



APPLICATION OF GREEN REACTIONS IN DAILY LABORATORY EXPERIMENTS TO MINIMIZE THE POLLUTION CAUSING DUE TO CHEMICAL POLLUTANTS.

¹A. S. Mahakalkar, ²S. N. Nandeshwar

Sevadal Mahila Mahavidyalaya, Sakkardara Square, Nagpur
Email: 1anjaliml@rediffmail.com, 2sapnanandeshwar89@gmail.com

Abstract:

Green chemistry is a branch of chemistry which deals with the environmentally benign chemical synthesis. It reduces the use and generation of hazardous substances or byproducts and the reactions which fulfill one or more principles of Green chemistry are known as green reactions. The present study has been done to find out the importance of Green reactions over routine chemical reactions which are generally carried out in our daily chemistry practices and to apply this Green reactions in laboratory experiments. For this study some of the basic reactions were replaced by Green reactions and the comparative analysis was done which showed that green reactions are very much superior to the routine reactions which are performed in the laboratory. Green reactions were easy to handle, having minimum waste, maximum product, safe for environment, low energy requirement and biodegradable. It concludes that application of Green reactions is much essential in the educational system so as to bring the revolution in conventional methods of practical analysis and make our environment clean and free of chemical pollutants. Think Green, be Green and go Green.

Introduction:-

Various scientific developments in the 20th century were responsible for number of environmental problem at local and global levels due to which environment is becoming highly polluted [1]. The most important factor which causes pollution is removal of hazardous byproducts of chemical industries and the release of agrochemicals in the atmosphere, land and water body [2]. So it becomes necessary to formulate guidelines and pass strict rules for practicing chemists and to bring about the changes at grass root level. This can be achieved by



necessary changes in the chemistry curriculum at colleges, universities and also in the secondary schools.

Green chemistry is defined as the environmentally benign chemical synthesis [3]. It reduces the use and generation of hazardous substances and byproducts. The reactions which fulfill one or more principles of green chemistry are known as green reaction. Bringing green reaction to the class room and laboratory will have the desired effect in educating the students at various levels about green reaction. There are various alternative methods over the conventional methods which are useful for the environmentally benign chemical synthesis [4,5].

In present work the comparative study has been done to find out the importance of Green reactions over routine chemical reactions which are generally carried out in our daily chemistry practices such as Inorganic analysis, Organic analysis, Acetylation of Primary Amine and Benzoin Condensation and to apply this green reactions in usual laboratory experiments.

Material and Methodology:

For this study some of the basic reactions which are performed by the UG and PG students in the laboratory were replaced by the green reactions having same aim but somewhat different alternative reagents and starting materials which are not only ecofriendly but also easily available at very cheap price.

All organic chemistry experiments such as preparation, separation of mixture of compounds, identification of functional groups etc were conducted in semi-micro or micro scale.

The comparative study of different experiments were done at our departmental laboratory in following manner-



1) Inorganic Analysis:-

Inorganic analysis mainly deals with the detection and estimation of basic and acidic radicals [6]. For the detection of radicals Spot-test was carried out instead of the conventional reactions which are used for inorganic analysis. Although spot reagents are costly, a little amount of the reagents are required. So, it will be cost-effective.

2) Organic Qualitative analysis:-

(Detection of extra elements- N, S, Cl, Br, I)

The use of metallic sodium for fusion with organic compound is terribly hazardous and is a cause of great worry and concern in the student laboratory.

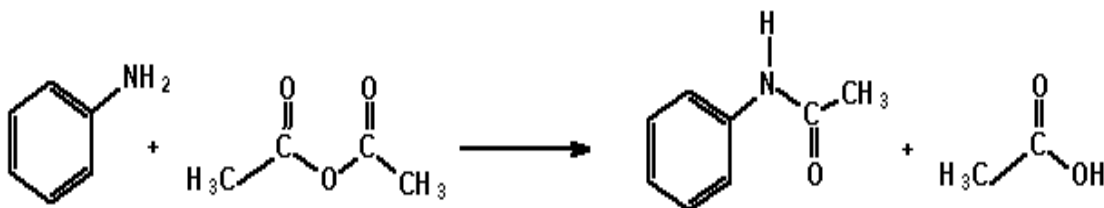
A non hazardous and safe procedure which can be performed alternatively is use of zinc dust and sodium carbonate instead of metallic sodium [6].

Organic sample was thoroughly mixed with an intimate mixture of Zn dust and sodium carbonate powder in a fusion tube, heated first gently and then strongly in a flame till it becomes red hot and kept at red hot condition for two minutes. The bottom part of fusion tube was plunged into 5ml distill water and then filtered. With the filtrate tests for N, S, Cl, Br and I were carried out as usual as in the case of Lassaigne's test [10].

3) Organic Preparations:- (UG level)

a) Acetylation of Primary Amine (Preparation of Acetanilide):-

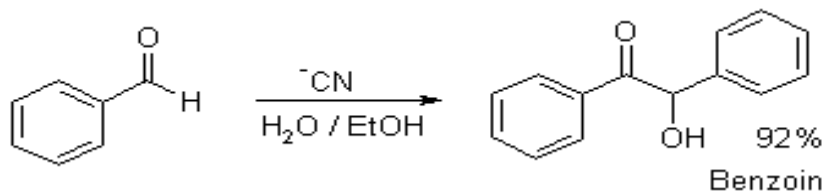
The conventional method for the preparation of acetanilide was reaction of Aniline with acetic anhydride in presence of pyridine and CH_2Cl_2 [9] which involve Use of chlorinated solvent like CH_2Cl_2 , Pyridine is also not eco-friendly, Acetic anhydride leaves one molecule of acetic acid unused (not atom-economic)

**Alternative Green Procedure [7]:-**

An alternative method for the preparation of Acetanilide is by using Acetic Acid instead of Acetic Anhydride, it is as follows- A mixture of aniline (10 ml) and zinc dust (0.5 g) in acetic acid (30 ml) in a 100 ml round bottom flask was heated over a gentle flame using water condenser. Heating was continued for about 2 hrs. The reaction mixture was then carefully poured in cold water (100 ml) in a 250 ml beaker with cooling and vigorous stirring. The shining crystals of acetanilide were separated slowly. After 15 min. the acetanilide crystals were collected by filtration. The solid crystals were washed over the Buchner funnel with water and the product was dried (yield, 10 gm). It was crystallized in boiling water.

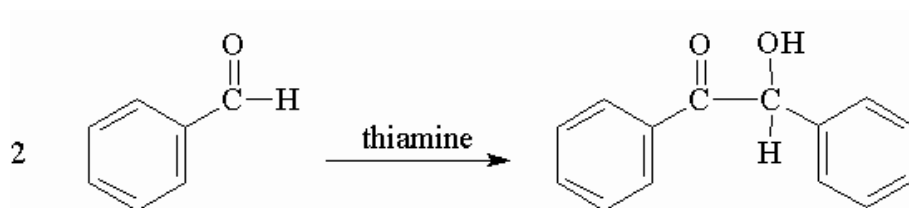
b) Benzoin Condensation (Preparation of Benzoin from Benzaldehyde):-

The conventional method for the preparation of Benzoin involves reaction of benzaldehyde with sodium cyanide in presence of ethanol and water [9]. Here the sodium cyanide is highly poisonous.



This reaction was replaced by the alternate Green reaction which includes preparation of Benzoin from two molecules of

benzaldehyde and thiamine hydrochloride in presence of Ethanol and water [8].



Result and Discussion:-

Experiment	Conventional Method	Green Reaction	Difference
Inorganic Analysis	By using Different Chemical reactions	By using Spot-test	Very low waste is produced
Organic Qualitative Analysis (Element Detection)	By using Sodium Metal	By using Sodium Bicarbonate	Safe to handle rather than inflammable sodium metal
Organic Preparation			
1) Acetylation	By using Acetic Anhydride	By using Acetic Acid	No side product, Maximum incorporation of reactant into product
2) Benzoin Condensation	By using CN⁻	By using thiamine	No poisonous effect as compared to cyanide group

The above result for inorganic analysis shows that **'SPOT TESTS'** must be introduced for the detection of basic as well as acid radicals so as to minimize the waste and hazardous gases which releases in the environment due to conventional method of qualitative analysis in Inorganic chemistry.

In case of organic qualitative analysis it has been found that, this experiment totally eliminates the risk of explosion and fire hazard which are often met while carrying out the same experiments using metallic sodium.

In Acetylation of primary amine by using green reaction the yield obtained was 89% and hence Green chemistry's second principle i.e. maximum incorporation of reactant into final product has been followed,



similarly first principle of waste minimization and sixth principle of use of most appropriate solvent was followed. Acetylation of primary amine by using acetic acid instead of acetic anhydride avoids use of acetic anhydride (usage banned in some states, due to its utility in narcotic business), Minimizes waste by-products and avoids hazardous solvent.

In benzoin condensation by using Green Reaction the yield obtained was 70% and the hazardous and poisonous cyanide ion was replaced by thiamine hydrochloride hence seventh principle of Green chemistry i.e. selection of appropriate starting material was followed and the reaction is effected at a lower temperature.

It means by applying all this green reaction in daily lab experiments one can save our environment from being polluted due to chemical pollutants.

Conclusion:-

From the above study it has been concluded that the application of green chemical reactions in our routine lab experiments is very essential and it can form a great revolution to overcome the environmental pollution which is causing due to the Chemical pollutants. The start should be done from grass root level so that we can apply these reactions to the class room and daily lab practices.

References:-

- Ahluwalia V. K., and Kidwai M., (2007) New Trends In Green Chemistry, Anamaya publisher New Delhi, 2nd edition, 5-18, 250.
- Ahluwalia V.K., (2006) Green Chemistry Environmentally Benign Reactions, published by India books, 2nd edition, 1-10.
- P. Anastas and J. C. Warner, (1998) Green Chemistry: Theory and Practice; Oxford Science Publications, Oxford.



- P. F.Schatz, (1996) Journal of Chemical Education. 173, 267.
- Choo J. L. and Trost B.M., (2008) Green Chemistry for chemical synthesis PNAS, 105 (36), 13197-13202.
- Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST
- H. Meshram, IICT, Hyderabad, Private Communication
- P.,D. L. Lampman, and G. M.Chriz, (1982) Introduction to organic lab technique; College Publishing, New York, experiment no 40
- Furniss B.S, Hannaford A.J, Smith P.W.G., and Tatchell A.R , (2005) Vogel's Textbook of Practical Organic Chemistry, Pearson education, 5th edition, 916-918.
- Vogel I. A., (2003) Elementary Practical Organic Chemistry Part I, Small Scale Preparation, CBS publishers and distributors, Delhi, 2nd edition, 263-264.