# GREEN SOLVENT FOR ENVIRONMENTAL SUSTAINABILITY IN NIGERIA

**Isife, Chima Theresa (Mrs.)**
*Institute for Development Studies, Enugu Campus*
*University of Nigeria, Nsukka*
Tel.: +234-806-798-5288; E-mail: chimatheresa@yahoo.com

## *Abstract*

*In Nigerian homes, schools and industries, traditional solvents are causing health and environmental hazards. These hazards can be avoided by replacing petrochemical solvents with green solvents, which are environmentally friendly. This paper reviews available secondary information on the havoc caused by use of traditional solvents, the development and environmental compatibility of green solvents and the need to do away with traditional solvents in Nigeria. It recommends a number of steps towards the replacement of traditional solvents with green solvents in the country.*

# Introduction

The World is becoming more environmentally conscious. Chemical processes are being developed with their environmental burden in mind. More traditional chemical methods are being replaced with innovations, including new solvents. Solvents are used in most areas, including synthetic chemistry, analytical chemistry, and pharmaceutical production and processing, the food and flavour industry and the materials and coatings sectors.[1] The principles of green chemistry advocate the use of less of them, or to use safer, more environmentally friendly solvents. Some conventional solvents are hazardous (e.g. toxicity and flammability) and the significant contribution that solvents make generate waste in many chemical processes.[2]

Solvent use is of a concern because young people, including pre-adolescents, are the primary users of solvents. It is one of the most used substances by youth after alcohol, tobacco and cannabis. The products containing solvents are readily accessible to young people, as they are inexpensive and in

common, every-day use. It can result in short-term and long-term harm to the health of users or in death. A phenomenon known as Sudden Sniffing Death (SSD) can occur among first time users of solvents or those who have been sniffing for years. Associated problems include family and social disruption from behaviours, such as theft, truancy and vandalism. In some remote communities petrol sniffing has resulted in tragedy for the individual, families and the whole community.[2]

Solvents are inhaled while in use. Many commercial products, from paints to perfumes, contain "evaporative bases" or solvents, such as alcohol, water, turpentine, petroleum by-products and various hydrocarbons (often used as propellants in spray cans). As the solvent evaporates at room temperature, the sniffer breathes the fumes into the lungs to be absorbed into the blood stream. The user can experience a feeling of euphoria, not unlike the effect of alcohol. Other immediate effects, also similar to drunkenness, can be restlessness, weakness, slurred speech, uncoordinated movements, aggression, blurred vision, hallucinations, nausea, vomiting and unconsciousness.[2]

These and other disadvantages of traditional solvents have given rise to the need to replace them with green solvents for environmental sustainability. This work attempts to review what the green solvent is, its uses and impacts on the environment in Nigeria.

## Definition of terms

Solvents are chemical substances that can dissolve, suspend or extract other materials, usually without chemically changing either the solvents or the other materials. Solvents can be organic, meaning the solvent contains carbon as part of its make-up; or inorganic, meaning the solvent does not contain carbon.[3]

Solvents are found in products that give off fumes at room temperature and, when inhaled, cause intoxication (similar to alcohol). They include items, such as butane in cigarette lighter gas, aerosol sprays, petrol, some glues, correction fluids, paint thinners, dry cleaning fluid, nail polish removers, nitrous oxide used in whipped cream dispensers, fire extinguishers and other common, often inexpensive, household and industrial products.[3]

Environmental sustainability is the process of making sure current process of interaction with the environment are pursued with the idea of keeping the environment as pristine as naturally possible based on ideal-seeking behaviour.[3]

Green solvents are environmentally friendly solvents or bio-solvents, which are derived from the processing of agricultural crops.[4]

## Theoretical and conceptual framework

Although, water ($H_2O$) has been described as universal solvent because it dissolves – no matter how little – every substance, it does not mix substantially with all compounds. Since it is inorganic in behavior and contains no carbon (C), it does not mix substantially with organic compounds (which contain C). Therefore, notwithstanding the cheapness and universal availability of water, other solvents had to take a major portion of water's role as an industrial solvent, especially for organic substances. Such solvents include acetone, xylene, methyl ethyl ketone (MEK), toluene, lacquer thinner and others, which are petrochemical solvents.[4]

Petrochemical solvents may be flammable, smell bad, have intolerable fumes, irritate the skin, burn and redden the skin and cause it to itch. Because of their environmental hazards, they impose protective clothing, gloves, goggles, and respirators on users. Spilled acetone or wastewater containing it can pose a significant risk to ecosystems and wildlife. Acetone dissipates slowly in soil and because of its high solubility in water; it is a significant groundwater contaminant. Acetone also can cause oxygen depletion in aquatic systems, as it is sometimes consumed by micro-organisms.[4]

Most petroleum-based solvent products give skin irritation. Some ready-to-use cleaning products may contain chemicals that will cause redness or swelling of the skin. Products may contain volatile organic compounds, which may escape to the atmosphere and react to form smog. Smog and other atmospheric pollutants have been shown to cause irritation of the eyes, nose, throat, lungs and to cause asthmatic attacks.[4]

As new environmental laws are implemented and consumer demand for safer products grows, environmentally friendly solvents or green solvents or bio-solvents are being promoted to

take the place of the petroleum-based solvents. The Montreal Protocol identified the need to re-evaluate chemical processes with regard to their uses of volatile organic compounds (VOCs) and the impact these VOCs have on the environment. Green solvents are carbon neutral and were developed as more environmentally friendly, safe alternatives to petrochemical solvents. They are less harsh, non-toxic, zero-carcinogen, biodegradable, contain no ozone depleting chemicals (EPA SNAP solvent), have no Global Warming Compounds, and have no environmentally hazardous ingredients (EHIs). Green solvent can be easily recycled though simple filtering or distillation for repeated reuse, and the low evaporation rate and high solvency formula can significantly reduce overall solvent usage.[5]

Green chemistry, also called sustainable chemistry, is a philosophy of chemical research and engineering that encourages the design of products and processes that minimize the use and generation of hazardous substances.[6] Whereas environmental chemistry is the chemistry of the natural environment, and of pollutant chemicals in nature, green chemistry seeks to reduce and prevent pollution at its source. While green chemistry seems to

focus on industrial applications, it does apply to any chemistry choice.[7] The focus is on minimizing the hazard and maximizing the efficiency of any chemical choice.[8]

**Green solvent and Environmental Sustainability**

Green solvent can be high performance blend designed as an alternative to acetone - a hazardous and highly flammable petroleum-based solvent. Green solvent is not flammable, contains no hazardous air pollutants (HAPs) and is not a HAZMAT. Because of the flashpoint of green solvents, they are not considered flammable liquid. Acetone and many other solvents have a low flashpoint and are flammable or extremely flammable. The flashpoint of a solvent is the temperature at which it would ignite. The flashpoint of a solvent determines how easily it will ignite and burn.[9]

Bio-solv, a brand of green solvent, is ideally suited for a variety of marine, automotive and industrial cleaning and surface preparation applications, including resin solving, paint and graffiti removal, vinyl graphics removal, adhesive clean-up, parts cleaning, and degreasing. It contains no water and is completely

reactive, unlike other green solvents which may contain up to 50% water.[9]

A bottom-paint job is unpleasant from start to finish, and wiping down the hull with acetone plays a role in that unpleasantness. When a green solvent, such as Bio-solv, was substituted according to the marketer, the product became slightly more expensive than acetone, but well worth it because it lasted longer (since it evaporated slower) than acetone. The biodegradable acetone replacement, which is also called "green acetone," carries the U.S. Environmental Protection Agency's Design for the Environment (DfE) logo. In order to display the DfE logo, the product underwent extensive screening by the EPA and other firms to ensure that none of the ingredients in Bio-solv are unsafe for humans or the environment.[9]

Some green solvents serve as environmental-friendly industrial and residential microbial cleaners designed to use microbes to clean and remediate unwanted hydrocarbons. They deliver maximum cleaning and disposal capabilities with zero harm done to the environment. Some of the solutions specialize in food services (for cleaning and maintaining grease traps), vent

hoods, drain pipes, floor drains, floors and garbage disposals. In municipal sewer treatment operations, green solvents are used for digesting organic wastes, odor control, and for preventing build-up of fats and grease in piping system. For industrial wastewater equipment, green solvents are used to reduce build-up of fat and grease in piping and equipment.[9]

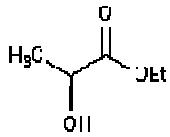
Green solvents are also used in personal homes to remove grease from driveways and grills, control odor, prevent build-up of fats and grease in drain fields. They are important in lawn and garden, where they are used to restore soil natural ability to support plant life.[9]

In automotive repair shops, green solvents eliminate heavy grease and grime. They are also used in refineries and chemical plants, where non-flammable property is desirable for the cleaning of such plants. In plating shops, green solvents are used as degreasers. In the highways, they remove contaminates where accidents occur. Where there is oil spillage, they are used to remedy hydrocarbon spills on soil, surface, salt water and fresh water.[10]

In process industries, they remediate soil around process equipment located outdoors. Also, in maritime industries, green solvents are used as great for bilge tanks, engine room and many other marine purposes. The green solvent is committed to providing multi-use environmentally friendly services to promote a safe and clean way to dispose of contaminated waste, grease oil and fat without using harmful solvents.[10]

An environmentally sensitive non-toxic cleaner/degreaser that really works and can be economically custom-diluted for many different uses is another kind of green solvent. Green solvents are used as all-purpose cleaner for floors, windows, walls, pots, pans, sinks, drains, stained carpets, and greasy tools. Only a little quantity of green solvent gets big jobs done around the house because it is packaged as a concentrate and diluted to clean anything dirty. Green solvents are replacements for most common cleaners, detergents, degreasers and laundry pre-soaks.[11]

Ethyl lactate, derived from processing corn, is a green solvent with the structure shown below:



Ethyl lactate

It is the ester of lactic acid. Lactate ester solvents are commonly used in paints and coatings industry and have numerous attractive advantages, including being 100% biodegradable, easy to recycle, non-corrosive, non-carcinogenic and non-ozone layer depleting. It is a particularly attractive solvent for the coatings industries, as a result of its high solvency power, high boiling point, low vapour pressure, and low surface tension. It is a desirable coating for wood, polystyrene and metals, and also acts as a very effective paint stripper and graffiti remover. Ethyl lactate has replaced traditional solvents, including toluene, acetone, and xylene, resulting in the workplace being made a great deal safer.[11]

Other applications of ethyl lactate include being an excellent cleaner for the polyurethane industry. Ethyl lactate has a high solvency power, which means it has the ability to dissolve a

wide range of polyurethane resins. The excellent cleaning power of ethyl lactate also means it can be used to clean a variety of metal surfaces, efficiently removing greases, oils, adhesives and solid fuels. The uses of ethyl lactate are highly variable as it has eliminated the use of chlorinated solvents.[11]

## Reasons for adopting green solvents in Nigeria

There are many reasons to advocate the substitution of traditional solvents for green solvents in Nigeria. First, the Nigerian population is youth.[12] Since young people, including pre-adolescents, are the primary users of solvents, the harms of these solvents impact them negatively.

Secondly, the traditional solvents are used in the laboratories of secondary schools and tertiary educational institutions, which are heavily populated by youths, thereby impacting negatively on increasing number of members of the most important segment of the society of today and the future. The population of the students of secondary schools increased from 4.6 million in 2001 to 6.2 million in 2005 – an annual increase of 0.4 million or 8.7%. Similarly, the population of the students of

universities (and their equivalents) increased from 0.71 million in 2001 to 0.97 million in 2005 – an annual increase of 0.065 million or 3.5%.[13]

Thirdly, the working and productive ages in every society is youth. Since, traditional solvents are involved in synthetic chemistry, analytical chemistry, and pharmaceutical production and processing, the food and flavour industry, the materials and coatings sectors, and the marine industries, which abound in Nigeria, the health of a large number of Nigerian youth in schools and industry is being compromised.

Since the products containing traditional solvents are inexpensive and in common, everyday-use, they are readily accessible to young people, leading in short- and long-run to their harm and death. Changing to green solvents would spare the lives so lost and the environmental and health hazards so occasioned.

# Recommendations

Doing away with traditional solvents has become imperative for environmental sustainability in Nigeria. To this end, it is recommended that:

1. Green solvents be used to replace traditional solvents in Nigeria;
2. Awareness of the harms of traditional solvents and the promotion of green solvents need to be stepped up in the country;
3. Lessons on green chemistry and sustainability of the environment need to be integrated into the curricula of schools;
4. Out-of-school programmes on green chemistry and environmental sustainability need to be designed and introduced;
5. Policy needs to be formulated for the teaching and practice of green chemistry and environmental sustainability;
6. Plants, from which green solvents can be produced, need to be planted massively; and
7. Product designs need to be addressed towards the adoption of green solvents.

# Conclusion

Most petroleum-based solvent products give skin irritation. Some ready-to-use cleaning products may contain chemicals that cause redness or swelling of the skin. Products may contain volatile organic compounds, which may escape to the atmosphere and react to form smog. Smog and other atmospheric pollutants have been shown to cause irritation of the eyes, nose, throat, lungs and to cause asthmatic attacks. In Nigerian homes, schools and industries, traditional solvents are impacting negatively on health and lives of the teeming population of Nigerian youths because of the characteristic environmental unfriendliness of the solvents.

# References

1. Howdle, S.M (2002), "Supercritical fluids: A clean route to polymer synthesis and polymer processing, Green Chemistry, 4(3): 29-31.
2. Adams, W.M. (2006), "The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century" .Report of the IUCN Renowned Thinkers Meeting, 29-31 January 2006, Retrieved on 6/29/2010 from

htt://cmsdata.iucn.org/downloads/iucn/futureofsustainability.pdf

3. Reid R.C.; Prausnitz, J.M and Poling, B.E. (1987), *The Properties of Gases and Liquids*, 4ed., McGraw-Hill, New York.
4. Ott, K. (2003), "The Case for Strong Sustainability," in Ott, K.& Thaapa, P. (eds.) *Greifswald's Environmental Ethics.* Greifswald: Steinbecker Verlag Ulrich Rose.
5. White, A.; Burns, D. and Christensen, T.W. (2006), "Effective Terminal sterilization using supercritical carbon dioxide, *J. Biotechnology*, 123(4): 504-515.
6. MacGillivray, L.R.; Reid J.L and Ripmeester (2000), "Supramolecular Control of Reactivity in the Solid state Using Linear Molecullar Templates", J.AM.Chem.Soc, 122:32; 7817-7818.
7. Wilson, M. and Schwzarzman, M. (2009),"Toward a New U.S. Chemicals Policy," *Rebuilding the Foundation to Advance New Science,Green Cemistry and Environmental Health,* 117(8): 1202-1209.

8. Linthorst J.A. (2010), "An Overview:Origins and Development of Green Chemistry", *Foundation of Chemistry*, 12(1): 55-68.
9. Radcliffe, C, Maguire K and Lockwood, B (2000), "Applications of supercritical fluid extraction and chromatography in forensic science, *J. Biochem Biophys Methods,* 43(1-3): 261s-272.
10. DeSimone, L. and Popoff, F. (1997), "Eco-efficiency" in *The business link to sustainable development*, Cambridge: MIT Press.
11. Dyllick, T. and Hockerts, K. (2002), "Beyond the business case for corporate sustainability" *Business Strategy and the Environment*, 11(2): 130-141.
12. United Nations System in Nigeria (2001), *Nigeria Common Country Assessment,* Abuja: United Nations System in Nigeria.
13. Eneh, O.C.(2008), "Expanding education and diminishing learning: a case for entrepreneurship for enterprise-readiness and employability of the products of the Nigerian education system," *Knowledge Review,* 17(7): 58-67.