seven subsequent times the separate MH through the PSA station (see the reports at the end of the pdf file [1]).

Therefore, to prevent misrepresentations, the reader should be aware that the conventional molecular species H_2 has indeed *fixed characteristics*, such as fixed 300 BTU/scf, a fixed molecular weight of 2 a.m.u., and other features. By contrast, the new species of MH has *variable characteristics* depending on the equipment and procedures used for its production. However, once said equipment and operating procedures are set, the characteristics of MH remain stable at ambient temperature, as well as at pressures up to 5000 psi.

It should be noted that, from an industrial viewpoint, it is sufficient to achieve a species of MH with at least 3.3 the specific weight of H_2 to have the same energy content of 1000 BTU/scf of Natural Gas (NG). In fact, under said conditions, MH would avoid the current needs to liquefy Hydrogen in order to achieve a sufficient range, since MH can be compressed like NG. Additionally, the magnecular structure of MH avoids the traditional seepage of Hydrogen through the walls [1,2], thus allowing long term storage that is currently prohibited by molecular Hydrogen due to current environmental laws.

The first independent experimental verification of the new species of Santilli MagneHydrogen was achieved in October 11, 2011, by D. Day [4] of the *Eprida Laboratory*, 3020 Canton Road Suite 104, Marietta, GA, via the use of a VSA station for the separation of MH from MG, the use of a GC–TCD for the measurement of the percentage of Hydrogen in the separated gas, and the use of conventional methods for the measurement of molecular weight. In this way, Day achieved a species of MH with about 97.5% pure Hydrogen, while having 3.89 times the specific weight of H_2, and a consequential energy content of 1167 BTU/scf. For brevity, we refer interested readers to report [4] for details.

The second experimental verification of Santilli MagneHydrogen was achieved by the authors in the fall of 2012 as follows. First, the authors secured a *Vacuum Swing Adsorption* (VSA) station (rather than a PSA station as used by Santilli in Ref. [2]) for the separation of MH from MG, the same GC–TCD described in Ref. [3] for the measurement of the conventional Hydrogen content, and a highly accurate balance for the measurement of the molecular weight of MH.

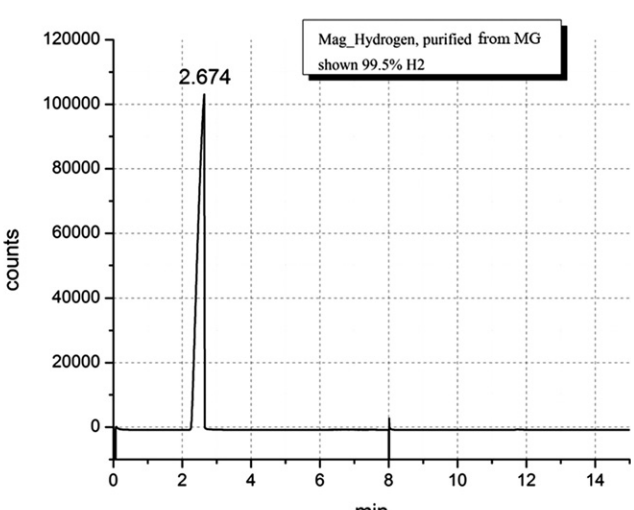
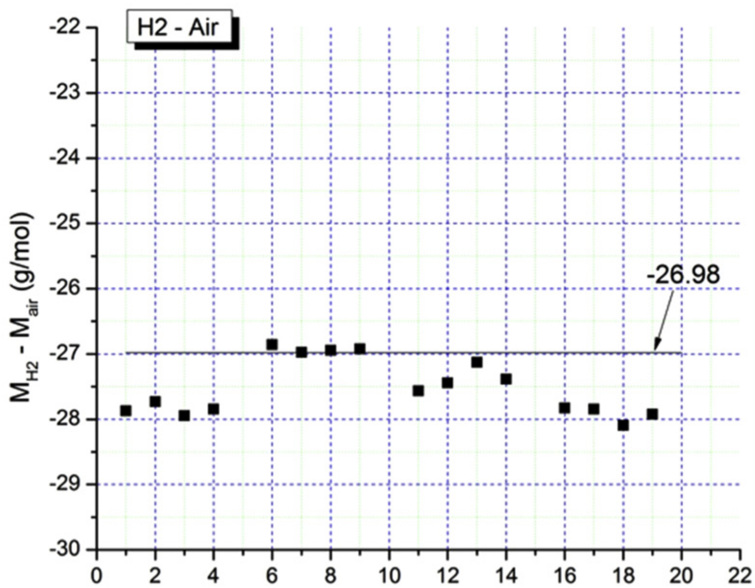


Fig. 2 – A scan of MagneHydrogen via the GC–TCD of Ref. [3] showing no appreciable difference of MH with pure hydrogen.



	H2	air
15 psi	-0.3018	-27.8709
	-0.3003	-27.7323
	-0.3026	-27.9447
	-0.3015	-27.8432
10 psi		
	-0.2439	-26.8554
	-0.245	-26.9765
	-0.2447	-26.9435
	-0.2445	-26.9215

	H2	air
5 psi		
	-0.2022	-27.5648
	-0.2013	-27.4421
	-0.199	-27.1286
	-0.2009	-27.3876
0 psi		
	-0.1458	-27.8265
	-0.1459	-27.8456
	-0.1472	-28.0937

Fig. 3 – Representative data on the verification and calibration of the methods for the measurement of the molecular weight H_2–air.

Following various calibrations and verifications, the authors first secured various species of MH separated from MG via the VSA station. Then, via the use of the Gas Chromatographer w/Thermal Conductivity Detector (GC–TCD), the authors established that the separated MH contains at least 99% pure Hydrogen (see Fig. 2). Note that the measurements of the Hydrogen percentage were done following the verification in Ref. [3] that the GC–TCD does indeed destroy all magnecular clusters and reduced MH to conventional molecules.

In order to measure the molecular weight of MH the authors conducted the measurements with an accurate balance and the use of a calibrated volume into which a measured mass of gas was admitted following the pulling out of a vacuum. By determining the mass per volume, and applying the ideal gas law, the authors were able to estimate the molecular weight as well as the underlying statistical error.

The molecular weight of a gas (MW_{gas}) with respect to the molecular weight of a standard gas (for example air, MW_{air}) can be calculated with the equation of ideal gas law:

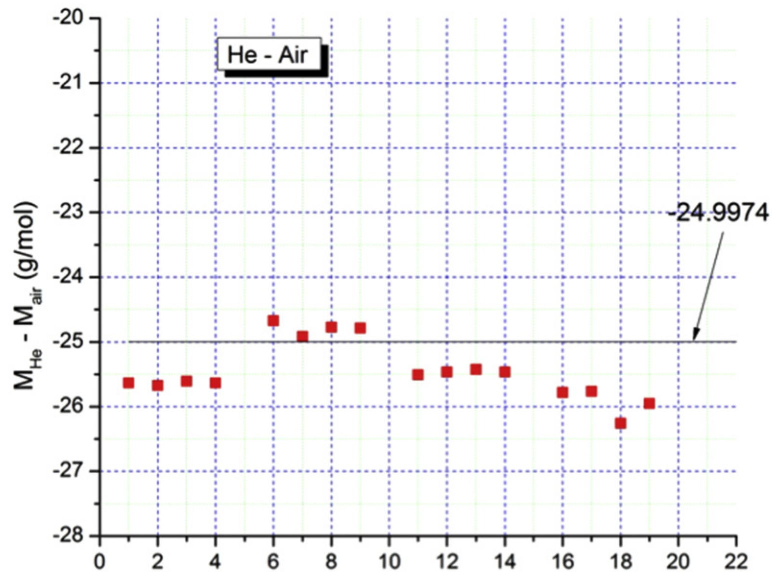
$$\Delta MW = MW_{gas} - MW_{air} = \Delta m RT/VP \quad (1)$$

where: we use the gas constant $R = 8.315$ J/K/mol; T is the gas temperature; V is the volume of gas; P is the pressure; Δm is increased mass in the volume; and the measurements are done with a high precision balance not shown for brevity.

In order to prove the accuracy of the measurement method, we first measured known gases, such as Helium 99.999% pure, molecular Hydrogen 99.995% pure, and air. Each individual gas sample was placed into a 150 ml flask and weighed.

Each measurement was repeated various times for accuracy, and their average was calculated to identify the statistical error. Atmospheric conditions were 101,325 pa, 23.9 °C, and 38% relative humidity. These measurements were done for the pair of gases H_2–Air, He–Air and N_2–Air.

The above procedure yielded an error with respect to the standard molecular weight of the H_2–Air system of 1.96%, for He–Air system of 1.81%, and for N_2–Air system of 2.45%. The difference between the average values is about 3.5% for all



		He	air
15 psi		-0.2776	-25.636
		-0.278	-25.673
		-0.2773	-25.6083
		-0.2776	-25.636
10 psi		-0.2241	-24.6752
		-0.2263	-24.9175
		-0.225	-24.7743
		-0.2251	-24.7854

		He	air
5 psi		-0.1871	-25.5063
		-0.1868	-25.4654
		-0.1865	-25.4245
		-0.1868	-25.4654
0 psi		-0.1351	-25.7844
		-0.135	-25.7653
		-0.1376	-26.2615
		-0.136	-25.9562

Fig. 4 – Representative data on the verification and calibration of the methods for the measurement of the molecular weight He–air.

above pairs. In this way, we established the reliability of the method (see representative measurements in Figs. 3 and 4).

The authors then conducted measurements for the pair MagneHydrogen–pure Hydrogen (MH–H_2) by using the same sample of MH as that injected in the GC–TCD of Fig. 2. In this way, we established that the above identified species of MH is 0.71 a.m.u heavier than conventional pure Hydrogen. Since Hydrogen has the molecular weight of 2 a.m.u., the selected MH has the molecular weight of 2.71 a.m.u., thus being 35% heavier than conventional Hydrogen.

It should be noted that heavier species of MH have been measured via the use of more appropriate zeolites in a VSA station, while much heavier species have been measured in Refs. [1,2] via PSA stations since their operating pressure appears to compound MH clusters. However, the 35% increase in anomalous weight has been sufficient for its release in this note since the anomaly is more than ten times the statistical error (Fig. 5).

We close this note with an analysis of the species of MH used in the above tests conducted by *Oneida Research Services*, 8282 Halsey Rd, Whitesboro, NY, via IVA 110s with an accuracy of ±5% 5000 ppmv (see also Ref. [3] for details), establishing that the tested MG contains detectable species in

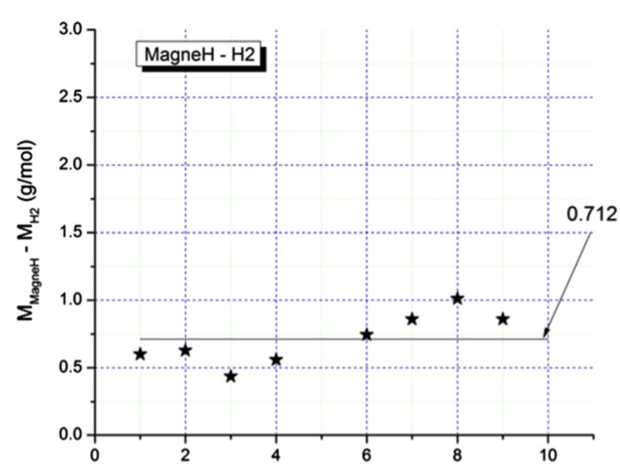


Fig. 5 – Statistical measurements on the molecular weight of MH with respect to that of H_2, which is represented by the abscissa, showing that the former is about 35% heavier than the latter, namely, the anomaly is about ten times the statistical error.

ORS REPORT NO.	196809-001		
DATE TESTED	9/5/2012		
QUANTITY TESTED	2		
PACKAGE TYPE	standard		
SAMPLE	ID	EQ09012	EQ02171
Mass	2	177,131	150,391
Mass	3	93,300	77,390
Mass	4	354,930	397,630
Mass	5	373	242
Mass	6	20,779	16,402
Mass	12	1,208	753
Mass	13	73	70
Mass	14	4,517	3,051
Mass	15	641	518
Mass	16	4,393	2,411
Mass	17	9,362	3,121
Mass	18	39,386	12,362
Mass	19	5,922	2,123
Mass	20	17,950	4,954
Mass	22	178	0
Mass	24	239	0
Mass	26	1,043	236
Mass	27	466	320
Mass	28	43,690	28,234
Mass	29	1,186	881
Mass	30	1,305	382
Mass	31	228	0
Mass	32	7,328	5,828
Mass	40	469	337
Mass	42	137	0
Mass	43	459	456
Mass	44	11,546	8,718
Mass	45	399	375
Mass	46	137	0
Mass	73	320	336

Fig. 6 – A scan of two species of MG [6] done with IVA 110A showing anomalous chemical species from 2 a.m.u. to at least 150 a.m.u., here reduced for simplicity to 73 a.m.u. The above analysis confirms the existence of MH in MG because all species up to 11 a.m.u. can only be MH due to the lack of He and other gases in MG at low a.m.u s.

increasing unit of a.m.u. from 2 a.m.u./to at least 150 a.m.u. (see Fig. 6).

Such a chemical structure confirmed Santilli's magnecular bonds as the dominant bond for MagneHydrogen due, again, to impossibility for the single valence electron of the Hydrogen atoms to achieve valence bonds with a large number of Hydrogen atoms.

It is appropriate to recall here the controversial character of the "molecule" H_3 due to the insufficiencies caused by the assumption of its bond as being of valence type. In fact, Santilli points out in this respect [1,2] that such an assumption would prohibit the achievement of the conventional binding energy of the H_2 molecule. Additionally, valence bonds occur for "valence electron pairs" that, as such, bond into singlets. Santilli argues that, according to quantum mechanics, it is not possible to achieve a stable bound state of a particle with spin 1/2, (such as the valence electron of the third H) with the spin zero of the single coupling of the other two electrons. These and other reasons suggest an impossibility in assuming that H_3 is a "molecule" and mandate the adoption of new vistas.

Santilli's identification of the sequence of species with 2, 3, 4, 5, 6, etc. a.m.u has essentially resolved the controversy [5] since the insufficiencies for the valence interpretation of the species H_3 are multiplied for heavier species H_4, H_5, H_6 etc., thus suggesting additional studies in Santilli's representation of these anomalous species as consisting of magnecular structures, e.g., for the three-H-atoms (see Figs. 7–9 for conceptual renderings)

$$MH_3 = \{H - H \times H, H \times H \times H\} \tag{2}$$

for the four H-atoms

$$MH_4 = \{H - H \times H - H, H - H \times H \times H, H \times H \times H \times H\} \tag{3}$$

and so on.

As also indicated at the end of Section 2 of Ref. [3], in the authors view, the identification of the equipment and procedure for the separation of molecular and magnecular species in a cluster of a given a.m.u. is one of the most intriguing open problems in contemporary chemistry.

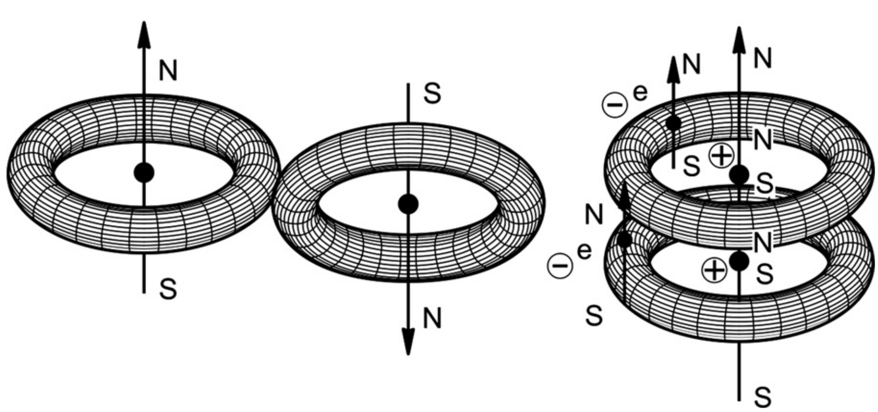


Fig. 7 – A conceptual rendering of the cluster MH_2 in MH which is predicted as being composed by part of the molecular species H – H and part by the magnecular species H × H.

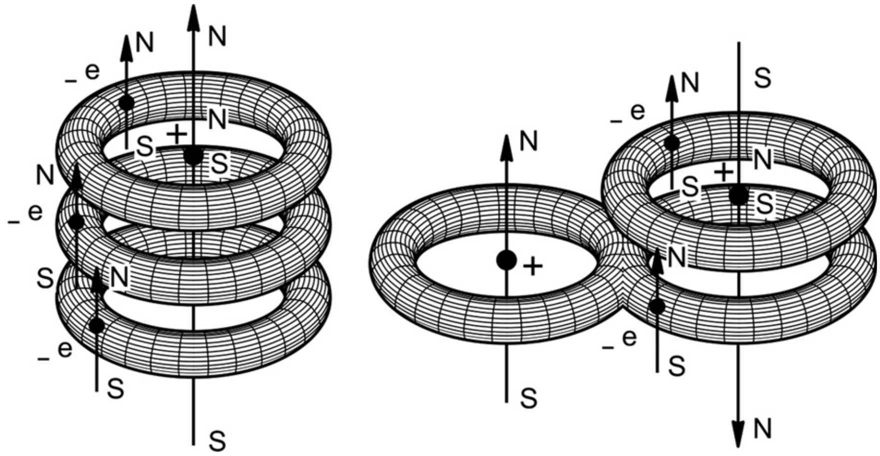


Fig. 8 – A conceptual rendering of the cluster MH_3 in MH which is predicted as being composed by magnecular species H × H × H and H − H × H.

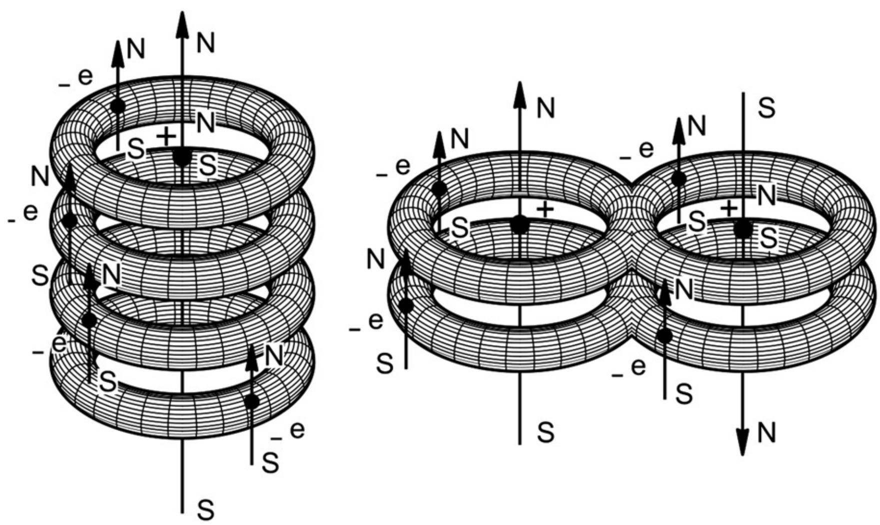


Fig. 9 – A conceptual rendering of the cluster MH_4 in MH which is predicted as being composed by the magnecular species H − H × H − H, H − H × H × H (not shown for simplicity) and H × H × H × H.

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