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Magnesium and the Magnesium Power Engine

[1]Sobin Santhosh and [2]Abhilash Nair

[1]Department of Aerospace Engineering, SRM University, Kattankulathur, Kanchipuram District, Tamil Nadu, India.
[2]Department of Aerospace Engineering, SRM University, Kattankulathur, Kanchipuram District, Tamil Nadu, India.

Abstract

Magnesium is an alkaline earth metal and the eighth most abundant element in the earth's crust. In powdered or stripped form, magnesium is highly flammable. Its reaction with water releases an equivalent 1921 KJ/mol of energy. This, in addition to the efficiency of reaction, ease of transportation and availability of material make magnesium powder a viable candidate as an alternative fuel. The harnessing of the energy generated by the reaction of magnesium powder and water can be realized with the help of an engine specifically designed for the said cause. The Magnesium Power Engine (MPE) incorporates measures such as the usage of springs and ammonia to stem the losses in mechanical energy and thermal energy respectively. No harmful emissions, such as carbon dioxide or nitrogen dioxide, are produced of any sort, the by-products being just magnesium oxide and water. Capable of generating large energy on comparatively small quantities of input, the MPE will be compact and light-weight in comparison to other engines. The MPE will be best suited in the field of automotive, aeronautical and marine engineering where compact, high-power generating engines are the need of the hour.

Keywords: Magnesium; energy; engine; reaction; fuel.

1. Introduction

Magnesium (Mg) is an alkaline earth metal not found naturally on earth owing to its highly reactive nature. Magnesium is highly flammable in powdered/shaved form. Capable of burning in nitrogen, carbon dioxide and water, its flame temperatures can reach as high as upto 3370 K. Magnesium has the 4th highest specific heat among metals. On earth, magnesium is the eighth most abundant metal, constituting 2.5% of

the earth's resources by weight. It is mainly found in the form of ores. The important ores of magnesium are brucite $Mg(OH)_2$ {containing 41.7% Mg} , magnesite $MgCO_3$ {containing 28.8% Mg} and dolomite $CaMg(CO_3)_2$ {containing 18.2% Mg}. Another source of magnesium, found abundantly throughout the globe, is sea-water {containing 4% Mg}.[1]

The violent reaction between magnesium and steam results in the release of a large amount of energy. Such energy can be harnessed and utilised by means of the Magnesium Power Engine. The output of the engine can be controlled by varying the amount of fuel (Mg powder) supplied to the engine and the temperature of the reactant (water). The energy produced can utilised through multiple means. The present study attempts to show the feasibility of using the dynamics of a magnesium and steam reaction in an engine specifically designed for the process.

2. Energy Production

Magnesium burns in steam to produce magnesium oxide and hydrogen gas. The reaction produces an equivalent 556 KJ/kg of energy at 623 K. [2]

$$Mg(s) + H_2O(g) = MgO(s) + H_2(g)$$

In presence of excess water, the reaction yields $Mg(OH)_2$ and H_2, the overall reaction releasing an incredible 1921 KJ/mol of energy.

$$Mg(s) + 2H_2O(l) = Mg(OH)_2(s) + H_2(g)$$

2.1 Making of the engine

The Magnesium Power Engine is aimed at efficiently tapping the energy released by the magnesium powder and water reaction through the help of its specialised design. The engine consists of a double-walled vessel made of aluminium bronze, the space between the double-walls being occupied by liquid ammonia.

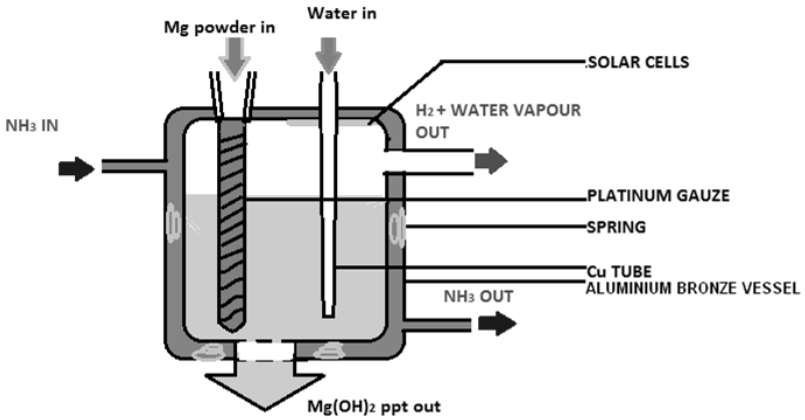

Figure 1: The Magnesium Power Engine.

The introduction of the fuel (Magnesium powder) into the reaction chamber is done through a gauze composed of platinum whereas the inlet for the heated water/steam is through a tube composed of copper. The reaction chamber provides an outlet for the by-products {$Mg(OH)_2$ and MgO}. Steel springs surround the vessel, thus protecting it from mechanical vibrations.

2.2 Working of the engine

Magnesium powder and water/steam react with one another in the reaction chamber generating large quantities of heat. Being highly volatile, liquid ammonia is used to absorb the heat energy released by the reaction in the reaction chamber. A special turbine located in the vicinity of the engine is driven by the heated ammonia gas, which generates power. The temperature of the hot water put through the inlet can be controlled along with the input of magnesium powder. The base reaction is even more efficient at higher temperatures, hence the output of the engine also improves with increase in the temperature of reaction.

3. Conclusions

Hence, it can seen how useful Magnesium would serve as an alternative fuel in the future. The Magnesium Power Engine is a machine aptly designed for the harvesting of energy from the reaction of magnesium with steam. Prospects of harnessing energy via other reactions of magnesium (especially with CO_2) are currently being looked upon.

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