APPLICATIONS OF CHEMISTRY THEORY AND PRINCIPLES IN EVERYDAY LIFE

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ABSTRACT

Chemistry theory and their applications appear regularly in people's daily lives. Almost everything is made up of chemicals. Many of the changes we observe in the world around are as a result of chemical reaction. Application of chemistry principles has been around for thousands of years, which can be seen from the way people extract metals for example from different ores, wool from animals, and created paints and dyes, made glasses, production of fertilizer used by farmers to restore soil fertility, pesticides to protect crops and preserve grains from pest, petrochemical refineries use fuels for power generation, diagnostic test carried out in the laboratory for medical prescription and the threat of weapon of mass-destruction like the nuclear, chemical and biological weapons. For instance, Boyles and Charles Laws have made a positive contribution to the progress in optimizing the conditions for the production of ammonia. Today, X-ray are used in medical diagnosis in the determination of molecular structure and in numerous ways that are beneficial to man. This review article presents selected examples of implementation of chemistry theory and principles in everyday life. It is hereby recommended that scientists should continue to explore chemistry laws and principles for the enhancement of human lives and mitigate risks associated with chemical usage.

Key words: Chemistry, Theory, Chemicals, Applications, Everyday Life

INTRODUCTION

In this new millennium, as the world faces new and extreme challenges, the importance of acquiring a solid foundation in chemical principles has become increasingly important to understand the challenges that lie ahead. Moreover, as the world becomes more integrated and interdependent, so do the scientific disciplines. The divisions between fields such as chemistry, physics, biology, environmental sciences, geology, and materials science, among others, have become less clearly defined (Ralph *et al*., 2011).

Chemistry is related to human lives. Unfortunately, one cannot assume that everybody is highly motivated to study chemistry for its own sake. One needs not to become professional chemists to know that a basic understanding of chemistry is useful in a wide range of disciplines and career paths. An understanding of chemistry helps you make informed decisions about many issues that affect you, your

community, and your world (Ralph *et al*., 2011). A major goal of this paper is to highlight the importance of chemistry theory and its application in our daily life and in our collective understanding of both the physical world we occupy and the biological realm of which we are a part.

Chemistry in the Modern World

Everything is made up of chemicals. Many of the changes we observe in the world around we see is caused by chemical reaction. Chemistry is the study of matter and the changes that material substances undergo. Of all the scientific disciplines, it is perhaps the most extensively connected to other fields of study. Geologists who want to locate new mineral or oil deposits use chemical techniques to analyze and identify rock samples. Oceanographers use chemistry to track ocean currents, determine the flux of nutrients into the sea, and measure the rate of exchange of nutrients between ocean layers. Engineers consider the relationships between the structures and the properties of substances when they specify materials for various uses. Physicists take advantage of the properties of substances to detect new subatomic particles. Astronomers use chemical signatures to determine the age and distance of stars and thus answer questions about how stars' form and how old the universe is (Krebs, 2006). The entire subject of environmental science depends on chemistry to explain the origin and impacts of phenomena such as air pollution, ozone layer depletion and global warming.

The disciplines that focus on living organisms and their interactions with the physical world rely heavily on biochemistry, the application of chemistry to the study of biological processes. A living cell contains a large collection of complex molecules that carry out thousands of chemical reactions, including those that are necessary for the cell to reproduce. Biological phenomena such as vision, taste, smell and movement result from numerous chemical reactions. Fields such as medicine, pharmacology, nutrition, and toxicology focus specifically on how the chemical substances that enter our bodies interact with the chemical components of the body to maintain health and well-being. For example, in the specialized area of sports medicine, knowledge of chemistry is needed to understand why muscles get sore after exercise as well as how prolonged exercise produces the euphoric feeling known as "runner's high". Examples of the practical applications of chemistry are everywhere. Engineers need to understand the chemical properties of the substances when designing biologically compatible implants for joint replacements or designing roads, bridges, buildings and nuclear reactors that do not collapse because of weakened structural materials such as steel and cement.

Archaeology and paleontology rely on chemical techniques to date bones and artifacts and identify their origins. Although law is not normally considered a field related to chemistry, forensic scientists use chemical methods to analyze blood, fibers and other evidence as they investigate crimes. In particular, DNA matching—comparing biological samples of genetic material to see whether they could have come from the same person—has been used to solve many high-profile criminal cases as well as clear innocent people who have been wrongly accused or convicted. Forensics is a rapidly growing area of applied chemistry.

In addition, the proliferation of chemical and biochemical innovations in industry is producing rapid growth in the area of patent law. Ultimately, the dispersal of information in all the fields in which chemistry plays a

part requires experts who are able to explain complex chemical issues to the public through television, print journalism, the Internet and popular books (Ralph *et al*., 2011)

Other chemical applications include how astronomers determine the distance of galaxies and how fish can survive in subfreezing water under polar ice sheets. Chemistry affects our daily lives through the following: the addition of iodine to table salt; the development of more effective drugs to treat diseases such as cancer, AIDS (acquired immunodeficiency syndrome), and arthritis; the retooling of industry to use non chlorine-containing refrigerants, propellants, and other chemicals to preserve Earth's ozone layer; the use of modern materials in engineering; current efforts to control the problems of acid rain and global warming; and the awareness that our bodies require small amounts of some chemical substances that are toxic when ingested in larger doses (Lagowski,1997).

Brief History of Chemistry

It was not until the era of the ancient Greeks that we have any record of how people tried to explain the chemical changes they observed and used. At that time, natural objects were thought to consist of only four basic elements: earth, air, fire, and water. Then, in the fourth century BC, two Greek philosophers, Democritus and Leucippus, suggested that matter was not infinitely divisible into smaller particles but instead consisted of fundamental, indivisible particles called atoms. Unfortunately, these early philosophers did not have the technology to test their hypothesis. They would have been unlikely to do so in any case because the ancient Greeks did not conduct experiments or use the scientific method. They believed that the nature of the universe could be discovered by rational thought alone. Over the next two millennia, alchemists, who engaged in a form of chemistry and speculative philosophy during the Middle Ages and Renaissance, achieved many advances in chemistry. Their major goal was to convert certain elements into others by a process they called transmutation.

In particular, alchemists wanted to find a way to transform cheaper metals into gold. Although most alchemists did not approach chemistry systematically and many appear to have been outright frauds, alchemists in China, the Arab kingdoms, and medieval Europe made major contributions, including the discovery of elements such as quicksilver (mercury) and the preparation of several strong acids (Anne & Garson, 2006).

The Role of Theory in Science

It is a historical fact that man has been observing the natural world and recording his observations since ancient times. The oral communication is even older. Observation such as time and routes of migrating animals are of crucial importance to people who live by hunting; knowledge of the rainy and dry seasons is essential to farmer (Lagowisk, 2004).

The importance of these and other natural phenomena made those whose knowledge of them was most extensive the leader of their communities and exceptional status was accorded to those who had or were believed to have the ability to predict such events.

Historically predict has been attempted (i) through an appeal to the supernatural or (ii) by mean of a reasoned extrapolation of facts that were already known. These two approaches to the same problem are not as different as they might appear. If observed facts are believed to be under the direct and immediate control of God, then it is quite

rational to consult Him about such events. This does not conflict with the making and recording of observation about such events. Thus, the ancient fascination with the prediction of the future led to an appeal to God but also to the recording and ordering of observations. The tendency to record and order observation was founded on the widespread belief that there must be a system or order in the universe. The challenge was to find this systemic order.

To demonstrate that one has found it entails the ability to predict the result of observations of basic or fundamental science research necessitates the collection of data and the arrangement of such data within some conceptual framework that makes them easier to understand, remember and use (Ralph *et al*., 2011).

We can distinguish two broad categories of models. There are models of an essentially descriptive nature in which a phenomenon in question is liked to objects of our everyday experience. There are also mathematical models in which natural phenomenon are described by a set of symbols, the meanings of which have to be particular rules of mathematical manipulation.

What do we mean when we speak of 'laws' in the physical sciences? What are these laws; how do they arise; and what is their value or purpose in science. The terms law, principle, theory and hypothesis as used in the natural sciences mean approximately the same thing. Any law, principle, theory or hypothesis that does not fit new experimental data must be amended. A physical law expresses either in words or in algebraic form, the result which is to be expected of a particular experiment. Thus, Boyle's law may be expressed (i) in words as 'At constant temperature the volume of a given mass of gas is inversely proportional to the applied pressure or (ii) algebraically as $V \alpha 1/P$ that is $PV = C$, where by C is a constant at any given temperature, V is volume of the gas and P is pressure of the gas (Atkins and De -paula, 2009).

Once we the value of the constant C for a particular gas, we can calculate either the volume V of the gas, given its pressure or its pressure P, given its volume. For the so-called ideal gas, the value of C is n RT. Where n is the number of moles of the gas, R is the universal gas constant and T is the absolute temperature. Thus, the ideal gas law, arising from the experimental of Boyle and Charles, is $PV= n RT$. Whereby P = pressure of the gas, V = volume of the container, n = no of a molecule, R = gas constant and T = Temperature.

It is important to emphasize that laws arise or are deduced as a result of experimental observation. It follows from this that they must also stand or fails by the results of any other experiment to which they relate. Thus, the ideal gas law fails the test of application to all gases, especially in the region of low temperature and or high pressure.

The value of laws to science and technology applies at various levels. A practical use of a law, which may be highly significant for applied science, is the prediction of a quantity which cannot be readily measured. An example is the necessary to calculate the gas pressure in a novel chemical plant which is still at the chemical stage. A law also establishes a framework into which new experimental results may be fitted. It must be borne in mind that theory is a suggestion and is subordinate to the results of experiments.

The Theory behind Ammonia Production

The reaction between hydrogen and nitrogen to produce ammonia is an equilibrium process;

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} \quad \Delta H = -46kJ$$

We shall use this reaction to illustrate the usefulness of Le Chatelier's principle in the industrial production of ammonia.

If a constraint is placed on an equilibrium mixture, then the equilibrium will shift so to oppose the constraint.

A manufacturer who is interested in making ammonia would want to get the maximum yield of his product. We observe that the reactants (N_2 and H_2) and the product (NH_3) are all gaseous. Gay- Lussac's law tells us that if we start with a combined volume of say four cubic meters of nitrogen and hydrogen in a ratio of 1:3, we end up with two cubic meters of ammonia. A constraint – a reduction in volume - has thus been imposed on the equilibrating system. According to Le Chatelier's principle the equilibrium will shift to oppose this constraint, that is, it will shift to the left and very little ammonia will be produced.

To increase the production of NH_3 pressure must be applied. This is because, Boyle's law tells us that if we increase the pressure on the reacting system its volume will decrease. Thus, increasing the pressure increases the yield of ammonia. We also note that heat is produced as ammonia is formed; ΔH= - 46 kJ per mole of ammonia produced. Thus, according to the (here Le Chatelier's principles), If we remove the heat produced by decreasing the temperature, we should get a higher yield of ammonia (Matthews, 2007). But here we meet a stumbling block.

Our knowledge of kinetics tells us that as the temperature of the reacting system decreases, the rate of reaction also decreases. So, lowering the temperature should give a high yield of ammonia, the rate of ammonia production would be so low that it would render the whole process useless to a manufacturer whose sole aim is to make a profit. In an industrial plant, a number of compromises have to be made; the reaction is typically carried out over iron catalyst at temperature ranging between 400 atmospheres, from 200 to 400 atmospheres. These are the optimum condition required for minimum production costs. Although the yield of ammonia could be increased by increasing the pressure above 400atmospheres, the cost of production would be highly increased by such a further increase in pressure, which will require more expensive, specialized vessels that can withstand the additional pressure (Matthews, 2007).

The Economic Importance of Ammonia

Ammonia is one of the most important industrial chemicals produced worldwide.it is used in the manufacture of fertilizer, nitric acid and polymers. Ammonia is normally produced by nitrogen. The source of nitrogen is the air, but hydrogen is obtained from natural gas; other sources are petroleum coke or biomass. Although process technology has improved over the years, the basic chemistry is identical with the process developed by Haber and Bosch in the early 20th century (Atkins and De - paula, 2009).

Nigeria should take an interest in the production of ammonia, because apart from the fact that Nigeria imports a lot fertilizer for agricultural purposes, the major reason is that there are moves to transform the US economy into hydrogen economy in which vehicles are fueled by the reaction of

hydrogen with oxygen in a fuel cell to produce electricity. In these ways, it is hoped to replace petrol with hydrogen in motor vehicles. A fuel cell is a primary cell in which the chemical that produced electricity are constantly replaced as soon as they are used (Matthews, 2007).

By passing hydrogen and oxygen through a fuel cell, it is possible to generate electricity to drive motor vehicles band possibly train. There are however disadvantages posed by using hydrogen directly, not the least of which is its tendency to explode in the presence of oxygen. Thus, replacing petrol station with hydrogen station would pose explosion hazards for the ordinary motorist. Proposals have therefore been made to use ammonia as a carrier for on-board vehicular hydrogen storage. Ammonia, though has its own problems. In particular, it has been declared a health hazard by the European Union. Therefore, replacing ammonia station will produce an environmental hazard.

Healthcare and Beauty

The diagnostic test carried out in laboratories, the prognostic estimation, medical prescription, pill, the vaccines, the antibiotics play very vital role in health monitoring, control of disease and in alleviating the suffering of the humanity. Right from birth control to enhancement of life expectancy, all have been made possible using the unequivocal service of chemistry principles.

From simple sterilization, surgical instruments with antiseptic solution to chemotherapy and genome sequencing are all nothing but application of chemistry principles in injecting cows, buffaloes, goats, and sheep with bovine some towrope increase milk production but it indiscriminately being used by sportspersons to un-ethically enhance performance.

Aging a chemical change can only be checked chemically. Most beauty products are produced through chemical synthesis to clean, nurture and protect skins. However, there are certain ingredients hazardous to health in the long run.

Industries and Transport

From cloth mills, lather factories, petro-chemical industries and refineries to metal industries-all use numerous fuels for power generation and chemical products for processing their production and improve the equaling and simultaneously produce pollution. Nowadays chemical effluent treatment plants use chemical to control or neutralist have hazardous impact of pollutants produced by the industries.

Aviation and shipping industries generate power through power plants which burn fuels, petrol and diesel emit greenhouse gases dangerous for the survival on earth which the ozone layer that protects us from UV rays. As a result, global warming has taken place which is a destroyer of the plants earth. But again, chemistry principles have paved the way with bio-fuels.

Perchloroethylene (PERC), $Cl_2C = CCl_2$ is commonly being used as a solvent for dry cleaning. It is now known that PERC contaminates ground water and is a suspected carcinogen. A technology, known as Micell technology developed by Joseph De Simons, Timothy Romark, and James McClain made use of liquid CO_2 and a surfactant for dry cleaning clothes, thereby replacing PERC. Dry cleaning machines have now been developed using this technique. Micell Technology, has also evolved a metal cleaning system that uses CO_2 and a surfactant thereby eliminating the

need of halogenated solvents (Anastas & Williamson, 1998).

Food Security and Agriculture

The famous green revolution to increase agriculture produce so as to ensure food security was triggered by the advent of inorganic fertilizer, since then fertilizer is extensively used by farmer to restore the fertility of soil bin the fields.

Pesticides are used to protect the crop during farming and preserve the grains from pest's rats and mice during storage. Genetically modified seeds which are used to enhance production and earn profits through export of food grains are agricultural application of Bio-chemistry, whereas refrigeration system for cold storage of vegetable and raw meat uses polyurethanes foam (PUF) and the chemical properties of gases, the preservation in packaged food products are known to have adverse impact on our body.

Versatile Bleaching Agents

It is common knowledge that paper is manufactured from wood (which contains about 70% polysaccharides and about 30% lignin). For good quality paper, the lignin must be completely removed. Initially, lignin is removed by placing small chipped pieces wood into a bath of sodium hydroxide (NaOH) and sodium sulphide (Na_2S). By this process about 80 - 90% of lignin is decomposed. The remaining lignin was so far removed through reaction with chlorine gas (Cl_2).

The use of chlorine removes all the lignin (to give good quality white paper) but causes environmental problems. Chlorine also reacts with aromatic rings of the lignin to produce dioxins, such as 1,2,3,4-tetrachloropdioxin and chlorinated furans. These compounds are potential carcinogens and cause other health problems. These halogenated products find their way into the food chain and finally into products, pork, beef and fish.

In view of this, use of chlorine has been discouraged. Subsequently, chlorine dioxide was used. Other bleaching agents like hydrogen per oxide (H_2O_2), ozone (O_3) or oxygen (O_2) also did not give this the desired results. A versatile agent has been developed by Terrence Collins of Camogie Mellon University. It involves the use of H_2O_2 as a bleaching agent in the presence of some activators known as TAML activators (Hall *et al*., 1999). These are catalysts which promote the conversion of H_2O_2 into hydroxyl radicals that are involved in oxidation (bleaching). The TAML activators allow H_2O_2 to break down more lignin in a shorter time and at much lower temperature. These bleaching agents find use in laundry and results in lesser use of water (Tundo & Anastas, 1998).

Turning Turbid Water Clear

Tamarind seed kernel powder, discarded as agriculture waste, is an effective agent to make municipal and industrial waste water clear. The present practice is to use Al-salt to treat such water. It has been found that alum increases toxic ions in treated water and could cause diseases like Alzheimer's. On the other hand, kernel powder is not-toxic and is biodegradable and cost effective. For the study, four flocculants namely tamarind seed kernel powder, mix of the powder and starch, starch ad alum were employed. Flocculants with slurries were prepared by mixing measured amount of clay and water (Ahluwalia & Kidwai, 2004).

The result showed aggregation of the powder and suspended particles were more porous and allowed water to ooze out and become compact more easily and formed larger volume of clear water. Starch flocks

on the other hand were found to be light weight and less porous and therefore didn't allow water to pass through it easily. The study establishes the powder's potential as an economic flocculant with performance close more established flocculants such as $K_2SO_4Al_2(SO_4)_3.24H_2O$ (potash alum) (Ahluwalia & Kidwai, 2004).

Cars - Past and Future, and Photography

In the past, bromine compounds were used in leaded fuel, as a constituent of "anti-knock fluid". However, this use has declined as lead has gradually been removed from fuel. Bromine compounds are now being tested in batteries for electric cars, designed to produce zero emissions. Such batteries can also be used as electricity storage devices.

Bromine compounds have a number of applications in photography. Several compounds are used to make the light sensitive component of a photographic mixture; without bromine compounds photographs would not capture sufficient light. Other bromine compounds are used as an ingredient in photo development (Ahluwalia and Kidwai, 2004).

Hair Colors

Hair coloring is very popular today, with over 75% of women coloring their hair. The first safe commercial hair color was created in 1909 by French chemist using the chemical Paraphenylenediamine.

Hair is mainly consisting of keratin which is the same protein found in skin and nails. The natural color of hair depends on the ratio and quantities of two other proteins, eumelanin and phaeomelanin. Eumelanin is responsible for brown to black hair while phaeomelanin is responsible for golden blond, and red colors. The absence of either type of melanin produces white/gray hair (Lagowisk, 2004).

It's the result of chemical series reactions between the molecules in hair and pigments. The bleach which is chemical material used to lighten hair, reacts with the melanin in hair. The melanin is still present, but the molecule becomes colorless. Bleach reacts more easily with the dark hair which contains high percentage of eumelanin than with the phaeomelanin.

Science and Technology

The destructive effects of Atomic Bomb dropped on Hiroshima and Nagasaki. Generations in Japan have suffered the devastation and there has –been on solace. The threat of weapon of mass-destruction (WMDS) like the Nuclear, Chemical and Biological weapons looms large on the humanity. Terrorists are using RDX and other explosives to run currents of fear down the spines across the globe. Nuclear reactors which are going to serve the future generation through power generation leaves us with the problem of nuclear waste management (www.chemistry.about.com).

Whereas the destructive power is generated through chains of chemical reaction, we remain assured that chemistry has facilitated the chain of counter measures too in the form of safety suites and NBC resistant bunkers, Forensic science-the comprehensive scientific analysis of material evidences in the context of law uses principles of chemistry to facilitate crime investigation. Telecommunication information technology and space mission – all bank on the chemistry of semi-conductors and nanotubes.

Environmental Issues

Chemistry theory and its applications is at the heart of environmental issues. What

makes one chemical a nutrient and another chemical as pollutant. How we can clean up the environment. What processes can produce the things we need without harming the environment. (www.chemistry.about.com). We are all chemists, we use chemicals reaction without thinking much about them. Chemistry is important because everything you do is chemistry, even our body is made of chemicals, chemical reactions occurs when we breathe, eat, etc. All matter is made of chemicals, so the importance of chemistry is that it's the study of everything.

CONCLUSION

An understanding of chemistry is essential for understanding much of the natural world and is central to many other disciplines**.** Chemists expand their knowledge by making observations, carrying out experiments, and testing hypotheses to develop laws to summarize their results and theories to explain them. Through application and extension of the principles, chemistry can contribute to sustainable development. Great efforts are still undertaken to design an ideal process that start from non-polluting materials. It is clear that the challenge for the future chemical industry is based on safer products and processes designed by utilizing new ideas in fundamental research.

Most scientist believe that a basic, fundamental understanding of all branches of science is required for progress to be made. We have shown above how the fundamental research conducted by Boyles, Charles and other has made a positive contribution in our everyday life, example in the production of ammonia by optimizing the condition for the production of ammonia, production of fertilizer used by farmer to restore soil fertility, pesticides to protect crop and preserve grains from pest, from petrochemical refineries to metal industries, from diagnostic test to medical prescription etc. There are other examples discussed in this article in which fundamental research has played a vital role in the advancement of scientific knowledge.

Many of today's electrical devices (e.g. radios, alternators and generators) can trace their roots to the fundamental research conducted by Michael Faraday in 1830s.during which he discovered the principle of electromagnetic induction that is, the relationship between electricity and magnetism. Our understanding of the properties of x-rays began with the fundamental research of Wilhelm Rontgen in the 1890s.Today, X-rays are used in medical diagnosis, in the determination of molecular structure and in numerous other ways that are beneficial.

RECOMMENDATIONS

The following recommendations were suggested for exploring the means of strengthening performance in basic research:

(1) Continue to work to improve the climate for the development of science and research careers and the key role of basic research in training researchers.

(2) Stimulate research excellence of world class quality in a wide range of sectors and disciplines, including social sciences and humanities by encouraging more competition in science- driven research at European level selected on the basis of excellence.

(3) Improve the exploitation of result of basic research by supporting transfer of knowledge between researchers, centers of excellence and enterprises, with particular reference to the role of polytechnics and universities as well as within society as a whole.

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