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Cryogenics-a new revolution

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Abstract
Cryogenic fuels are stored at very low temperature so that they can be remained in liquid state and are used mostly in rockets as a prime fuels as other fuels can't be used their due to absence of environment required to burn the fuel

Keywords:*Cryogenic,engine,fuel,combustion,machinery.*

INTRODUCTION

Cryogenics is the study of manufacturing very low temperature (as low as 123K) and how the cloth is going to act at that temperature.

The word cryogenic is derived from Greek phrases Cryos that means low temperature and Genics which means producing. In 19 66 agency named Cryo tech experimented The possibility of the usage of cryogenic instead of warmth remedy as a way to bea utify the lifestyles of gear.

It was based on a simple methodology if the temperature is lowered to room temperature and then if it is further more reduced then it can increase the tool life but it got failed due to sudden shocks in the material tool Characteristic temperatur es of cryogenic fluids[K]

Table1:*Cryogenic Technology*

cryogen	triple point	normal bp	critical point
methane	90.7	111.6	190.5
oxygen	54.4	90.6	154.6
argon	83.8	87.3	150.9
nitrogen	63.1	77.3	126.2
neon	24.6	27.1	44.2
hydrogen	13.8	20.4	33.2
helium	2.2	4.2	5.2

This technology is the process of combining fuels at cryogenic temperature which is liquid oxygen & liquid hydrogen. This mixture of fuel offers highest energy efficiency which in turn produces the highest amount of thrust and the rocket engine is designed in such a way that the oxidizer remain referigeted in liquid state and during exhaust no harmful gases are produced as the combination of hydrogen & oxygen only produces water.

HISTORY OF CRYOGENIC ROCKET ENGINE

In 1963, United States of America was the first country to develop the CRE with the use of RL-10 engines with the successful flight and it's far nevertheless used on Atlas-V rocket. Different international locations are like: Japan used LE5 in 1997, France used HM7 in 1979 used the respective rocket engines. Here the mixture of liquid N2, H2 and O2 are used as fuels. In 1987, first CRE was launched with human in space.

COMPONENTS OF CRYOGENIC ROCKET ENGINE

1. Combustion Chamber
2. Pyrotechnic igniter
3. Fuel injector
4. Fuel cryopumps
5. Oxidizer cryopumps
6. Gas turbines
7. Cryo valves
8. Regulator
9. Fuel tank & rocket nozzle

WORKING

Cryogenic rocket engines are designed in such a way that the fuels remain liquid fuels can be held at "cryogenic temperature" The components are also cooled so that the fuel doesn't get boiled off. The thrust for the rocket comes from the rapid expansion of the liquid fuels & the energy needed to heat the fuel comes from burning them once they are gases. The cryogenic rockets are the highest performance engines but the only disadvantage while designing these engines is that they are bulky and require heavy installation for propellants.

The Space Shuttle's main engines used for liftoff are cryogenic engines. The Shuttle's smaller thrusters for orbital maneuvering use non-cryogenic hypergolic fuels, which are compact and are stored at warm temperatures. Currently, only the United States, Russia, China, France, Japan and India have mastered cryogenic rocket technology.

The cryogenic engine gets its name from the extraordinarily bloodless temperature at which liquid nitrogen is stored. Air transferring across the vehicle is used to warmness liquid nitrogen to a boil. once it boils, it turns to gas inside the identical manner that heated water paperwork steam in a steam engine. A rocket just like the Ariane 5 makes use of oxygen and hydrogen, both saved as a cryogenic liquid, to provide its power. The liquid nitrogen, stored at 320 degrees Fahrenheit, is vaporized with the aid of the heat exchanger. Nitrogen gasoline fashione d inside the heat exchanger expands to approximately seven hundred instances the extent of its liquid form. This distinctly pressurized gasoline is then fed to the expander, in which the force of the nitrogen gasoline is converted into mechanical energy.

WHY HIGH EFFICIENCY

The rocket engine works on newton's 3rd law of motion. The thrust produces is in opposite direction in lower atmosphere which makes the use of liquid oxygen & liquid hydrogen which produces extremely high heat fluxes as pure liquid oxygen works significantly at hotter combustion chambers which is not possible in any of the jet engines .

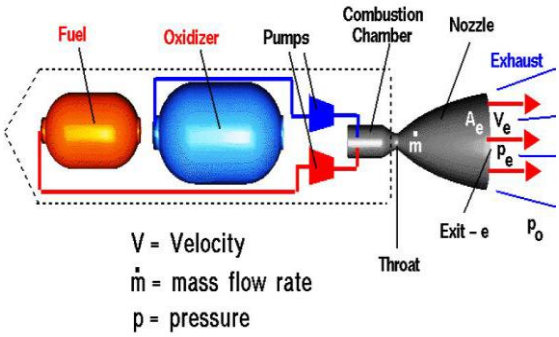

Fig 1: *Next Generation Rocket Engine*

Currently NASA is working on 'Xenon ion engine' which accelerates the ion at extremely high rate to create thrust by using Lorentz forces or Columbian forces

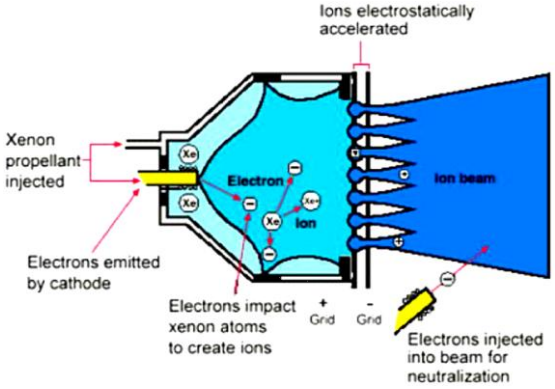

Fig 2

APPLICATIONS

1. Cryo pumps and turbo molecular pumps are required in space as the level of vacuum required in space simulation chambers are very high.
2. Life of tools, Die casting & their dies, forging, jigs & fixtures increase when subjected to cryogenic heat treatment.
3. Cryogenic recycling turns the scrap in raw material by subjecting it to cryoge nic i.e.extremely lowtemperatures. This is mostly used for PVC, Rubber.
4. Cryo-surgery is a novel technique in which the harmful tissues are destroyed by freezing them to cryogenic temperature. It has shorter recovery time.
5. Preserving food at low temperature is a well-known technique

ADVANTAGES

1. High Specific Impulse
2. Non-toxic and non-corrosive propellants
3. Non-hypergolic, improved ground safety

DISADVANTAGES

1. Low density of liquid Hydrogen – more structural mass
2. Low temperature of propellants - Complex storage
3. Transfer systems and operations
4. Hazards related to cryogens
5. Overall cost of propellants relatively high
6. Need for ignition system

CONCLUSION

In the nutshell cryogenics has now became a basic of not only for aerospace but also for medical, manufacturing process and many others. It may also solve a major problem of fuel in future and can be proved to be a reliable source of energy for major purposes

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