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Sugar Rocket boosters

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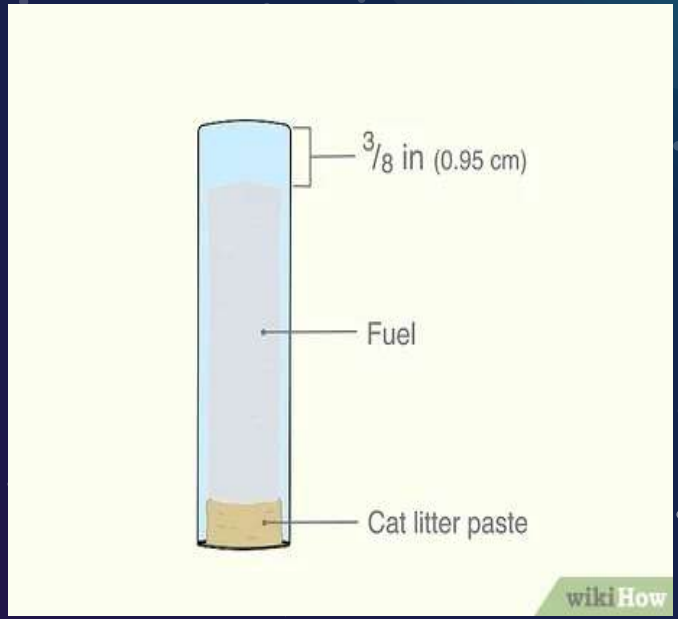
What is sugar rocket?

. A sugar rocket is a simple home project that uses potassium nitrate or KNO_3 and powdered sugar as fuel. While it's easy to make a sugar rocket, it's also very dangerous, so use caution throughout your project. To build your rocket, you'll need to make a rocket body out of heavy paper. A sugar rocket is also known as a Rocket candy.



what would be the density of gas when we burn potassium nitrate with sugar

- To find the density of gas we have to know molar mass of gas (Molar mass : The amount of entities present E.G Atoms, molecules, etc).
- When we burn potassium nitrate it releases the gases such as water vapour, carbon dioxide, nitrogen gas, so we have to know the molar mass of all of these :
- Water vapour (18 g/mol)
- Carbon dioxide (44g/mol)
- Nitrogen gas (28g/mol)
- For every mole of sugar that reacts with 6 moles of potassium nitrate will produce 3 moles of nitrogen gas, 1 moles of water and 6 moles of CO2

Some governing equation to find different properties :

- compressible continuity : $\rho.A.V = Constant$
- Energy Equation: $cpT1 + V^2/2 = Constant$
- Pressure: $\rho.R.T$
- Thrust Equation : $M.Ve + (Pe – Po)Ae$

Components of sugar rocket:

:Chemicals

- Potassium Nitrate
- Sugar(Sorbitol,Glucose)
- Binder(Cat litter,Araldite)
- Red Iron Oxide

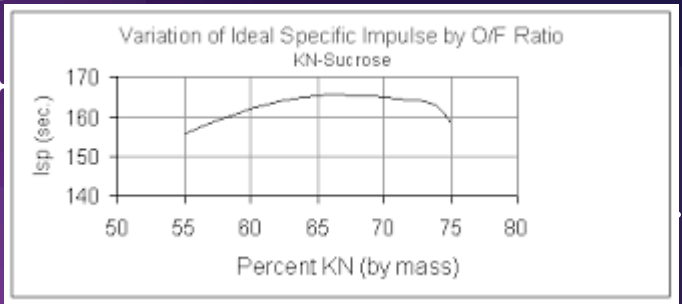
Components:

Rocket candy can be broken down into three major groups of components: fuels, oxidizers, and additives. The fuel is the substance that burns, releasing rapidly expanding gases that provide thrust as they exit the nozzle. The oxidizer provides oxygen, which is required for the burning process. The additives can be catalysts, to speed up or make the burning more efficient. However, some additives are more aesthetic, and can add sparks and flames to liftoff, or add smoke for ease of following the rocket in the air.

Chemical Percentage:

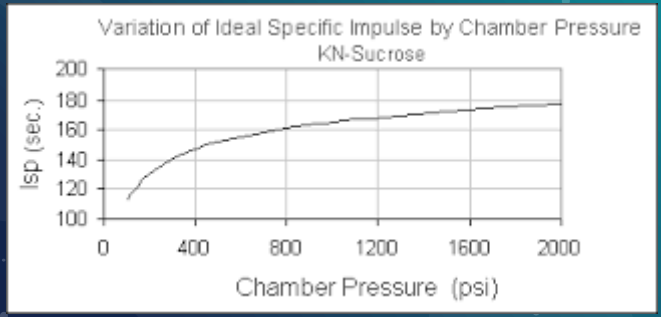
The standard ratio of constituents for fuel is 65% of Potassium Nitrate($KMNO_3$)

And 35% of Sugar by Mass fromulation

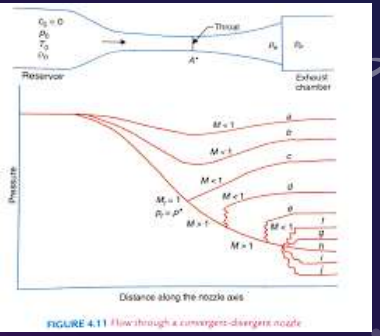


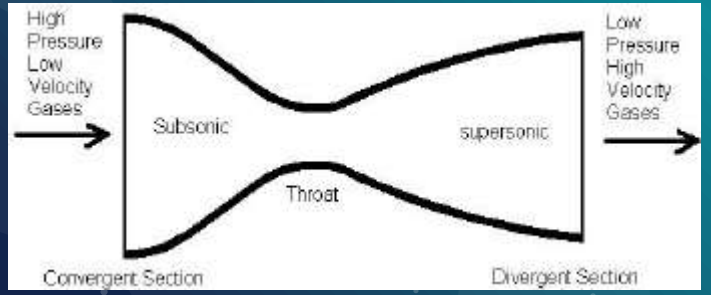
This ratio, although found with Potassium Nitrate as the oxidizer and sugar as the fuel, can be applied to many other concepts, because the same rough ratios applies to similar fuels, including the one used in the solid boosters of the space shuttle. Furthermore, by knowing the correct ratio, the termperature, pressure, and length of the reaction can be found, and used to calculate the most efficient rocket nozzle design for that fuel.

Performance



- Sugar based rocket propellants have an average I_{sp}(specific impulse) of between 115 and 130 seconds. Compare that to the average I_{sp} of an APCP (Ammonium perchlorate composite propellant), which is 180 to 260 seconds. Sorbitol and KNO_3 based propellants with a typical 35:65 ratio are capable of an I_{sp} of between 110 and 125 seconds. However, sorbitol and KNO_3 rockets with additives have been recorded as having specific impulses of up to 128 seconds.[4]
- Xylitol and KNO_3 based rocket propellants are capable of a specific impulse of ~100 seconds. These have an unconfined burn rate of about 1.3 mm/s. Dextrose and KNO_3 based fuels are capable of an I_{sp} of 137 seconds.[7] Overall, the performance characteristics of sugar rockets approach those of professional grade propellants





CD NOZZLE

- We have made use of a Converging diverging nozzle.
- A nozzle is a relatively simple device, just a specially shaped tube through which hot gases flow. Ramjets and rockets typically use a fixed convergent section followed by a fixed divergent section for the design of the nozzle. This nozzle configuration is called a **convergent-divergent**, or **CD**, nozzle. In a CD nozzle, the hot exhaust leaves the combustion chamber and converges down to the minimum area, or **throat,** of the nozzle. The throat size is chosen to **choke** the flow and set the mass flow rate through the system.

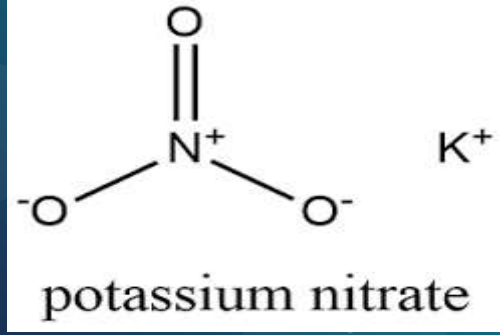
Specific impulse

- Specific impulse is the change in momentum per unit mass for rocket fuels, or rather how much more push accumulates as you use that fuel.
- The speed of a rocket depends on thrust (which is roughly the amount of propellant that is thrown out of the back of the rocket and the speed at which that propellant is thrown out) compared to the rocket's weight.
- **Sugar based rocket propellants have an average I_{sp}(specific impulse) of between 115 and 130 seconds. Compare that to the average I_{sp} of an APCP (Ammonium perchlorate composite propellant), which is 180 to 260 seconds.**

APPLICATIONS

- Rocket candy was also employed in a small amateur rocket described by Lt. Col. Charles M. Parkin in a lengthy *Electronics Illustrated* article that continued over several issues, beginning in July 1958. Parkin described how to prepare the propellant mixture by using an electric frying pan as a heat source for the melting operation. This article was reprinted in Parkin's book, *The Rocket Handbook for Amateurs*, which was published in 1959. Parkin's article contributed to the increasing popularity of the rocket candy propellant among amateur rocket groups beginning in the late 1950s and early 1960s.
- Sugar-fueled rockets have been used as crude weapons of war, such as during the attacks on Israel by Hamas during 2000-2003.[8]

Potassium nitrate



- Potassium Nitrate is a chemical compound with the chemical formula $KMNO_3$. It is anionic salt of potassium ions K+ and nitrate ions NO_3-.
- The safest, cheapest, most reliable, and easiest to apply system of propulsion is the one in which only solid fuels are used. In particular, the nitrate based propellant is very popular. When preparing a nitrate-based fuel, the components must be dissolved to ensure thorough mixing and a uniform texture throughout the fuel. One of the most efficient nitrate-based propellants is a mixture of potassium nitrate and sugar, commonly referred to as "Rocket Candy."

RESULT

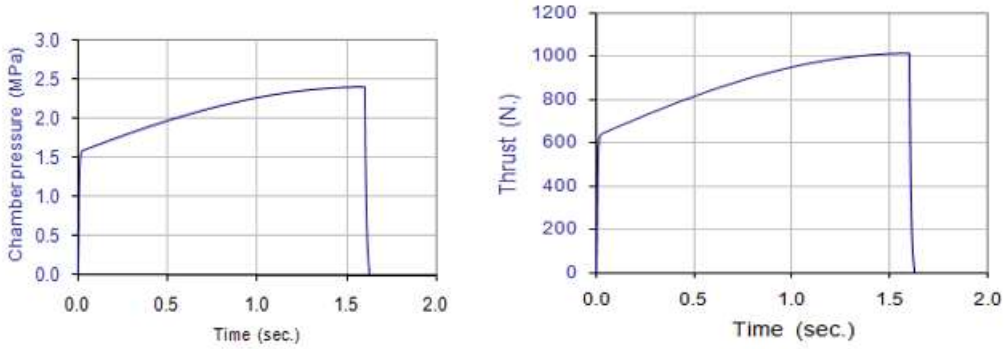


Figure 4: Graphs depicting the variation of motor Chamber pressure and thrust with burn time.

THANKS!