International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 8, Issue 4, April 2019)

A Study on Cryogenics

K Nived Maanyu[1], Shruti Bhargava Choubey[2], P S Ravali[3]
Sreenidhi Institute of Science and Technology Hyderabad, India.

***Abstract*—This paper focus on an "cryogenics" as it is the production and behaviour of materials at very low temperatures. A person who studies about the components that are subjected to extraordinarily cold temperatures is named a cryogenicist.**

I. INTRODUCTION

The branches of engineering that involve the study of terribly low temperatures, a way to turn out them, and the way materials behave at those temperatures.

Cryobiology

The branch of biology involving the study of the consequences of low temperatures on organisms.

Cryoconservation of animal genetic resources

The conservation of genetic material with the intention of preserving a breed.

Cryosurgery

The branch of surgery applying refrigerant temperatures to destroy malignant tissue, e.g. cancer cells.

Cryoelectronics

The study of electronic phenomena at cryogenic temperatures. Examples include superconductivity and variable-range hopping.

Cryotronics

The practical application of cryoelectronics.

Cryonics

Cryopreserving humans & animals with the intention of future revival.

The U.S. National Institute of Standards and Technology has chosen to think about the sphere of physics as that involving temperatures below −180 °C (93 K). It is not well-defined at what purpose on the metric refrigeration ends and physics begins, however scientists assume a gas to be refrigerant if it are often liquefied at or below −150 °C (123 K).

This is a logical distinction, since the conventional boiling points of the questionable permanent gases (such as element, hydrogen, neon, nitrogen, oxygen, and traditional air) lie below −180 °C while the refrigerants, hydrocarbons, and other common refrigerants have boiling points above −180 °C. Cryogenicists use the Kelvin or Rankine temperature scale, both of which measure from absolute zero, rather than more usual scales such as Celsius or Fahrenheit, with their zeroes at arbitrary temperatures. Discovery of superconducting materials with crucial temperatures considerably higher than the boiling purpose of atomic number 7has provided new interest in reliable, low cost methods of producing high temperature cryogenic refrigeration. The term "high temperature cryogenic" describes temperatures ranging from above the boiling point of liquid nitrogen, −195.79 °C (77.36 K), up to −50 °C (223 K), the generally defined upper limit of study referred to as cryogenics.

II. ETYMOLOGY

The word cryogenics stems from Greek κρύο (cryo) – "cold" + γονική (genic) – "having to try to to with production".

III. INDUSTRIAL APPLICATIONS

Liquid nitrogen is that the most typically used component in physics and is wrongfully purchasable round the world. Liquid element is additionally normally used and permits for all-time low gettable temperatures to be reached. These liquids are stored in Dewar flasks, these are double-walled containers with a high vacuum between the walls to reduce heat transfer into the liquid. Typical laboratory Dewar flasks square measure spherical, made of glass and protected in a metal outer container. Dewar flasks for terribly cold liquids like liquid element have another double-walled instrumentality stuffed with atomic number 7. Dewar flasks square measure named once their creator, James Dewar, the man who first liquefied hydrogen.

Thermos bottles square measure smaller vacuum flasks fitted in an exceedingly protecting casing. Cryogenic transfer pumps are the pumps used on LNG piers to transfer liquefied natural gas from LNG carriers to LNG storage tanks, as are cryogenic valves.Cryogenic barcode labels are used to identify these dewar flasks containing liquids, and will not frost over down to −195 degrees Celsius.

IV. Cryogenic Processing

The field of physics advanced throughout warfare II once scientists found that metals frozen to low temperatures showed additionalresistance to wear. Based on this theory of refrigerant hardening, the industrial refrigerant process trade was based in 1966 by ED Busch. Busch found a company in Detroit called Cryo Tech in 1966 which merged with 300 Below in 1999 to become the world's largest and oldest commercial cryogenic processing company. Busch originally experimented with the likelihood of skyrocketing the lifetime of metal tools to anyplace between 200%-400% of the first life exploitation refrigerant tempering rather than heat treating. This evolved within the late Nineteen Nineties into the treatment of alternative components. Cryogens, like atomic number 7, square measure more used for specialty chilling and temperature reduction applications. Some chemical reactions, like those accustomed turn out the active ingredients for the popular lipid-lowering medicine medication, must occur at low temperatures of approximately −100 °C (−148 °F). Special refrigerant chemical reactors square measure accustomed take away reaction heat and supply an occasional temperature setting. The temperature reduction of foods and biotechnology product, like vaccines, requires nitrogen in blast freezing or immersion freezing systems. Certain soft or elastic materials become laborious and brittle at terribly low temperatures, which makes cryogenic milling (cryomilling) an option for some materials that cannot easily be milled at higher temperatures. Cryogenic process isn't a substitute for warmth treatment, however rather associate degree extension of the heating - extinguishing - tempering cycle. Normally, once associate degree item is quenched, the final temperature is ambient. The only reason for this can be that almost all heat treaters don't have cooling instrumentation. There is nothing metallurgically significant about ambient temperature.

The refrigerant method continues this action from close temperature all the way down to −320 °F (140 °R; seventy eight K; −196 °C). In most instances the refrigerant cycle is followed by a heat tempering procedure. As all alloys don't have an equivalent chemical constituents, the tempering procedure varies per the material's chemical composition, thermal history and/or a tool's specific service application. The entire process takes 3–4 days.

V. Fuels

Another use of cryogenics is cryogenic fuels for rockets with liquid hydrogen as the most widely used example. Liquid oxygen (LOX) is even more widely used but as an oxidizer, not a fuel. NASA's workhorse space shuttle used cryogenic hydrogen/oxygen propellant as its primary means of getting into orbit. LOX is also widely used with RP-1 kerosene, a non-cryogenic hydrocarbon, such as in the rockets built for the Soviet space program by Sergei Korolev.

Russian aircraft manufacturer Tupolev developed a version of its popular design Tu-154 with a cryogenic fuel system, known as the Tu-155. The plane uses a fuel referred to as liquefied natural gas or LNG, and made its first flight in 1989.

VI. Other Applications

- Many infra-red (forward looking infrared) cameras require their detectors to be cryogenically cooled.
- Certain rare blood groups are stored at low temperatures, such as −165 °C at blood banks.
- Cryogenics technology using liquid nitrogen and CO_2 has been built into nightclub effect systems to create a chilling effect and white fog that can be illuminated with colored lights.
- Cryogenic cooling is used to cool the tool tip at the time of machining in manufacturing process. It increases the tool life. Oxygen is used to perform several important functions in the steel manufacturing process.
- Many rockets use cryogenic gases as propellants. These include liquid oxygen, liquid hydrogen, and liquid methane.
- By freezing the automobile or truck tire in liquid nitrogen, the rubber is made brittle and can be crushed into small particles. These particles can be used again for other items.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 8, Issue 4, April 2019)

- Experimental research on certain physics phenomena, such as spintronics and magnetotransport properties, requires cryogenic temperatures for the effects to be observed.
- Nuclear magnetic resonance (NMR) is one of the most common methods to determine the physical and chemical properties of atoms by detecting the radio frequency absorbed and subsequent relaxation of nuclei in a magnetic field. This is one of the most commonly used characterization techniques and has applications in numerous fields. Primarily, the strong magnetic fields are generated by supercooling electromagnets, although there are spectrometers that do not require cryogens. In traditional superconducting solenoids, liquid helium is used to cool the inner coils because it has a boiling point of around 4 K at ambient pressure. Cheap metallic superconductors can be used for the coil wiring. So-called high-temperature superconducting compounds can be made to super conduct with the use of liquid nitrogen which boils at around 77 K.
- Magnetic resonance imaging (MRI) is a complex application of NMR where the geometry of the resonances is deconvoluted and used to image objects by detecting the relaxation of protons that have been perturbed by a radio-frequency pulse in the strong magnetic field. This is mostly commonly used in health applications.

VII. Production

Cryogenic cooling of devices and material is usually achieved via the use of liquid nitrogen, liquid helium, or a mechanical cryocooler (which uses high pressure helium lines).

Gifford-McMahon cryocoolers, pulse tube cryocoolers and Stirling cryocoolers are in wide use with selection based on required base temperature and cooling capacity. The most recent development in cryogenics is the use of magnets as regenerators as well as refrigerators. These devices work on the principle known as the magnetocaloric effect.

VIII. Detectors

There are various cryogenic detectors which are used to detect cryogenic particles.

For cryogenic temperature measurement down to 30K, Pt100 sensors, a resistance temperature detector (RTD), are used. For temperatures lower than 30K it is necessary to use a silicon diode for accuracy.

REFERENCES

[1] Bilstein, roger e. (1996). Stages to saturn: a technological history of the apollo/saturn launch vehicles (nasa sp-4206) (the nasa history series). Nasa history office. Pp. 89–91. Isbn 0-7881-8186-6.

[2] "dichlorodifluoromethane at pubchem".

[3] "propane at pubchem".

[4] J. M. Nash, 1991, "vortex expansion devices for high temperature cryogenics", proc. Of the 26th intersociety energy conversion engineering conference, vol. 4, pp. 521–525.

[5] "cryonics is not the same as cryogenics". Retrieved 5 march 2013.

[6] Cryogenic systems by randall barron mcgraw-hill book company.

[7] Thermal, timmy. "cryogenic labels". Midcomdata. Retrieved 11 august 2014.

[8] Gantz, carroll (2015). Refrigeration: a history. Jefferson, north carolina: mcfarland & company, inc. P. 227. Isbn 978-0-7864-7687-9.

[9] "eso signs technology transfer licence agreement for cooling system". Retrieved 11 june 2015.

. .