

Space propulsion 8530

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The following is a research project on Space Vehicle Propulsion. It shall consist of four sections, each discussing specific topics. Section One lays out the basic ideas of rocketry. Section Two compares Rocket Propulsion Systems, and shows the basis for the comparison. It also shows how each specific Rocket System works and Section Three gives a description of how Space Propulsion has evolved and contains a conclusion. SECTION 1 The Basics Section One is a brief description of the basic properties of Rocket Systems. It defines the key terms and shows how a basic rocket works. It also shows the State of The Art. I have chosen to do my project on space vehicle propulsion. Basically, this means that my research shall be based primarily on rocketry. Rocketry is a way of propulsion that has developed in numerous ways since it was first used to propel fireworks in the 16th century. It has emerged into an extremely complicated science that few actually understand. Most space rocketry in America is used in

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NASA (National Aeronautics and Space Association) space projects. NASA, a government association that focuses on space exploration, is the main user of rocket technology. It is used mostly to power their satellites and shuttles into space. Pushing an object that weighs as much as a space shuttle does directly vertical until escaping the Earth's atmosphere requires a tremendous amount of power. This is why NASA uses rockets. Rockets are essentially the most powerful forms of propulsion there is today. Space Vehicle Propulsion is based rocket engines. The basic principle of rocket engine is that when fuel is burned in the engine, the reaction mass is expelled at high speeds. As a result of Newton's law of action and reaction this pushes the vehicle in the opposite direction of the one in which the reaction mass is moving. Thrust is the force that the engine exerts on all space behind it in order to "push" the vehicle forward. Efficiency is the way that the quality of rocket engines is measured by. It is measured by the time it takes for one kilogram of propellant to create one

kilogram of thrust. The goal of my research is to find out what makes these engines more efficient. In rocketry, the state of the art is extremely hard to define, since there are so many different forms of rocketry ranging from liquid propellant rockets to fireworks. The state of the art though is probably nuclear powered rockets. It is much more efficient because it does not use chemical combustion like most rockets do. Instead NFRRs (Nuclear Fission Reactor Rockets) heat hydrogen in a fission reactor which expels the propellant at blistering speeds. Much research is being done with NFRRs. They are still highly experimental because of the dangers that could be associated with them. The NERVA (Nuclear Engine for Rocket Vehicle Application) was one of the most extensive NFRR research projects, however it failed because of the inability figure out an approach to putting the research into a developmental stage.

SECTION 2 Specific Rocket Propulsion Systems Section One has laid the foundation for further research in the are of rocketry. Section two shall discuss

properties of efficiency in more depth, it shall lay out the types of rockets in existence now. It shall also show which type of rocket is the most efficient.

After this section, the next one shall describe how the reasons for these specific rockets efficiency and depending on the outcome of that report, the topic of the fourth shall be decided. EFFICIENCY Efficiency is the most important part of my research as yet. Since the object of my research is to find

out which type of rockets are the most efficient and why, the reader of this paper must have a basic understanding of efficiency. Once this is established,

new definitions will come into play, all of these shall be crucial in the understanding of the paper. Terms Needed To Understand Efficiency G- a unit of

acceleration [equal to 9.8 meters/second/second (accelerating at a pace of 9.8

meters per second every second)] Specific Impulse (Isp)- A measurement in seconds of efficiency. Properties of Efficiency Efficiency is the most accurate indicator of rockets performance. As stated in the aforementioned definitions,

specific impulse is the basic unit of measurement of rocket efficiency. Isp is found by dividing the exhaust velocity by g (definition also mentioned above).

Since velocity is measured in m/s (meters per second) and each g is equal to 9.8

m/s/s (meters per second every second), the terms cancel to leave just a unit in

seconds. The resulting figure, is the duration of time for which one kilogram of

propellant can produce one kilogram of thrust. Thus, a higher number represents

a better, and more efficient rocket. To give the reader an idea of the average

Isp of several type of rockets, I have listed some average figures for

efficiency of certain types of rockets below. Average Efficiencies of Certain

Rockets Next, I have listed the Isp values for some basic types of rockets.

After that I shall explain some of the most well known types of rockets. Basic

Rocket Types An RPS (rocket propulsion system) is a powerplant that pushes a

vehicle forward by ejecting matter that is stored within the vehicle. This

matter is called propellant. The propellant is the most crucial part of moving a

vehicle through space. Their energy source, the vehicles they are used on, and

the type of propellant classify the specific types of systems. Liquid Propellant

Rockets All LPRs (Liquid Propelled Rockets) contain the same basic devices.

The

next paragraph shall discuss these functions and examine their purpose. The

first such device is the thrust chamber. The thrust chamber contains an

injector, a combustion chamber and a nozzle. The thrust chamber is the place

where the propellants are injected, atomized, then mixed and finally burned to

form reaction products in the form of gas. Next, the products are accelerated

and ejected at extremely high velocities to create thrust. The injector is a

series of pipes that allow the liquid propellant to move into the combustion

chamber chamber to be made into thrust while atomizing and mixing them.

The

exhaust nozzle is the last step in the releasing of thrust. It allows the hot

gas to expand and then accelerates them to supersonic velocities. On some vehicles, the nozzle acts as a steering mechanism by placing it on an electronic

axis for which it can be turned by an automated steering wheel. There are two

major types of feed systems used by LPRs; one uses pumps to move propellants to

combustion chambers; the other, uses high pressure to expel propellants from

their tanks. On most space vehicles the engines are mounted in pairs at the

perimeter of the craft. Normally two opposite facing thrust chambers are

controlled automatically to turn the ship. Generally, a minimum of 12 thrust

chambers is required for turning. Solid Propellant Rockets Solid Propellant

Rockets (SPRs) contains a huge number of types of engines. The propellant that

is to be burned is held in the combustion chamber. The propellant charge (grain)

contains chemical elements for complete burning. When it is ignited, it burns on

all its exposed sides. If the design of the grain is changed, then less can be

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exposed; the less exposed, the less fuel burned. The average burning rate is around 1.8 cc per second. The rate normally depends on the propellant ingredients. The more chamber pressure, the more propellant burnt. The way to

make an efficient SPR is to pack as much solid propellant into a chamber volume

as possible. Theoretically, it would be ideal to burn the propellant like a cigar, from one end to the other. For this reason, scientists created an end-burning grain, which has proved extremely successful. Electric Rockets There

are three types of electric propulsion systems (EPS); the three include electromagnetic, electrothermal and electrostatic. They are, in some ways more a

rocket of the future than one of the present, somewhat like the NERVA project

(see next section). In the electrothermal system the propellant is heated or vaporized electric heaters. The hot gas is then expanded through a nozzle the

way it is in a chemical rocket. In an electrostatic system, interacting

electrostatic fields and small charged particles such as colloidal particles achieve acceleration. In an electromagnetic rocket, acceleration is achieved by placing propellant plasma (a high temperature, electrically neutral gas that contains electrons, ions and neutral molecular species) in an electromagnetic field thus causing a reaction that releases thrust. Nuclear Rockets Unlike the aforementioned rockets, nuclear rockets do not generate its power through chemical combustion. The way its power is formed, is through nuclear fission. It heats a propellant like hydrogen in a fission reactor and the explosion expels the propellant at amazing speeds, which exceed twice what any other rocket can produce. Its efficiency rating is around 850, as compared to the 450 of the next best type, the cryogenic rocket. Unfortunately due to the extreme dangers of nuclear fission inside a shuttle, the main project for researching the nuclear rockets, NERVA, was scrubbed. Most likely, in the future, scientists will devise

a plan to minimize the risks, whereupon research will begin again. SECTION 3
A

History INTRODUCTION The third section of this report shall begin by
indicating

the steps in which rocketry was created, as to allow the reader of this paper
to

better understand the way rockets work. It shall show the works of
Tsiolkovsky,

Goddard, Oberth and a few others. The report shall then end in a detailed

conclusion. The conclusion will be based on the summary and discuss all that
has

been written. It shall end in giving opinions as to the future uses of the

specific areas found in the research. Development of Modern Rocketry EARLY

HISTORY In around 1232 AD, in China, rockets were created. During the war
with

the Mongols, the Chinese would strap an early form of gunpowder to the
shaft of

an arrow. This made them fly longer and faster than any of the regular
arrows

that the Mongols used. About ten years later, in Europe, another major discovery

was made. An Englishman, Robert Bacon, created a more practical formula for

gunpowder. He did this by mixing 41.2 parts saltpeter, 29.4 parts charcoal and

29.4 parts sulfur. He was able to distill saltpeter, which produces oxygen, to

allow the rocket to burn faster. In the 18th century, the British encountered rocket warfare with India. The Indians probably learned the secret

of rocket treat from Arab traders in the 17th century. The Indians, who were led

by Hyder Ali, gave thousands of men the task of throwing rockets. The rockets

were first thrown, then propelled itself. They attached an eight foot long

bamboo stalk to six pound iron tube filled with fuse and powder. The rockets

were able to fly up to 1.5 miles. Modern Discoveries Tsiolkovsky Tsiolkovsky, a

Russian teacher, established that a rocket would work in the vacuum of space, in

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1883. In 1903, he wrote a book explaining how space travel was possible, using

liquid propelled rockets. He created drawings of possible space ships propelled

by either liquid oxygen and liquid hydrogen or liquid oxygen and kerosene.

The

sketches also show valves to transport the liquid propellant into a combustion

chamber and showed how vanes could be created in the exhaust for steering. He

also illustrated the crew lying on their backs in a pressurized cabin in order

to withstand the pressure of such high speeds. Tsiolkovsky also thought of

rocket staging. Rocket staging is a series of rockets that fire one after the

other. When one finishes and the other fires, the useless rocket is jettisoned.

He thought this was the only way to put heavy objects such as satellites into

space. Goddard Although Tsiolkovsky thought up the ideas of advanced rocketry,

still more had to be considered, and it had to become reality. The next pioneer,

was the father of American rocketry, Robert Goddard. He first, created a bazooka

type rocket. The bazooka was fairly large solid-propellant rocket. In 1919, he wrote a text called A Method of Reaching Extreme Altitudes. Two years later, he

began to experiment with the liquid fuels that Tsiolkovsky. In 1926, Goddard

finally launched the first liquid propelled rocket. It was fueled by gasoline

and liquid oxygen. It rose to a height of 41 feet and traveled at 60 miles per

hour. It only traveled 56 meters but it set the foundation for the future of

rocketry. In May 1935, he released a rocket that featured gyro controlled

exhaust vanes which pushed it to travel 1.5 miles above the ground at a totally

unprecedented 700 miles per hour. GERMAN ROCKET SCIENTISTS In 1923 a

German

rocket scientist Hermann Oberth published The Rocket Into Planetary Space.

He

avored liquid propellants, as Goddard, because of their power. His

experimentation inspired the creation of the Society for Space Travel. The

society passionately experimented with ways to improve the liquid propellant

rocket. On February 21, 1931, a member of The Society for Space Travel, Johannes

Winkler, launched the second liquid fuel rocket. Winkler's rocket was propelled by liquid methane and liquid oxygen. It failed totally, going a mere ten feet forward. Three weeks later another rocket ascended to about 2000 feet.

The entire Society for Space Travel began working on two rocket series, the Mirak and Repulsor. The late model Repulsors could reach an altitude of 1 mile.

When The Society for Space Travel ran out of money, they made a demonstration of

the Repulsor for the German Army. A member, Werner Von Braun compiled some

statistics for the army who gave it to Hitler. They realized that this did not violate the treaty which did not allow them to build airplanes. Hitler started the Army Weapons Department. Von Braun was placed in charge of rocket development. Within a few years Von Braun was experimenting with highly

developed rockets and was firing them in secret at the island of Birkum. In 1934

he created two rockets, that could ascend to over 1.5 miles. After that, The Society for Space Travel fell apart due to financial problems. In 1937, a rocket

research station was constructed on the Baltic coast. Here the Germans created

such rockets as the famous V-1 Buzz Bombs, and the mammoth V-2 which were really

rocket-powered flying bombs. Conclusion In this research, it has been

demonstrated how all rocket engines work. It illustrates how propellants are moved into a combustion chamber, and expelled at extremely high speeds. It shows

the properties of efficiency, the basic measure by which all rockets are compared. It shows how efficiency is measured by specific impulse, which is calculated by the propellants exhaust velocity divided by g . It has given a

basic comparison as to the efficiency of various rockets and has shown the reasons for being at their respective ranks. Also shown, is the pioneering of rocketry starting in the mid 1200s. All this has shown the basic properties of

space propulsion.

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