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Comparative study of nitration of aromatic compounds by green synthetic approach over conventional procedure

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Abstract
Aromatic nitration is one of the most important unit processes in synthetic organic chemistry and in the chemical industry. Aromatic nitrates such as nitro-phenols are important precursors for the production of dyestuffs, pharmaceuticals, agrochemicals, explosives, plastics, and other industrially important products. Conventional processes are commonly lead to mixtures of regioisomers and are not environment friendly. Recent advances in the synthesis of nitro-aromates by green chemistry approaches have been minimized the production of chemical waste, practical yield of an aromatic nitrated product increased by using green procedure over conventional procedure. Practical yield was found to be 66.5% in case of green synthetic approach where as in case of conventional process it was found to be 41.87%. Likewise green chemistry approach is superior over conventional procedure.

Keywords: Environment friendly, nitrophenols, chemical waste, green synthesis, conventional procedure, regioisomers

Introduction

Green chemistry approach includes inorganic salts so the by products can be useful agrochemicals rather than chemical waste [1]. In conventional procedure hazardous chemicals are used which is harmful for human being and nature as well. Regioselective nitration, rapid nitration, environment friendly and higher practical yield is the bullet points of green chemistry approach over conventional procedure [2].

Designing of chemical products and processes that decrease or remove the use or production of unsafe and dangerous substances is known as Green chemistry. Green chemistry involved in designing, synthesis, chemical production, application and disposal of chemical product. Other name of green chemistry is sustainable chemistry. Advantages of Green chemistry are:

- Reduce or prevent pollution at molecular level
- Applies for all the discipline of chemistry.
- To reduce environmental problems applies innovative solutions.
- Modifications to equipment or technology, process or procedures, reformulation, redesign of products, substitution of raw materials results to prevent the generation of pollutants.
- Minimize the opposite or negative effect of chemicals on human health and environment.
- Minimize and eliminate hazards from existing procedures.
- Intrinsic hazardous effects reduced by designing chemical methods and products.

Green chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacturing and application of chemical product. The reagents and by-products in this reaction are safe and eco-friendly [4-8].

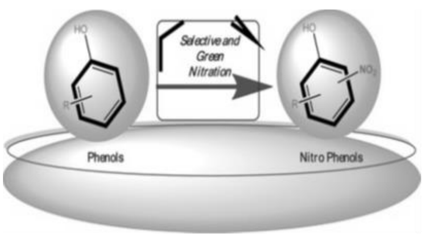


Fig 1

Principles of Green Chemistry

1. **Principle of prevent waste:** No waste after and during the chemical process is called principle of Prevent waste.
2. **Maximize atom economy**: Development of such process by which produced chemical product contains the maximum or full proportion of reactant is known as Maximize atom economy.
3. **Design less hazardous chemical syntheses**: Generation of substances with low or no toxicity is the third principle of green chemistry.
4. **Design safer chemicals and products**: designing of effective nontoxic and safer chemical products with full effectiveness.
5. **Use safer solvents and reaction conditions**: avoid use of hazardous chemicals for separation, and preparation of new products avoidance of the use of auxiliary chemicals or safer one should be used.
6. **Increase energy efficiency**: Run chemical reactions at room temperature and pressure whenever possible.
7. **Use renewable feedstocks**: At the time of reaction use of renewable starting material which is known as feedstocks is another principle of green chemistry. Deployable starting materials are much harmful. The renewable feedstocks is often agricultural products or the wastes of other processes; the source of depletable feedstocks is often fossil fuels (petroleum, natural gas, or coal) or mining operations.
8. **Avoid chemical derivatives**: Chemical derivatization increase the time and uses of chemical compounds, avoid using such blocking or protecting agents, groups or any temporary modifications if possible. Such derivative reagents generate additional waste.
9. **Use catalysts, not stoichiometric reagents**: Using of Catalytic reaction can minimize waste because catalysts are more effective in small quantity and single catalyst can carry out many times for single reaction. Catalysts are preferable to stoichiometric reagents, which require huge quantity to carry out any reaction for only once.
10. **Design chemicals and products to degrade after use**: Designing of chemical products to degrade to innocuous substances after use so that chemical waste do not accumulate in the environment.
11. **Analyze in real time to prevent pollution**: to minimize or eliminate the formation of by-products include in-process, real-time monitoring and control during syntheses.
12. **Minimize the potential for accidents**: Design physical forms (solid, liquid, or gas) synthesis to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

Material and method

For conventional method concentrated nitric acid and sulphuric acid is required. [8-12] For green chemistry approach salicylic acid, boiled with calcium nitrate and acetic acid and washing of precipitate requires ice cold water. [13-15]

2.1 Conventional approach

Use of Nitric acid and sulphuric acid involved in the conventional methods. Aromatic nitration is selective with the degree of nitration.

1. Step

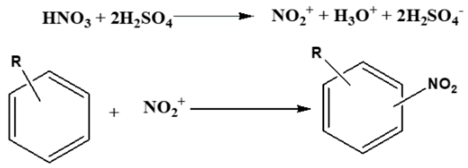
Formation of nitronium ion by acceptance of a proton from sulphuric acid and dissociation to form nitronium ion.

2. Step

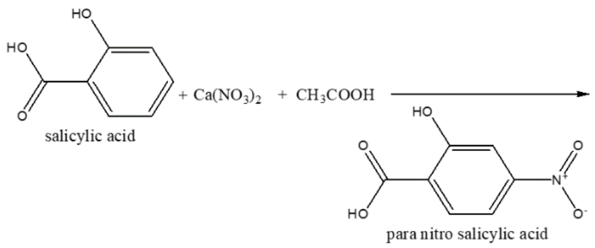
The nitronium ion acts as electrophile react with aromatic compound to form arenium ion.

3. Step

Arenium ion loses proton to Lewis base to form Nitrobenzene.



(R= acetaniline, methyl, hydroxyl)



The yield of nitration mainly depends on temperature of reaction, change in substract may increase or decrease the practical yield.

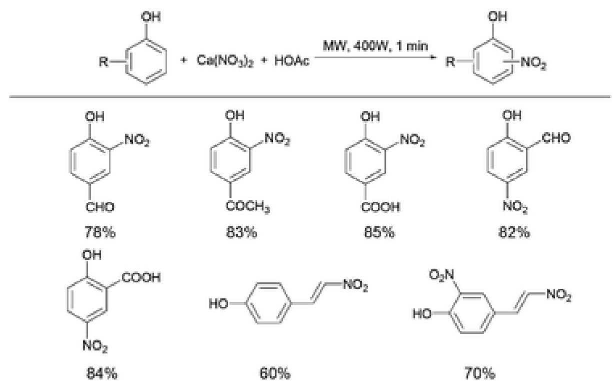


Fig 2: Compounds with practical yield

Result and discussion:

Practical yield was found to be 68.70% in case of green synthetic approach where as in case of conventional process it was found to be 39.44% and the chemicals involved in conventional approach are highly corrosive Likewise green chemistry approach is superior over conventional procedure.

Conclusion

Aromatic nitration is one of the most important unit processes in synthetic organic chemistry and in the chemical industry. Green chemistry approach is superior over conventional approach due to less inherent toxicity, impact on environment is less harmful, energy efficiency more and less hazardous

material used.
Proposed study reveals that practical yield improves with green chemistry approach and reduced the time consumed in the reaction.

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