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An Overview of the Impacts of Chlorofluorocarbon on the Port Harcourt Environment in Nigeria

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ABSTRACT

Chlorofluorocarbon (CFC) is a beneficial compound utilized in the manufacturing of common products such as aerosols, inhalers, and air conditioners. Nonetheless, it poses enduring concerns for health and the environment, particularly with regard to its impact on the ozone layer. In this study, we examine the varieties and origins of CFCs and their consequences on human well-being and the ecosystem in Port Harcourt, Nigeria. Employing secondary documentary information, the research concludes that CFCs have significant adverse effects on both the environment and human health, leading to conditions like skin ailments, vision issues, weakened immune systems, changes in plant photosynthesis, and disturbances in aquatic life equilibrium. The study advocates for the promotion of cooperation between developing nations, such as Nigeria, and developed nations to curtail and eventually eliminate the use of CFCs, commencing with smaller-scale initiatives in Port Harcourt.

Keywords: Air conditioners, ozone layers, health, human, environment and CFC

INTRODUCTION

In the early years of the 20th century, air conditioners and refrigeration systems were designed to use compounds such as propane, Ammonia, Sulphur Dioxide and Chloromethane as cooling agents or refrigerants [1-4]. These compounds, though effective as cooling agents, were flammable and toxic such that their exposure to humans could lead in severe injury or in worse cases, death [5-7]. In the early 1930s, scientists at Frigidaire headed by Midgely Thomas developed safer, non-toxic alternatives to the cooling agents or refrigerants [8-9]. They focused mainly on refrigerant alternatives that contain carbon and halogens like chlorine and fluorine. Such compounds are usually inert and volatile and they have some suitable properties required for refrigerant in refrigeration systems [10-11]. The initial compound they considered for use was a compound; dichlorodifluoromethane (CFCs) generally called "Freon." In the 70s, they became generally used as refrigerant in refrigeration system and the global production level had reached close to one million tons yearly [12-14]. Two scientists; Molina and Rowland, in 1973, uncovered that this compound used as refrigerant (CFCs) were not as harmless as initially purported because of their effect on the stratosphere [12-14]. They also ascertained that these compounds when exposed to UV light rays, disintegrate into three components: carbon, chlorine and fluorine through a chemical reaction that is devastating to the ozone layer in the atmosphere [15-18]. This happens in such a way that over a hundred thousand molecules of ozone are disintegrated and destroyed. The main chemical reaction in this process is unique because the chlorine molecule released during the disintegration of the CFCs is used to continuously and repeatedly disintegrate the ozone in a corresponding chain reaction [19-21]. Based on History, chlorine is considered as one of the most essential and safe industrial chemicals [22-25]. They are not flammable, cheap, stable, efficient, effective and non-corrosive, when considering industrial hygiene. It also has low level of toxicity, non-irritating, non-sensitizing and has a slightly offensive odour. Because of these

impressive attributes, Chlorine-based hydrocarbons, became widely used and according to a report in 1991 a whopping 682 million tons of these compounds were already used globally [26-27]. They also had some other impressive features such as low boiling point and low level of reactivity. The boiling point related properties made them good cooling agents because they quickly change to vapour with slight heating and easily absorbed heat without heating up the item which it intends to keep in a cool state. The low level of toxicity was an additional advantage because other refrigerants which were in use (sulphur dioxide, ammonia and chloromethane) were highly toxic [9-13]. Finally, their low level of reactivity ensured that they did not easily react with their container or other compounds used in the cooling process. Their chemical and physical features made them a crucial part of several manufacturing processes such as electronics production. However, it was later uncovered that they are responsible for the destruction of the ozone layer contained in the stratosphere, with unimaginable implications to all lives on earth. This discovery later led to a global consensus to stop the production of these compounds on or before the end of the 20th century. The interaction between these compounds (CFCs) and ozone depletion has been expressed by empirical and numerical modelled studies and also through direct measurements in the atmosphere [9]. The Montreal Agreement and consensus to end production and use of ozone-depleting substances (ODS) is currently among the substantial environmental successes of the 20th century. Since the agreement entered into effect in the late 80s, it triggered worldwide reductions and an end of the production of CFCs which critically deplete the ozone; first among developed nations, then followed by developing nations, with all nations accepting to essentially end CFC production on or before 2010 especially CFC-11 and CFC-12 [12]. This impending termination of the CFCs forced manufacturers especially electronics firms to re-examine possible alternative compounds and processing procedures [13]. In 1985, observation of a hole in the ozone layer within the Antarctic Pole presented proof that the layer was being depleted in a faster rate and this led to the adoption of the Montreal Agreement as a baseline for global collaboration regarding control of CFCs based on Vienna Convention for the Ozone Layer Protection. Also, CFC alternatives that are not reactive to the ozone layer were quickly produced through several rigorous research. The approximate global use chart for CFCs as at 1985 was 15% as refrigerants, 35% as foam making reagent, 31% as aerosol catalysts, 7% as miscellaneous and 12% as unallocated reserved product [8-12]. Recent CFC-11 assessment revealed that emissions of the gas have increased not minding global near-zero production agreement that was supposed to end in 2010. This situation raises some concerns on the future of the ozone layer and the level of emission that is still coming from CFCs used in several equipment [14].

Materials and Methods

This paper explores the health and environmental impacts of Chlorofluorocarbons (CFCs) in Port Harcourt, Rivers state, Nigeria. It uses secondary documentary and descriptive data from various sources to highlight the effects of using CFC-based equipment in the city and globally, highlighting the need for further research in this area.

Study Area

Port Harcourt, the capital city of Rivers State, is located in the sub-equatorial region and occupies nearly a hundred and eighty thousand hectares. Established in 1912 by the British colonial government, it was built to connect the interior of Nigeria to the coast areas for easier conveyance of agricultural produce and resources. The construction of the railway and loading terminal attracted businesses from both within Nigeria and around the world, promoting the city's cosmopolitan status. Port Harcourt Urban Area comprises the city and some parts of Obio-Akpor Local Government Area (LGA), making it Nigeria's 5th largest urban area. The area has two seasons: wet and dry, with over 70% of yearly rainfall occurring between August and April and less than 30% between September and November. Rainfall is sufficient for year-round crop production in the state. The city lies in a flat terrain consisting of levels of gently undulated sandy plains without isolated depressions. The soil type is mostly drained clay

combined with sand, classified as Benin formation, organic in nature. There is also a mangrove swamp-based alluvial soil observed in the northern part down to the coastal areas, brownish in colour. Port Harcourt City is influenced by urbanization and urban sprawl, where smaller communities merge together to form a megacity, adding pressure on water supply. As of 2020, the population of Port Harcourt was about 2,667,435 persons.

Structure, Properties and Production of Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are a type of carbon molecule with a tetrahedral shape, similar to simple alkanes. However, the methane-derived CFCs have a different tetrahedral form due to the differences in chlorine and fluorine atoms from hydrogen. The most crucial procedure for producing CFCs is the catalytic replacement of chlorine in Chlorocarbons with Fluorine through reaction with hydrogen fluoride. CFCs have physical properties that can be tuned by changes in identity and number of halogen atoms. They are generally volatile but not as flammable as their initial alkane compounds, with a drop in volatility linked to molecular polarity caused by the halogen creating intermolecular connections. CFCs also have higher boiling points due to chloride's polarizable nature compared to fluoride, making them suitable cooling agents in refrigeration systems. CFCs have a higher density than their parent alkanes, which is connected to the number of chlorides in the compound. They are mostly produced by the exchange of halogen, starting from chlorinated ethane and methane. Brominated derivatives are produced by reactions of chlorofluorocarbons, replacing Carbon-Hydrogen bonds with Carbone-Bromine bonds. CFCs have a wide range of uses due to their good characteristics, leading to their production and consumption mainly in advanced nations after the 1960s. The modern lifestyle observed in the second half of the 20th century was greatly possible due to the production and application of CFCs. Port Harcourt, Nigeria's 5th largest urban area, is influenced by urbanization and urban sprawl, with smaller communities merging to form a megacity. As of 2020, the city had a population of about 2,667,435 persons. The use of CFCs has led to the development of modern lifestyles in the second half of the 20th century.· Refrigerants–CFC gas is used in the cooling process of refrigerators, automobiles and air-conditioners and this gas is injected into the compressor of these appliances.

Fig 2.0 Air Condition

Fig 3.0 Refrigerator

Fig 4.0 Compressor

Fig 5.0 Refrigerant gas

· Blowing agents –These are CFCs in powder form which were used to produce cells that helped to harden or alter the physical conditions of plastics, metals or polymers. They are also applied in making foams etc.

Fig 6.0 Blowing Agent

Fig 7.0 Foam

· Cleaning agents for semi-conductors and precision parts and to also to degrease solvents.

Fig 8.0 CFC based Cleaning Agents

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Foaming agents - used to insulate materials and also as packing cushions in electronics

· Aerosol sprays Propellants - CFCs are also used to decrease the pressure and increase the content in propellant.

Fig 9.0 Propellants

· Inhaler – they are used to control the volume and the pressure of the content of inhaler for asthmatic patients.

Fig 10.0 Inhaler

Developments on the Use of CFC since the Montreal Protocol

After the Montreal Agreement in 1987, refrigerant made from CFCs were stopped in 2000 and subsequently replaced with HCFCs and this provided an opportunity and lead way for the production of HCFCs. After the 2037/3000 and 842/2006 EU regulations these developments took effect:

1. The permanent discontinuation of the use of HCFCs that has high impact on greenhouse effect in 2015.
2. HFCs should gradually replace HCFCs.
3. Complete containment of refrigeration process to reduce the quantity of cooling agent by 2015.
4. The use of low-Global warming potential (GWP) HFCs.

It also recommended the reduction and complete stop to the production of the gases that triggers the depletion of the ozone layer and those that have substantial effect on greenhouse effect which are mainly refrigerants that contain substantial molecules of chlorine. The conferences organized later also highlighted the trend and reduced the deadlines: In Copenhagen conference, they made decision to completely stop CFCs production by December 31, 1994 and HCFC by December 31 2014. CFCs are completely stopped except in small quantities and mainly necessary use in medicine, as propellants in metered amount in inhalers [11].

Indices for Calculating Impact of CFC

The effects and impact of the gases emitted from the use of CFC can be estimated and certain indices are used to determine it. These impacts especially from the use of refrigerants, affect the ozone layer and three main indices are defined:

- **Ozone Depletion Potential (ODP)**: This indicator reveals the involvement of any substance in ozone layer depletion. It is calculated with reference to some major molecules known for their depletion of the ozone layer such as R11 or R12 that have ODP = 1.
- **Global Warming Potential (GWP)**: This indicator reveals the level of involvement of any substance in creation of greenhouse effect. It is calculated with reference to major substances with known effect on greenhouse such as carbon dioxide (CO_2) within defined period of time which is measured in years. CO_2 hence has a reference GWP = 1.
- **Total Equivalent Warning Impact (TEWI):** This concept was designed to exploit the possibility of global warming throughout the operational life span of any refrigeration system, for instance, using a known cooling agent considering the direct impact of the emission of the cooling agent and the indirect impact arising from the energy needed to operate the refrigeration system. It is commonly expressed as;

$$TEWI = (GWP \times L \times n) + (GWP \times m[1-C]) + n \times E \times \beta$$

Where:

GWP: Global Warming Potential:
L: Yearly emissions of Refrigerant;
n: the Life span of the Refrigeration system expressed in years;
m: mass of the refrigerant used in kg;
C: factor recovery and recycling between 0 and 1;

E: Yearly power consumed in operation in kWh;

β: Mass of emitted CO2 in kg / kWh.

***Source*: [4].**

Effects of CFCs on the Atmosphere

In the practical sense, all CFCs are finally released in to the atmosphere except those used as chemical in production of other chemicals. Most CFC release into the atmosphere happen during the disposal of used equipment that contain the refrigerant and not during production, storage, or usage. The release of CFCs has substantially dropped due to the legislative restrictions on application and use of the compound in several countries. Due to the high vapour pressure of the CFCs at normal room temperatures, almost all the CFCs released into the atmosphere gradually accumulate within the region of ozone layer. Once the compound is released into the air during or after use, they penetrate into the lower atmosphere, and usually persist for several years because of their stable nature. The lifespan of CFCs is between 20 to 100 years, and one atom of chlorine can disintegrate over hundred thousand ozone molecules before being changed to a non-reactive radical. Though the release of CFCs in developed countries has been substantially controlled because of global conformity to several protocols on its usage, the deterioration which it has triggered on the ozone cannot be stopped due to their long lifespan.

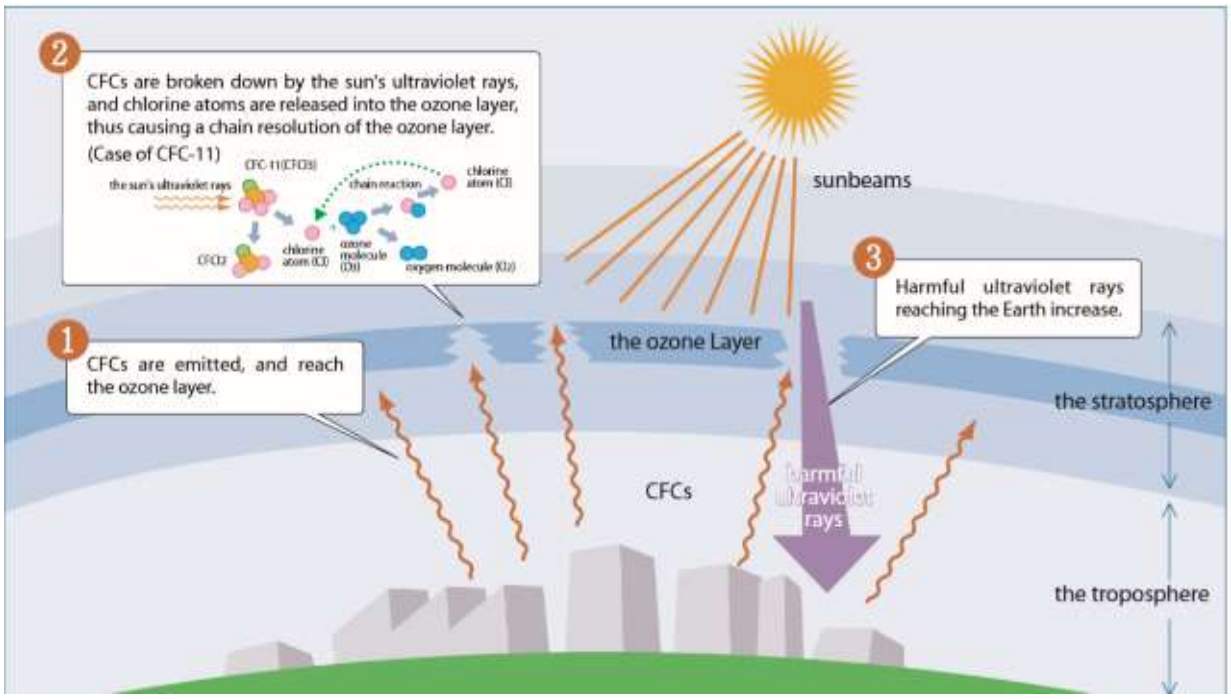

Fig. 11.0 CFC cycle
Source; (*Abdullah A. A et al, (n.a).*

Their lengthy lifespan allows some CFCs to ultimately reach the upper stratosphere because they are not easily disintegrated on the surface of the Earth; they gradually rise into the upper atmosphere where the ozone layer is located. Once, they have settled in the stratosphere, UV radiation from the sun disintegrate their molecular bonds which releases chlorine atoms. These chlorine atoms undergo several chemical reactions that deteriorate the ozone layer through gradual reduction of its concentration. The Chlorine atoms reacts with ozone (O_3) to produce Chlorine monoxide (ClO) and Oxygen. This ClO produced during this reaction continues the process by disintegrating the ozone to produce more Chlorine that start the process all over again. This process, gradually, depletes the ozone molecules contained in the ozone layer causing the layer to reduce or shrink gradually. Though there are several factors that aid or contribute to this process like the presence of barium. However, CFCs are

considered and confirmed as the main reasons for the overall shrinking of the ozone layer.

CFCs and its Effect on Port Harcourt City

The presence and consequent release of Chlorofluorocarbons have been spelt out in this work to be as a result of its benefits and use in making refrigerants, foams, propellants, inhalers, blowing agents etc. These applications find expression greatly in urbanized areas like Port Harcourt City in Rivers state of Nigeria. According to Abdullah A. A. et al, (n.a), emissions as a result of using CFCs occur mostly during the disposal life cycle of some of these CFC using items and it points to the importance of the mode or practice of waste disposal within such a locality. Studies show that Port Harcourt is known to have a poor waste management disposal system hence it is no surprise that her contribution to the nations GHG figures (which includes emissions from CFCs, CO_2, NMVOC, Methane etc) is substantial [17]. Irrespective of the benefits and advantages of CFCs, they are toxic to the environment and humans. The impacts that these harmful chemical compounds cause on the health and environment is also being daily fast tracked by the rapid and overwhelming urbanization in terms of population and spatial area which are factors that impact on consumption and waste disposal practices. This is also in addition to the effects that are already being generated from the region by virtue of being the centre of oil and gas production activities in Nigeria. The impact of CFC usage and generation from the city of Port Harcourt has a domino effect on the climate of not just the state but Nigeria at large. In recent years, Port Harcourt city temperature has increased drastically resulting to high level of heat wave and more records of excessive rainfall and flooding. Particularly affected are areas like New GRA, D/Line, Rumuola an Port Harcourt City areas just to mention a few [12].

Resultant Health Effects of Ozone Depletion

Since the ozone layer absorbs UV-rays from the sun, it then follows that depletion of the ozone layer will supposedly increase the level of UV-B which could result to several problems like skin cancers. However, there are no notable and direct evidence which has linked depletion of the ozone to higher cases of skin cancer in humans. This is partially because UV-A which is equally involved in several cases of skin cancer, is not absorbed by ozone and the specific implications noticed are;

1.) Increased UV: The major public issues concerning the depletion of the ozone and the hole noticed in the ozone layer has been the impact on human health. The level of UV-B ray radiation that penetrates the ozone decreases massively with increase in density and thickness of the layer. This is so because, UV rays creates the ozone that forms the layer from oxygen and a reduction of ozone molecules will possibly increase photochemical ozone production within the troposphere which could be considered as a health concern to humans.

2.) Skin cancer: Having continued exposure to U-V radiations could result to skin cancer. UV radiations can change the biomolecule structure of the skin leading to different skin diseases. Skin is part of the human body that is commonly exposed to UV radiations. There are two main kinds of skin cancer, Melanoma and Non-melanoma. Melanoma is confirmed as the most severe kind of cancer which is usually fatal, while non-melanoma is the commonest type and not usually fatal. Ozone layer depletion causes both skin cancer and sun burn [2].

3.) Cortical Cataracts: It was observed that there are some links between cataracts and exposure to UV-B. A study on ocular exposure to UV-B showed that men are highly limited to the danger of cataract than women but no relationship was noticed [4].

4.) Suppression of the immune system: Excessive exposure to U-V rays could equally trigger immune response suppression to some diseases like skin cancer, infectious-related diseases and other pathogens. The suppression of the immune is linked to the alterations in photoreceptors of the skin and antigen giving cells caused by UV radiations. More rise in ozone depletion leads to more drop in effectiveness of the immune system [6].

5.) Inhibition of photosynthesis: Plant exposure to UV B rays leads to reduction in their growth and this potentially will lead to a consequent reduction in global food production.

6.) Sea life: UV radiation can penetrate water bodies by close to 20m during clear weather conditions. Phytoplankton and Zooplankton vulnerable to this radiation are the major part of the marine food chain, therefore, rise in the level of these radiation could devastate the marine food supply chain and their ecosystem.

7.) DNA Damage and Lung Diseases; Short time exposure to these radiations could trigger damage to DNA because they can alter biomolecule structures like lipids, nucleic acids and proteins. As a result of UV-B radiations some cryptic transposable substances that might result to mutations could be formed and there could be more harm done than the immediate damage of the DNA. Excess UV-B exposure results to basal and squamous carcinomas. These kinds of cancers are normally caused by transcriptional errors during the replication of the DNA triggered by alterations in pyrimidine. The main cause of these entire mechanism is excessive and lengthy exposure to these U-V rays. It is estimated that there is a 2% increase of incidences of this nature [8].

Health Effects, Kinetics and Metabolism

CFCs can penetrate organism or human body through ingestion, inhalation or through dermal contact. Entering through Inhalation is the simplest and crucial entry pathway while exhalation is also a substantial pathway for the elimination of these substances from the human body. Controlled research on volunteer and experimental animals provided significant data from exposures to different forms of CFCs. These data revealed that:

1.) They can gain entry through alveolar membrane, gastro-intestinal pathways or skin.

2.) They are rapidly taken-up by human blood after inhalation.

3.) Chlorofluorocarbons are readily taken-up by the blood at reduced rate as concentration of blood increased.

4.) Chlorofluorocarbons contained in the blood are readily absorbed through various body tissues.

5.) Chlorofluorocarbons reach certain equilibrium blood levels when exposure takes place substantially over a long time indicating a balance between the air that contains CFC and the blood.

6.) Chlorofluorocarbons are absorbed through the tissue, even after the first stabilization level of the blood is attained, and continue to be absorbed into body tissues.

Studies carried out using animals revealed that CFCs are readily taken-up or absorbed after being inhaled and evenly distributed by blood, to virtually all the tissues that are in the human body. The highest concentrations are mostly noticed in tissues that contain fat or lipid. However, CFCs are also noticed in organs that have significant supply of blood like the heart, muscles, lung and kidney. Outcomes of human and animal metabolic experiments showed resistance of CFCs to disintegration or metabolic change in biological systems; these results suggest that they are disintegrated to a little extent after exposure [22-27]. No significant recovery of CFCs or their metabolites was recorded in any studies in attempt to ascertain the product of their metabolic transformation through extraction from faeces or urine [20]. Other recorded health effects are:

- **Short term (acute) Effects**

Exposure to CFCs under pressure which might occur in leakage of refrigerant from refrigeration systems could trigger skin frostbite and also problem to the upper airway when they are inhaled. High temperature exposure of CFCs could cause them to disintegrate into toxic gases like chlorine and phosgene. Inhaling these CFC compounds in significant amount affects the CNS with symptoms that resemble alcohol intoxication, impaired coordination, headedness, tremor, headaches and in some cases, convulsions. Inhalation in substantial amount could trigger disturbances in the rhythm of the heart beat and intentional inhalation of CFCs has been reported to trigger deaths, presumably arising from disruption of rhythm of the heartbeat. In study conducted on excessive inhalation of these compounds, humans were exposed for some hours to increased CFC concentrations. As the amount increased, it was observed that their health effect equally increased.

- **Long-term (Chronic) Effects**

Occupational studies were carried out and it showed that for workers who were exposed to CFCs at occupational stand ard, there were no remarkable negative health issues. Another study on lab animals orally exposed to CFC-11, increased death rate was noticed. Guinea pigs exposed to CFC-12 through inhalation developed liver problem. Other species of lab animals which were exposed under same conditions showed no negative health effects.

Effects (Ability to Cause Cancer)

Studies that involved different species of animals exposed to these compounds showed zero evidence of cancer, although the Environmental Protection Agency in the United States of America have not assessed CFCs for carcinogenic possibilities. Studies available have only shown results that appear to support the possibility to cancer at very low level.

Reproductive/Developmental Effects

Research done so far with laboratory animals which have been exposed to CFCs have not shown any observable adverse health effects to their reproductive and developmental health [15].

Solution to CFC: Development of Alternatives

After the discovery of the ability of CFCs to deplete the ozone layer in the 70s, there was massive search and research for alternative for the CFCs. Then came the use of HCFCs and also HCFs as replacement for CFCs. These new substances do not possess the same impact on ozone layer; they have some impact but on very low scale. They showed lesser impact on ozone layer because they are easily deformed before getting to the stratosphere as they are disintegrated rapidly and relatively into different products like Tri-fluoroacetic acid (TFA) and Chloro-difluoroacetic acid (CDFA). These compounds readily dissolve in rain water and are washed away from the atmosphere by rainfall and join surface water bodies along with other substances in the soil. Microbiological deterioration slowly removes them from the waters [10].

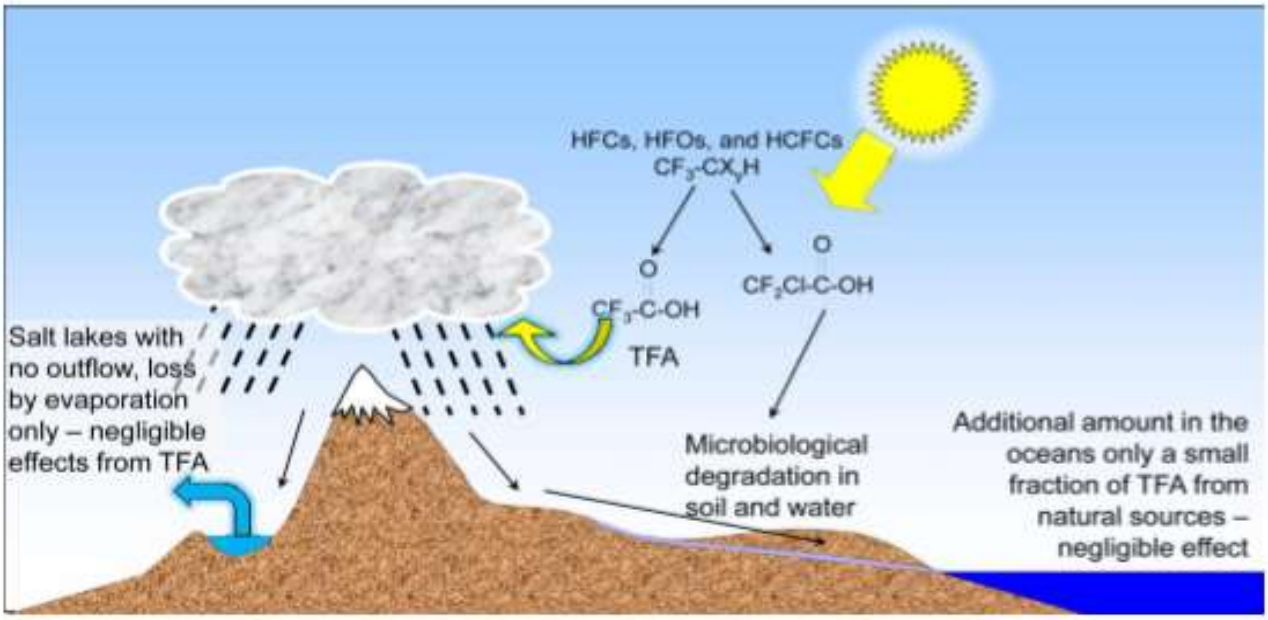

Fig. 11.0: Process of breakdown of HFCs and HCFCs into the environment *Source;* [12]

Carbon-based fuels (CFCs) are bonded symmetrically in a tetrahedral shape, similar to simple alkanes. However, due to the differences in size and charge effectiveness between chlorine and fluorine atoms, methane-derived CFCs change from their natural tetrahedral form. The most crucial procedure for producing some important CFCs is the catalytic replacement of chlorine in Chlorocarbons with Fluorine through reaction with hydrogen fluoride.

CFCs have physical properties that can be tuned by changes in identity and number of halogen atoms. They are generally volatile but not compared to their initial

alkane compounds, with a drop in volatility linked to the molecular polarity triggered by the halogen which created intermolecular connections. Methane boiling point is −161°C, while Floro-methane compounds boil within that range of −51.7 °C for CF2H2 and −128 °C for CF4. CFCs also have higher boiling points due to chloride due to its polarizable nature compared to Fluoride, making them suitable cooling agents in refrigeration systems.

CFCs are not as flammable as methane, partly because they have fewer Carbon-Hydrogen bonds and also because they release halides which stop the free radicals responsible for sustaining flames. In terms of density, CFCs possess higher density than their parent alkanes, usually connected with the number of chlorides in the compound. They are mostly produced by the exchange of halogen, starting from chlorinated ethane and methane.

The most known, wide uses of CFCs include:

1. Port Harcourt Urban Area, Nigeria's 5th largest urban area, which is affected by urbanization and urban sprawl, adding pressure on water supply. The area has high humidity and temperature throughout the year, with two different seasons: wet and dry. The soil type is mostly drained clay combined with sand, classified as Benin formation, and there is also a mangrove swamp-based alluvial soil observed in the northern part down to the coastal areas.
2. Hydrofluorocarbons (HFCs) do not much have an effect on the ozone layer like CFCs do due to their instability. Their chlorine content is readily taken up in rain before reaching the ozone in the upper-most part of the atmosphere, whereas CFCs are stable and react in the low atmosphere, depleting the layer.
3. HFC-134a is currently used to replace CFC-12 in air conditioners. Hydrocarbon-based coolants such as propane and isobutane are also used substantially in air conditioning systems for motors in the USA, Australia, and other nations due to their good thermodynamic attributes and performance under higher atmospheric temperatures.
4. Natural H-C coolants have negligible environmental effects and are used globally in commercial and domestic refrigeration systems. Some solvents are already employed to replace CFCs in lab analysis procedures.

However, there are still small applications for CFCs, such as asthma inhalers and Halon fire-suppression systems, which HCFCs cannot replace. Instead, CFCs are allowed due to the small amounts required for these applications. As CFCs are currently not being applied or used in large scale due to the introduction of HCFCs as safer options, the ozone layer seems to be repairing itself gradually.

Tab 1.0 CFC replacement and their u

Applications and replacements for CFCs		
Application	Previously used CFC	Replacement
Refrigeration and air-conditioning	CFC-12 (CCl_2F_2); CFC-11(CCl_3F); CFC-13($CClF_3$); HCFC-22 ($CHClF_2$); CFC-113 ($Cl_2FCCClF_2$); CFC-114 ($CClF_2CClF_2$); CFC-115 (CF_3CClF_2);	HFC-23 (CHF_3); HFC-134a (CF_3CFH_2); HFC-507 (CF_3CH_3); HFC 410 (CF_3CF_2H))
Propellants in medicinal aerosols	CFC-114 ($CClF_2CClF_2$)	HFC-134a (CF_3CFH_2);

		HFC-227ea (CF_3CHFCF_3)
Blowing agents for foams	CFC-11 (CCl_3F); CFC 113 ($Cl_2FCCClF_2$); HCFC-141b (CCl_2FCH_3)	HFC-245fa ($CF_3CH_2CHF_2$); HFC-365 mfc ($CF_3CH_2CF_2CH_3$)
Solvents, degreasing agents, cleaning agents	CFC-11 (CCl_3F); CFC-113 (CCl_2FCClF_2)	None

This is because production and destruction processes are part of natural equilibrium in which ozone molecules are naturally disintegrated to O_2 and O when UV rays come in contact with them. However, same amount of ozone is also produced by same UV-radiation process.

CONCLUSION AND RECOMMENDATION

Today's world is more serious about keeping an environmental and health friendly environment, thanks to the Kyoto protocol and the cooperation of most countries to do away with the harmful Chlorofluorocarbons. However, there are negative effects of the CFCs which have been used over time and mankind is currently paying for it. It is necessary that research is continuously done to get replacements for these toxins because the dastardly effects are no longer tolerable to nature. The importance of the ozone layer cannot also be over emphasised because continuous depletion of it will spell doom for mankind. Hence, to control the depletion of the ozone layer we have to stop in entirety the use of CFCs. Scientists are doing their best to save the ozone layer by recommending the use of substitutes of CFCs which are not as harmful to the ozone and as a result, we can see positive result over this phenomenon. The skin and the eyes are part of the human body that are commonly and highly exposed to UV rays, therefore there is high possibility of cases of skin cancer, eye related sicknesses and immune suppressions as a result of continuous exposure to these toxins. It is therefore important to use full-body clothing and sunglasses especially in summer when the intensity of sun rays is high so that we can be protected from harmful effect of these radiations. It is also advised that people should use sun-block creams on the exposed parts of the body such as the face. Although the necessity of CFCs is supplementary, it is our duty to save our planet and ensure that while we are here, we do not intentionally make our conditions of leaving more difficult than it should be. Finally, it is recommended that efforts should be geared towards encouraging developing countries to join hands with developed countries to take these issues of eradicating harmful CFCs from their nations and this can be achieved by starting in smaller quarters like in the city of Port Harcourt.

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