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ASSIGNMENT 2

TECHNICAL SUMMARY

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Fluorine and its applications

Fluorine production starts with the mining of fluorspar, South Africa's main sources of fluorspar are the Vergenoeg and Witkop mines. The flourspar is converted to hydrogen Flouride gas by heating calcium fluoride and sulfuric acid inside a rotary kiln.

Fluorine research has been identified as a priority area in South Africa and the South African Nuclear Energy Corporation (NECSA) is embarking in an effort to expand it hydrogen fluoride and aluminium trifluoride production capacity. (Pouris, 2008)

Professors Philip Crouse and Deresh Ramjugernath have been appointed SA research chairs for Fluoro-materials Science and Process Integration and Fluorine Process Engineering and Separation Technology respectively.

Ramjugernath leads a large team of postgraduate students and researchers – arguably one of the leading research groups in its field globally – which undertakes cutting-edge research contributing towards chemical process development and optimization in South Africa and abroad. (Fluorine process, no date)

Fluorine is a highly reactive element which enhances combustion of other materials, making it a dangerous fire and explosion hazard. Additionally, HF differs from other acids because the fluoride ion penetrates the skin, resulting in destruction of deep tissue layers, including bone.

In modern times, safety precautions are taken to ensure the safest working space possible(clothing, eyewear, handling and storage training). Different sets of rules are also followed in cases of liquid spillage or gas leakage respectively. All medical personal must wear rubber PVC gloves when treating HF burns. During medical treatment the burnt skin is removed from the contact area, to avoid a continuous reaction.

Many scientists that studied fluorine over the years have died from excessive exposure to the this dangerous element. According to Nobel lectures, (1966) Professor Henri Moissan was admired for the great experimental skill with which he had isolated and studied fluorine; the "savage beast amongst the elements".

The fluorine industry is an established industry in South Africa, with the heart of the industry being in Palindaba. Palindaba has twenty fluorine cells which contributes

greatly towards the fluorine and fluoropolymer industry in South Africa. Fluoropolymers takes up a large area of the fluorine industry. Over the years the fluoropolymer industry has increased due to a greater demand, and this has resulted in the establishment of a large value chain.(Crouse, 2017)

One of the most well know fluoropolymers is PTFE, or commonly known as Teflon. Ethylene is used in the production of PTFE. PTFE is known to be chemically stable, suffer from creep and thus deforming under high pressure, slippery, hydrophobic, thermo plastic, and has a melting point of around 390 degrees celsius. At 450 degrees celsius it is at a high viscosity and starts to decompose, reverting to TFE. This has resulted in a certain production process. It starts in powder form, pressed, put into an oven, fired slightly above melting point and starts to twist producing mechanical strength.(Crouse, 2017)

Characteristics of some other fluoropolymers include, low refractive index, highly repellant, low surface tension/energy, chemically and thermally stable, and very strong organic acids. Some examples of other fluoropolymers include, PVDF which is very resistant to UV. ETFE, which is non flammable and self extinguishing. Polyethylene, which is non-polar, weather proof and expensive. A fuel cell, which utilises a reaction that produces energy, uses a membrane called Nafion.(Crouse, 2017) The combination of fluorinated backbone, sulfonic acid groups, and the stabilizing effect of the polymer matrix make Nafion a very strong acid. Nafion’s properties allow it to be used widely. (Teng, 2012)

Ultimately fluorine is known in the fluoropolymer industry as the prostitute element, because it reacts with everything besides helium.(Crouse, 2017)

Fluorine plays a significant role in the chemistry of pharmaceuticals. Fluorine atoms can replace hydrogen atoms in the organic molecule's structure to produce a molecule that has a longer life span once assimilated in the body. This fluorine containing molecule is also lipophilic. Subsequently it penetrates cell membranes rapidly. This correlates to faster assimilation time in the body.

Fluorine based medicines are also used extensively in anesthetics like isoflurane, desflurane, enflurane and sevoflurane.

Fluorine is used extensively in the nuclear industry, with respect to the enrichment of uranium. Mined uranium oxide is converted to uranium hexafluoride through a number of chemical steps. Uranium hexafluoride is convenient to work with in industry because the compound can behave as a gas, liquid or solid under reasonable temperatures and pressures. These phase changes allow uranium to be transported, stored and converted chemically with great ease as it is enriched.

The following is a summary of some of the important or interesting questions that were asked at the end of the presentation as well as their answers.

- Is Fluorine dangerous to the environment?

  Yes. Fluorinated gases are powerful greenhouse gases, with a global warming effect up to 23 000 times greater than carbon dioxide. (Climate Action - European Commission, 2017) The ozone depleting property of chlorofluorocarbons (CFCs) is a more serious effect caused by fluorine, but banning of such products has dealt with this. (Crouse, 2017)

- Besides the method given above, are there any other methods of formulating F2

  There are no alternatives.(Crouse, 2017)

- Why does the Fluorine in the medication not react (dangerously) with the calcium and sodium within the body?

  The strong covalent bonds within the medication prevent it from reacting with other compounds within the body.(Crouse, 2017)

- How much of a threat is Flourine in drinking water?

  Not very much of a threat as it can be removed from water by ion exchange. (Crouse, 2017)

- Does Du Pont (and other companies) patent its methods of creating new compounds along with registering trade marks?

  They do and this allows them a competitive advantage in the market for twenty years.(Crouse, 2017) For example the PTFE (Teflon) patent was assigned to Du Pont on 7 Jan 1947. (Plunkett, 1839)

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