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# Propulsion of Rocket Using potassium Nitrate

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**ABSTRACT**

A solid rocket or a solid-fuel rocket is a rocket with a motor that uses solid propellants (fuel/oxidizer). The earliest rockets were solid-fuel rockets powered by gunpowder; they were used by the Chinese, Indians, Mongols and Arabs, in warfare as early as the 13th century. The evolution of the rocket has made it an indispensable tool in the exploration of space. For centuries, rockets have provided ceremonial and warfare uses starting with the ancient Chinese, the first to create rockets. The rocket apparently made its debut on the pages of history as a fire arrow used by the Chin Tartars in 1232 AD for fighting off a Mongol assault on Kai-feng-fu.

**KEYWORDS:**
solid rocket fuel,motor body , aluminium material,rocket, fins and nozzle

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## 1. INTRODUCTION

Effective The Rocket propellant has been identified as a component that played an important role in the development of rockets. The ejected material in rocket propulsion is due to a material called propellant. Without propellant, a rocket cannot be launched. A solid rocket is a class of rocket in which the fuel, oxidizer and binder are mixed together and cast into a solid material. A fuel propellant is often burned with an oxidizer propellant to produce large volumes of very hot gas. These gases are expand and push through a nozzle at extremely high speed and making thrust. Under room temperature conditions, the propellant does not self-ignited except they were exposed to an external source of heat. Once the burning starts, it will proceed until all the propellant is burned and hot exhaust gases is produced which is used to propel the rocket.The principal advantage is that a solid propellant is relatively stable, therefore it can be manufactured and stored for future use. Solid propellants have a high density and can burn very fast. They are relatively insensitive to shock, vibration and acceleration. No propellant pumps are required thus the rocket engines are less complicatedDisadvantages of solid propellant are they cannot be throttled turned off or restarted once they were ignited. The surface area of the burning propellant is critical in determining the amount of thrust being generated. Cracks in the solid propellant increase the exposed surface area thus the propellant burns faster than planned.

## 2. COMPONENTS OF THE SOLID FUEL IGNITED ROCKET

PARTS OF THE ROCKET VEHICLE

- PAY LOAD
- BATTERY
- CONNECTING WIRES
- BODY
- MOTOR
- SOLID FUEL
- NOZZLE
- FINS
- COMBUSTION CHAMBER
- NICHROME WIRE
- SENSORS
- RELAYS
- PARACHUTE

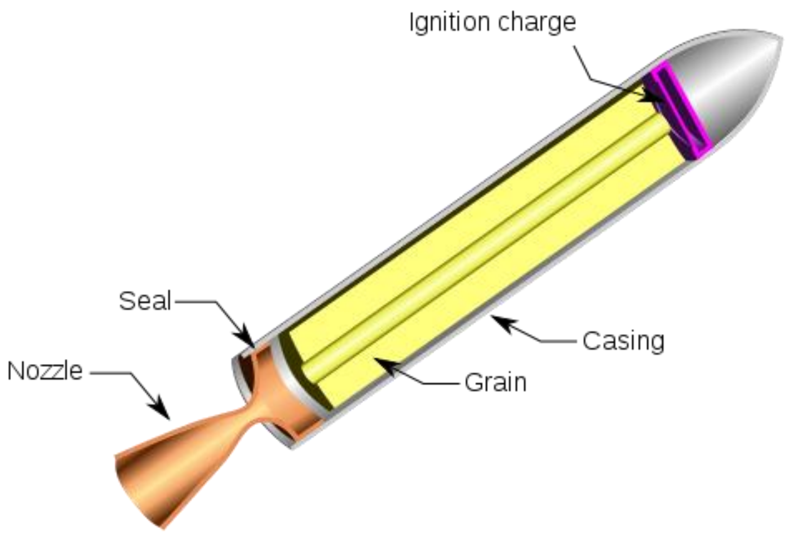


**FIGURE 1 PARTS OF THE SOLID FUEL ROCKET**

## 3. ALUMINIUM MOTORBODY

In this project work Aluminium is used as a motor body. Motor body is the main part of the rocket were the solid propellant is stored for ignition. The motor body is placed inside the outer surface of the body but it is not connected with the outer body. The space between the outer body and motor is filled with substance which does not release the heat produced by the fuel during the ignition process. Motor body should be the poor conductor of heat and to withstand the high pressure caused during the ignition process.Pure aluminium is soft, ductile, corrosion resistant and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide the higher strengths needed for other applications. Aluminium is one of the lightest engineering metals, having a strength to weight ratio superior to steel.By utilising various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminium is being employed in an ever-increasing number of applications. This array of products ranges from structural materials through to thin packaging foils.

**FIGURE 2 FUEL MOTOR BODY**

## 4. SOLID PROPELLENT FUEL

The Solid propellants come in two main types. "Composites" are composed mostly of a mixture of granules of solid oxidizer, such as ammonium nitrate, ammonium dinitramide, ammonium perchlorate, or potassium nitrate in a polymer binding agent, with flakes or powders of energetic fuel compounds (examples: RDX, HMX, aluminium, beryllium). Plasticizers, stabilizers, and/or burn rate modifiers (iron oxide, copper oxide) can also be added.Single, double, or Solid propellants come in two main types. "Composites" are composed mostly of a mixture of granules of solid oxidizer, such as ammonium nitrate, ammonium dinitramide, ammonium perchlorate, or potassium nitrate in a polymer binding agent, with flakes or powders of energetic fuel compounds (examples: RDX, HMX, aluminium, beryllium). Plasticizers, stabilizers, and/or burn rate modifiers (iron oxide, copper oxide) can also be added triple-bases (depending on the number of primary ingredients) are homogeneous mixtures of one to three primary ingredients. These primary ingredients must include fuel and oxidizer and often also include binders and plasticizers. All components are macroscopically indistinguishable and often blended as liquids and cured in a single batch. Ingredients can often have multiple roles. For example, RDX is both a fuel and oxidizer while nitrocellulose is a fuel, oxidizer, and structural polymer.

Further complicating categorization, there are many propellants that contain elements of double-base and composite propellants, which often contain some amount of energetic additives homogeneously mixed into the binder. In the case of gunpowder (a pressed composite without a polymeric binder) the fuel is charcoal, the oxidizer is potassium nitrate, and sulphur serves as a reaction catalyst while also being consumed to form a variety of reaction products such as potassium sulphide.

## 5.PREPARATION OF SOLID FUEL MADE UP OF POTASSIUM NITRATE AND SUGAR

There are a number of different methods for preparing a sugar-based rocket propellant. These methods include dry compression, dry heating, and dissolving and heating. The latter two methods involve heating the propellant.In dry compression, the sugar and potassium nitrate are individually ground as finely as possible, and then mixed in a ball mill or tumbler toensure uniform mixing of the components. This mixture is then compressed into the motor tube, similar to the method for packing black powder into a muzzle loading rifle. However, this method is rarely used for serious experiments, and careful safety considerations should be made before deciding to employ this method. There is a significant chance for self-ignition while mixing, which could lead to serious injuryAnother, more common, and safer method of preparing a sugar-based rocket propellant is dry heating. First, the potassium nitrate is ground or milled to a fine powder, and then thoroughly mixed with powdered sugar which is then heated. This method does not actually melt the potassium nitrate, as themelting temperature of $KNO_3$ is 323 °C (613 °F), but it melts the sugar and coats the grains of $KNO_3$ with the melted sugar. The melting process must be performed using a heat spreader, so as to avoid creating auto ignition hot-spots. Dissolving and heating the propellant actually dissolves both elements of the propellant and combines them. First, the $KNO_3$ and sugar are placed in a pot or saucepan. Then, just enough water is added to be able to completely dissolve the $KNO_3$ and the sugar. The mixture is then heated and brought to a boil until the water evaporates.The mixture will go through several stages: first boiling, then bubbling and spitting, then it will turn to a smooth creamy consistency. There are several advantages to dissolving the sugar and $KNO_3$ in water before heating. One advantage is that the $KNO_3$ and the sugar do not have to be finely powdered, because they both end up completely dissolved. This method of preparation also causes the resultant propellant to resist caramelization in the pot, giving more time to pack it into the motorsIn this project, there is one type of propellant that must be produced using one types of oxidizer that is potassium nitrate. The propellant will contain ingredients of fuel, oxidizer and binder. With a mixture of all three of these ingredients, propellant will produce according to the procedures specified.

### 5.1FUELS

To The first ingredient in solid propellant was fuel. Fuels used in this project are sucrose. Sucrose, the technical name for table sugar, cane sugar, or white sugar is made of one glucose molecule and one fructose molecule bound together. It comes in powdered and granulated forms, sugar is made from highly processed form of sugar beet or sugar cane plant extracts. Sucrose, ordinary table sugar, is probably the single most abundant pure organic chemical in the world and the one most widely known to no chemists.Sucrose is the organic compound commonly known as table sugar. A white, odourless, crystalline powder with a sweet taste, it is best known for its nutritional role. The molecules are a disaccharide composed of the monosaccharides glucose and fructose with the molecular formula C12H22O11.Sucrose used in this project can acts as a binder material and fuel. Sucrose used was from a local product that is in another language is sugar. This will be a fine-grained sugar before being used in making the propellant. Sucrose classified as carbonate organic matter and very dangerous when mixed with potassium nitrate. Therefore, the equipment used to prepare potassium nitrate and sucrose should be separate to avoid mixing of this materials.

### 5.2OXIDISER

Second ingredient is oxidizers which supply oxidizing materials for combustion process of a solid propellant. The main oxidizer used in this project is potassium nitrate. These types of oxidizer will be discussed further and in detail and the functions of this oxidizer in solid propellant is also to be discussed.Potassium nitrate is a chemical compound with the formula KNO3. It is an ionic salt of potassium ions K+ and nitrate ions NO3−. It occurs as a mineral nitre and is a natural solid source of nitrogen. Potassium nitrate is a transparent, colourless-to-white crystalline powder or crystals with a cooling, pungent, saline taste. It is soluble in water and slightly soluble in alcohol and glycerine. Potassium nitrate is one of several nitrogen that is containing compounds collectively referred to as saltpetre. Major uses of potassium nitrate are in fertilizers, food additive, rocket propellants and fireworks; it is one of the constituents of gunpowder.Potassium nitrate is a powerful oxidizing agent which is used in pyrotechnics, explosives, matches, fertilizers, metallurgy, analytical, chemistry and preparation of medicines . In rocket technology it is used as an oxidizer in solid propellant grains . Potassium nitrate is also known as saltpetre. This material is the initial propellant that has been used for the rocket engine propulsion system. Potassium nitrate is the fuel that is classified as low explosives, where they bring their own materials for the oxidation of it was burned but did not explode. Not as a substance which is classified as a high explosive materials such as a trinitrotoluene, dynamite, tetryl ammonium perchlorate are not as fuel. However, most of these materials ignited using the flame or heat. If the material is heated from the inside it will explode.Fabrication of a propellant that contains a powerful oxidizer such as potassium nitrate is very dangerous and could cause an explosion. Potassium

## 6. WORKING PRINCIPLE OF THE SOLID FUEL ROCKET

Solid rocket engines are used on air-to-air and air-to-ground missiles, on model rockets, and as boosters for satellite launchers. In a solid rocket, the fuel and oxidizer are mixed together into a solid propellant which is packed into a solid cylinder. A hole through the cylinder serves as a combustion chamber. When the mixture is ignited, combustion takes place on the surface of the propellant. A flame front is generated which burns into the mixture. The combustion produces great amounts of exhaust gas at high temperature and pressure. The amount of exhaust gas that is produced depends on the area of the flame front and engine designers use a variety of hole shapes to control the change in thrust for a particular engine. The hot exhaust gas is passed through a nozzle which accelerates the flow. Thrust is then produced according to Newton's third law of motion.

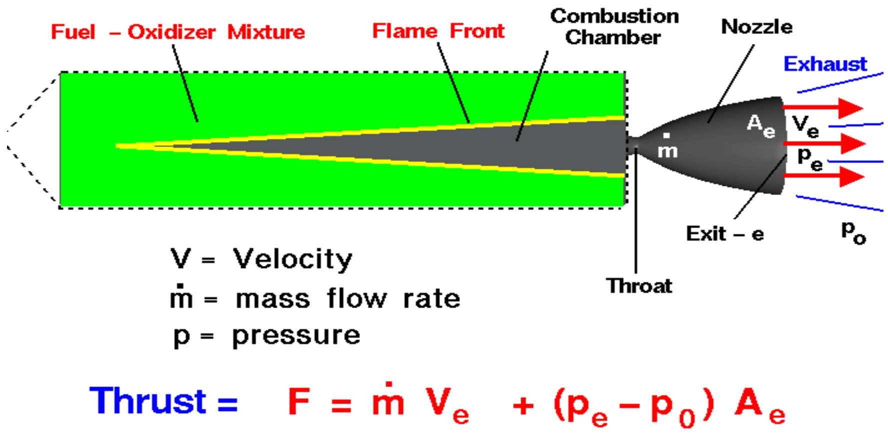


**Figure 3 Working principle of the solid fuel rocket**

The amount of thrust produced by the rocket depends on the design of the nozzle. The smallest cross-sectional area of the nozzle is called the throat of the nozzle. The hot exhaust flow is choked at the throat, which means that the Mach number is equal to 1.0 in the throat and the mass flow rate m dot is determined by the throat area. The area ratio from the throat to the exit **Ae** sets the exit velocity **Ve** and the exit pressure **pe**.

The exit pressure is only equal to free stream pressure at some design condition. We must, therefore, use the longer version of the generalized thrust equation to describe the thrust of the system. If the free stream pressure is given by **p0**, the thrust **F** equation becomes:

F = m dot * Ve + (pe - p0) * Ae

Notice that there is no free stream mass times free stream velocity term in the thrust equation because no external air is brought on board. Since the oxidizer is mixed into the propellant, solid rockets can generate thrust in a vacuum where there is no other source of oxygen. That's why a rocket willwork in space, where there is no surrounding air, and a gas turbine or propeller will not work. Turbine engines and propellers rely on the atmosphere to provide the oxygen for combustion and as the working fluid in the generation of thrust.
The thrust equation given above works for both liquid and solid rocket engines. There is also an efficiency parameter called the specific impulse which works for both types of rockets and greatly simplifies the performance analysis for rocket engines.

**Figure 4Propulsion of rocket**

**7.Advantage of using Solid Propellant**

Solid propellant rockets are much easier to store and handle than liquid propellant rockets. High propellant density makes for compact size as well. These features plus simplicity and low cost make solid propellant rockets ideal for military and space applications.Their simplicity also makes solid rockets a good choice whenever large amounts of thrust are needed and the cost is an issue. The Space Shuttle and many other orbital launch vehicles use solid-fueled rockets in their boost stages (solid rocket boosters) for this reason.

**8.Disadvantage of Solid Propellant**

solid fuel rockets have lower specific impulse, a measure of propellant efficiency, than liquid fuel rockets. As a result, the overall performance of solid upper stages is less than liquid stages even though the solid mass ratios are usually in the .91 to .93 range, as good as or better than most liquid propellant upper stages. The high mass ratios possible with these unsegmented solid upper stages is a result of high propellant density and very high strength-to-weight ratio filament-wound motor casings.
A drawback to solid rockets is that they cannot be throttled in real time, although a programmed thrust schedule can be created by adjusting the interior propellant geometry. Solid rockets can be vented to extinguish combustion or reverse thrust as a means of controlling range or accommodating warhead separation. Casting large amounts of propellant requires consistency and repeatability to avoid cracks and voids in the completed motor. The blending and casting take place under computer control in a vacuum, and the propellant blend is spread thin and scanned to assure no large gas bubbles are introduced into the motor.
Solid fuel rockets are intolerant to cracks and voids and require post-processing such as X-ray scans to identify faults. The combustion process is dependent on the surface area of the fuel. Voids and cracks represent local increases in burning surface area, increasing the local temperature, which increases the local rate of combustion. This positive feedback loop can easily lead to catastrophic failure of the case or nozzle.

## 9.SUMMERY OF THE PROJECT

In this project solid fuel made up of potassium nitrate and iron oxide is used as a propellent for the rocket and aluminium body is used as a motor body ,card board material is used in the fabirication of outer body and fins of the rocket.parachute is made up of nylon material and thay are attached to rocket with the help of thin iron cables ,for ignition of the rocket 12v battery is used .nichrome wire attached with match sticks are connected to the lower end of the motar with the wire connection from the battery.when the battery is switched on the power is supplied to the nichrome wire attached with the match stick begins to burn because nichrome wire cannot with stand the less amount of the current this burning will ignite the motar .The motar will begin burning uniformally and makes the rocket to move up wards .when the rocket reached the maximum heightafter releasing the payload the remaining body will fall down ,when the rocket changes the path from upward to downward the gyroscopic sensor will start its process so that the parachute inside the cone will be discharged and then the rocket will safe land with the help of the parachute.during the whole process the sensors fixed inside the rocket will help us to obtain the information such as temperature,pressure.and altitude.

## 10.CONCLUSION

As of yet, we have not been able to perform any significant testing. Until this point, most of our efforts have been focused on perfecting methods of building various parts of the rocket engine and testing apparatus. This included successfully constructing a concrete-based nozzle, gaining a familiarity with working with the propellant that we are using, creating a working ignition system, and gathering and calibrating the sensors. So far, we have manufactured multiple propellant grains. However, there were usually errors in their making (i.e. the coring rod could not be removed or the grain could not be removed from the casting stand) and they could not be used for actual data collecting purposes. We have only recently solved the problem with the coring rod, as outlined in step 6 in the instructions for making a coring rod. We recently tested a grain without the core produced by a coring rod. Not using a coring rod decreases the amount of surface area which could burn at any given moment. This has the effect of increasing burn time. This grain had a burn time of around two minutes and the maximum thrust was only approximately 2N. We also noticed that the PVC engine casing had very pronounced deformations so we used Aluminium engine which we hypothesized was a result of the long burn time. We predicted that building an engine with a core will increase the burning surface area, thus increasing thrust and decreasing the burn time. In addition, we predicted that a shorter burn time would mean that the PVC would be exposed to the high combustion temperatures for a shorter period of time but the Aluminium shows greater Thermal stability. Problems that must be addressed in the future include finding a way to manufacture the engines such that they reach maximum chamber pressure (and thus exhaust) more quickly. Also, makingALUMUNIUM deformation a minimum is a priority, though this may be achieved as a side effect of making the overall burn time shorter. This is because the amount of deformation depends on the temperature of the casing, which only increases after the engine has been heated for quite some time. If the entire burn time is less than the time it takes for the engine to deform, then there will be minimal deformation. Deformation occurs as combination of pressure being exerted on the casing as a by product of the internal combustion reaction. After the iginition process rocket will move upwards till the fuel is fully ignited then the payload will be separated and then the motor parts is dislocated from the rocket during this time sensors fixed to the rocket will calculate the path of the motion when the rocket path changes from the upward motion to downward motion the gyroscopic sensor will function so that the cone having the parachute attached with the rocket body will dislocated so that the parachute will open and then depending upon the motion and weather conditions the parachute will go upward by blowing of the wind so the wind pressure is acting downward of the of the parachute makes the parachute to move upwards during the same time rocket body will attracted towards the ground side of the earth using of the parachute the falling pressure is reduced and the rocket body is safely landed .during the whole process the temperature of the rocket and motor body are calculated and pressure acting on the inside and outside of the body are calculated, The angular direction of the rocket is calculated with the help of the gyroscopic sensor.

Next stage of the process in the project is to use the GPS module for finding the location of the rocket and position were the seperation of the rocket parts are happening ,after this using of the module single stage rocket is modified into the multistage rocket **.**

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