

Determination of the Formula of Magnesium Oxide

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23/10/2023



Keywords:

1 INTRODUCTION

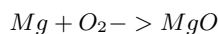
The experiment conducted was to determine the formula of magnesium oxide. By using an analysis of the mass to mole ratio of magnesium (Mg) and oxygen (O). Magnesium chips were heated over a Bunsen burner and the product was recorded, the mass was measured before and after the experiment were used to make the calculations.

2 THEORY

Magnesium is the lightest metal by structure¹. When ignited with Oxygen, the heat of combustion is -601.83 KJ/mol^2 meaning that it is an exothermic reaction. Having a very hot, exothermic reaction in a light material that requires little energy makes it ideal for an ignition source within OME.

Oxygen is a colourless, non-metallic and odourless gas which is required by living organisms in one way or another. Oxygen can also - with catalytic assistance - form compounds with most other elements "Oxygen's role in rocket propellant is to act as the oxidizer. Oxygen is essential in combustion processes such as the burning of fuels. Oxygen helps burn the fuel in order to help launch the spacecraft. We know oxygen is the most common oxidizing agent used in other applications. As the third most abundant gas on earth, oxygen is a great source to use as an oxidizer".³

A compound of Oxygen is formed by any substance, using Magnesium, reacts and combines with the reactant, in this case Oxygen, which produces an oxide. In this experiment Magnesium reacted with Oxygen produces Magnesium Oxide as shown below:



The density and volume of the reaction will remain the same this is to do with the Law of Conservation of Mass: "for any system closed to all transfers of matter and energy, the mass of the system must remain constant over time, as the system's mass cannot change, so the quantity can neither be added nor be removed."⁴ Shown by

$$\text{Mass} = \text{Volume} \cdot \text{Density}$$

A quantity of an atomic substance is measured in Moles (mol). 1mol contains $6.02214076 \cdot 10^{23}$ particles. This is more commonly known as Avogadro's constant - the creator - and is used as a base for calculations as it is precisely 12g of carbon⁵. The molar mass of an element can be found on the periodic table underneath the element. Utilising the known constant allows for accurate and precise production of specific compositions.

3 METHODS

3.1 Apparatus

Chemicals	Equipment	PPE
Magnesium Chips 1 - 1.5g	Crucible and cover	Lab Coat
Atmospheric air	Ring stand	Safety Goggles
	Bunsen Burner	Nitrile Gloves
	Clay triangle	
	Crucible tongs	
	Digital balance	

3.2 Procedure

1. Set up the equipment on a heat resistant mat. The clay triangle sits on top of the ring. Light the Bunsen burner and open the vent to attain a blue flame. When not used the Bunsen burner must be placed on a safety orange flame.
2. Ensure the the crucible and lid is clean and dry. These should be weighed on the scales so as to not take a false reading.
3. Add 1 - 1.5g of magnesium chips. Record the weight and data of the whole crucible.
4. Gently heat the crucible for 1 minute, then heat strongly.
5. After approximately 10 minutes the magnesium will turn into a white powder.
6. Allow to cool, weigh and record.

4 RESULTS

Below is a recreation of the observation record sheet supplied by UWTSD:

Mass of crucible and cover.	72.6g
Variable 1	
Mass of crucible, cover and magnesium.	73.5g
Variable A	
Mass of magnesium before heating.	73.5 - 72.6 = 0.9g
Mass of crucible, cover and product after heating.	73.7g
Variable B	
Mass of product after heating.	B - 1 = 1.1g
Mass of oxygen which reacted with magnesium.	B - A = 0.2g
Moles of oxygen.	Mol = 0.2g/16g/mol. Mol = 0.0125
Moles of magnesium.	Mol = 0.9g/24g/mol. Mol = 0.0375
Mole ratio of Mg to O	Mg=0.0375/0.0125=3. O=0.0125/0.0125=1 Ratio = 3:1
Determined formula of the oxide	MgO
Oxide Mg mass %	%=0.2/1.1x100=18.18% 2dp
Oxide O mass %	%=0.9/1.1x100=81.82% 2dp
Balanced chemical equation	2Mg+O ₂ =2MgO

Fig. 1. UWTSD provided observation sheet

5 DISCUSSION

As can be seen from 1, the complete mass increased after oxidising. Contrary to the hypothesis outlined in the Theory section. Observations showed a residue left in the crucible alongside the expected magnesium oxide solid. This is due to the presence of air, which is not 100% oxygen and instead is made up from Nitrogen(78%), Oxygen(20%), Argon(0.9%), Carbon Dioxide(0.04%)⁶ and other minor elements less than 1%. It is more than likely that the absence of pure oxygen has invalidated the experiment.

5.1 Analysis

To ascertain the correct molar masses, the table in the Results section must be recalculated using the molar mass of air which is 28.9647 g/mol⁷ which can be rounded to 29 g/mol to make the equation easier to understand

Moles of Air	$Mol = 0.2g/29g/mol. Mol = 0.0069$
Moles of magnesium	$Mol = 0.9g/24g/mol. Mol = 0.0375$
Mole ratio of Mg to O	$Mg = 0.0375/0.0069 = 5.43$ $Air = 0.0069/0.0069 = 1$ $Ratio = 5.43 : 1$

5.2 Recommendations

For the theoretical values to be correct pure oxygen must be used in a controlled environment to minimise or eliminate contaminants. For a full analysis computer based spectroscopy should be used to provide the most accurate data on this experiment.

6 CONCLUSION

As detailed above the experiment carried out is flawed and cannot provide accurate data. However for a theoretical demonstration it is perfectly adequate. Within a controlled lab environment providing context and learning capabilities there is no necessary changes required.

ACKNOWLEDGEMENTS

I thank Dr E. Kazimierska for heading the experiment and for teaching the theory necessary for context. I also thank Dr M. Broadhead for

acting as lab assistant and providing extra information and real world applications for this experiment.

REFERENCES

- [1]"Magnesium — Description, Properties, & Compounds — britannica.com." <https://www.britannica.com/science/magnesium>. [Accessed 15-06-2024].
- [2]S. L. Kujan, "Burning of Magnesium — rutchem.rutgers.edu." <https://rutchem.rutgers.edu/cldf-demos/1016-cldf-demo-burning-magnesium#:~:text=The%20heat%20of%20formation%20of,sanded%20to%20remove%20oxide%20coating>. [Accessed 17-07-2024].
- [3]"How Liquid Gas Rocket Propellant Helps Fuel Spacecrafts & Air-source Blog — air-source.com." <https://air-source.com/blog/how-liquid-gas-rocket-propellant-helps-fuel-spacecraft#:~:text=Oxygen's%20role%20in%20rocket%20propellant,to%20help%20launch%20the%20spacecraft>. [Accessed 17-07-2024].
- [4]"Conservation of mass - Wikipedia — en.wikipedia.org." https://en.wikipedia.org/wiki/Conservation_of_mass. [Accessed 17-07-2024].
- [5]"The Mole — chem.fsu.edu." <https://www.chem.fsu.edu/chemlab/chm1045/mole.html#:~:text=The%20value%20given%206.022%20x%2010%2023,6%20protons%20and%206%20neutrons>. [Accessed 17-07-2024].
- [6]<https://www.facebook.com/thoughtcodotcom/>, "The Chemical Composition of Air — thoughtco.com." <https://www.thoughtco.com/chemical-composition-of-air-604288>. [Accessed 18-07-2024].
- [7]"Air - Molecular Weight and Composition — engineeringtoolbox.com." https://www.engineeringtoolbox.com/molecular-mass-air-d_679.html. [Accessed 18-07-2024].