Green Chemistry-green approach towards life

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Green Chemistry

Green Chemistry is defined as invention, design, development and application of chemical products and processes to reduce or to eliminate the use and generation of substances hazardous to human health and environment.

12 Principles of Green Chemistry

1) It is better to prevent waste than to treat or clean up waste after it is formed.

2) Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3) Wherever practicable, synthetic methodologies should be designed to use and generate substances that posses little or no toxicity to human health and the environment.

4) Chemical products should be designed to preserve efficacy of function while reducing toxicity.

5) The use of auxiliary substances (e.g. solvents, separation agents etc.) should be made unnecessary wherever possible and, innocuous when used.

6) Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.

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7) A raw material feedstock should be renewable rather than depleting whenever technically and economically practical.

8) Unnecessary derivatization (blocking group, protection/deprotection, temporary modification of physical/chemical processes) should be avoided whenever possible.

9) Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10) Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.

11) Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances.

12) Substances and the forms of the substance used in chemical reaction should be chosen so as to minimize the potential of chemical accidents, including releases, explosions, and fires.

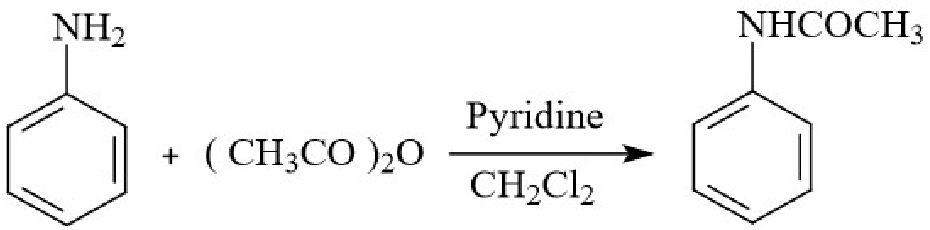

GREEN
FLAVOUR
By S.Bhanumati.

Green Guidelines for Teachers and Students in Laboratory

1. Experiments should involve the use of alternative reagents which are not only eco-friendly but also be easily available anywhere in the country in bulk quantities at very cheap price. They should not preferably invo lve the use of organic solvents (like ether, petroleum ether or ethyl acetate); ethanol and methanol are mostly preferred.
2. Modified Experiments, if possible should not involve sophisticated instrumentation techniques like high-pressure system, evacuated system, inert atmosphere using argon, *etc*. This is in view of the stringent situations in many of the laboratories in most of the institutions of our country, specially, in rural areas.
3. Experiments should avoid tedious experimental procedure like longer reaction time, reaction at high temperature *etc*.
4. All organic chemistry experiments (preparation, separation of mixture of compounds, identification of functional groups *etc*.) should preferably be conducted in semi-micro or micro-scale. Thin-layer chromatography (TLC), spectroscopic techniques (UV, IR and wherever available NMR) should be methods of choice for determining purity, functional groups and structure elucidation.
5. One can use ethyl chloroformate as a substitute for PCl_5, PCl_3, $POCl_3$ or $SOCl_2$. The acid is converted to anhydride which can be used for the same purpose
6. Dimethyl carbonate may be used as a suitable substitute for dimethyl sulfate and methyl halides for methylation as the end product is only carbon dioxide

ACETYLATION OF PRIMARY AMINE
(Preparation of acetanilide)

Conventional Procedure:



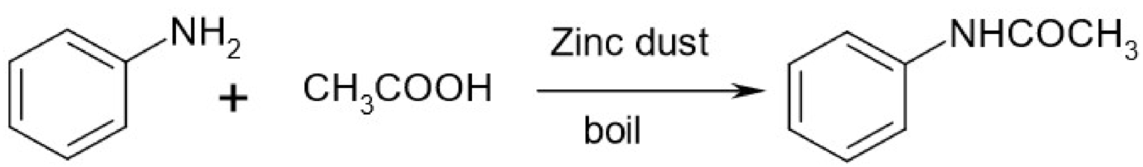
Non-green Components:

Use of chlorinated solvent like CH_2Cl_2

Pyridine is also not eco-friendly

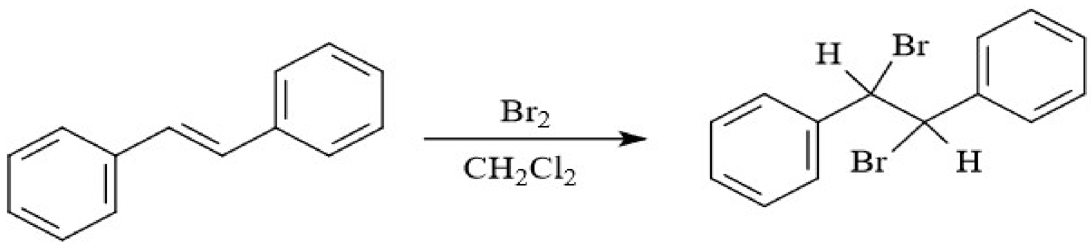
Acetic anhydride leaves one molecule of acetic acid unused (not atom -economic)

Alternative Green Procedure:



HALOGEN ADDITION TO C=C BOND
(Bromination of *trans*-stilbene)

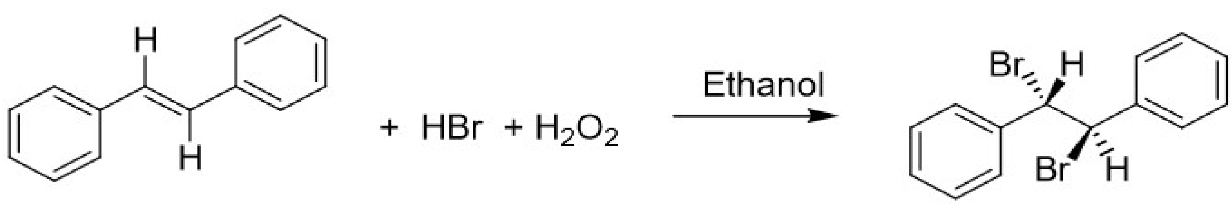
Conventional Procedure:



Non-green Component:

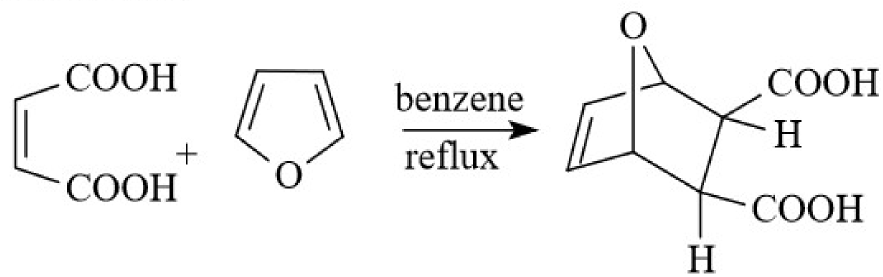
Use of liquid bromine
Chlorinated solvents

Green Procedure 1[1]:



[4+2] CYCLOADDITION REACTION
(Diels-Alder reaction between furan and maleic acid)

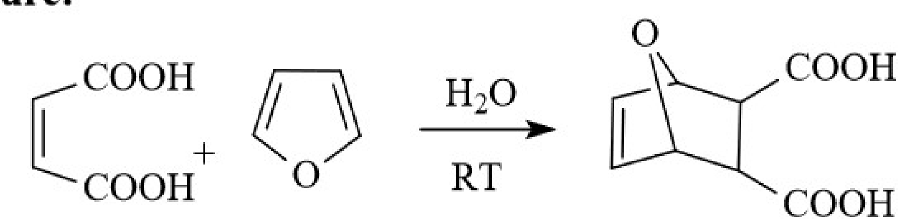
Conventional Procedure:



Non-green Component:

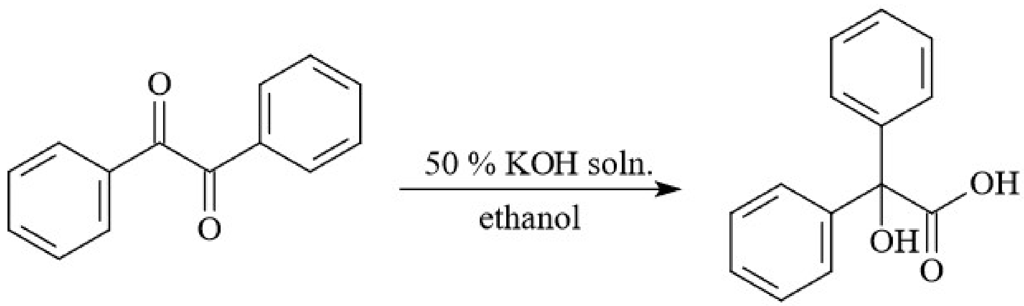
Use of benzene which is one of the most toxic solvents

Green Procedure:



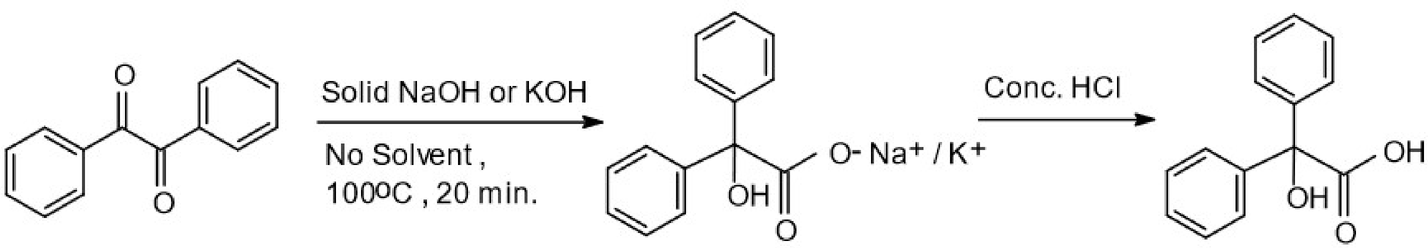
REARRANGEMENT REACTION - III
(Benzil Benzilic acid rearrangement)

Conventional Procedure:



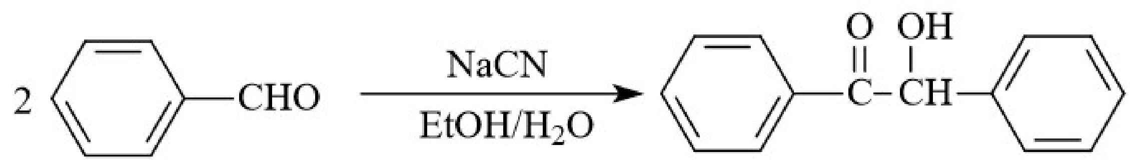
Alternate Green Procedure:

Preparation of Benzilic Acid in Solid State under Solvent -free Condition:



COENZYME CATALYZED BENZOIN CONDENSATION
(Thiamine hydrochloride catalyzed synthes is of benzoin)

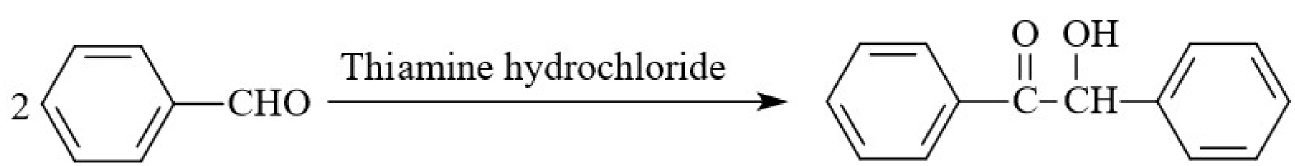
Conventional Procedure:



Non-green Component:

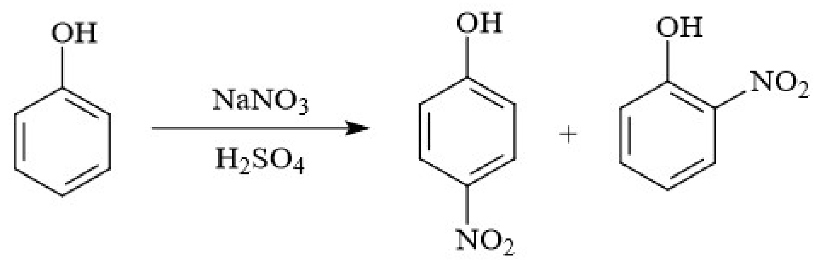
Involves the use of highly poisonous sodium cyanide

Alternate Green Procedure:



ELECTROPHILIC AROMATIC SUBSTITUTION REACTION -I
(Nitration of phenol)

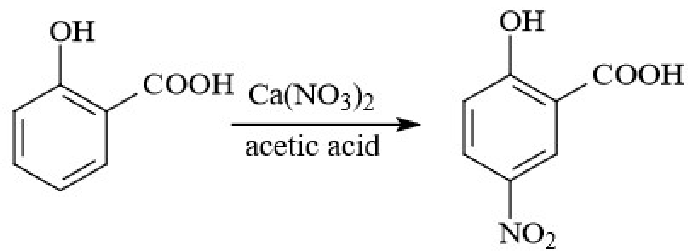
Conventional Procedure:



Non-green Component:

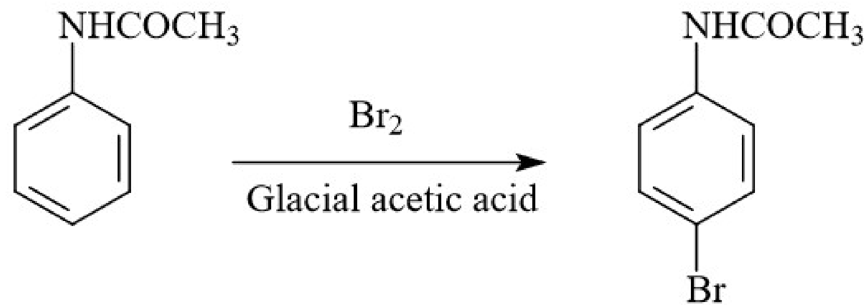
Involves use of Con. Sulfuric acid

Alternative Green Procedure:



ELECTROPHILIC AROMATIC SUBSTITUTION REACTION -II
(Bromination of acetanilide)

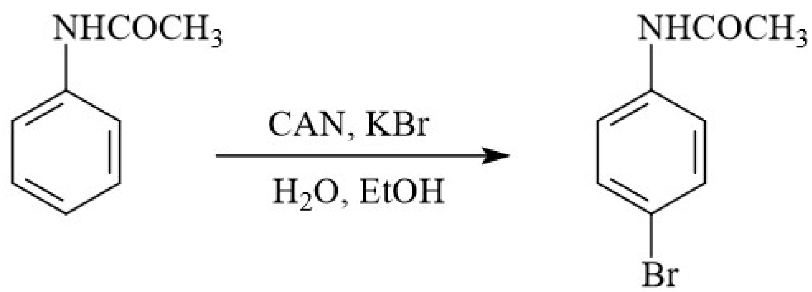
Conventional Procedure:



Non-green Component:

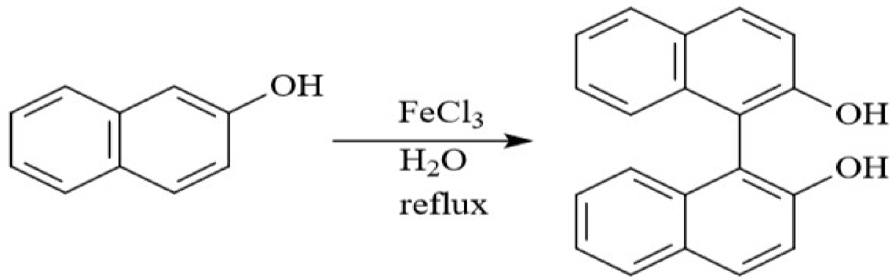
Liquid molecular bromine is used

Alternative Green Procedure:



RADICAL COUPLING REACTION
(Preparation of 1, 1-bis-2-naphthol)

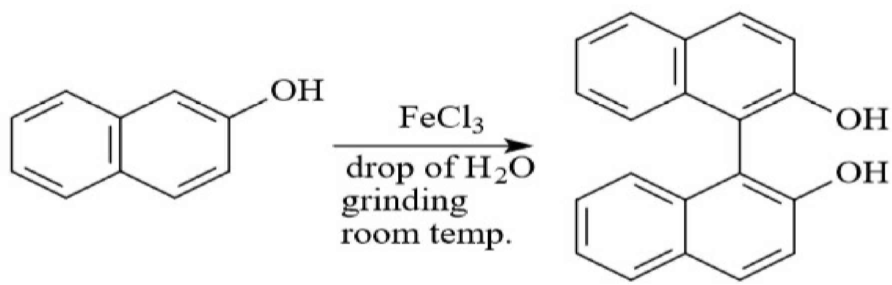
Conventional Procedure:



Non-green Component:

Use of more energy (reflux)

Green Procedure:



Preparation of Manganese(III) acetylacetonate, $Mn(acac)_3$ or $Mn(C_5H_7O_2)_3$

Conventional Procedure:

$$Mn^{2+} + KMnO_4 + C_5H_8O_7(acacH) \xrightarrow[\text{A large amount of sodium acetate}]{P^H\ ca.5} Mn(acac)_3 \text{ or } Mn(C_5H_7O_2)_3$$

Non-green Component:

- Use of an excess of acetylacetone
- Use of large amount of sodium acetate as buffer

Green Procedure:

$$KMnO_4 + 8C_5H_8O_2 \rightarrow Mn(C_5H_7O_2)_3 + 2[(CH_3CO)_2CH]_2 + 4H_2O + KC_5H_7O_2$$

Preparation of Iron(III) acetylacetonate, Fe(acac) $_3$ or Fe $(C_5H_7O_2)_3$

Conventional Procedure:

$$FeCl_3 + C_5H_8O_7(acacH) \xrightarrow[\text{of sodium acetate}]{\text{A large amount}} Fe(acac)_3 \text{ or } Fe\ (C_5H_7O_2)_3$$

Non-green Component:

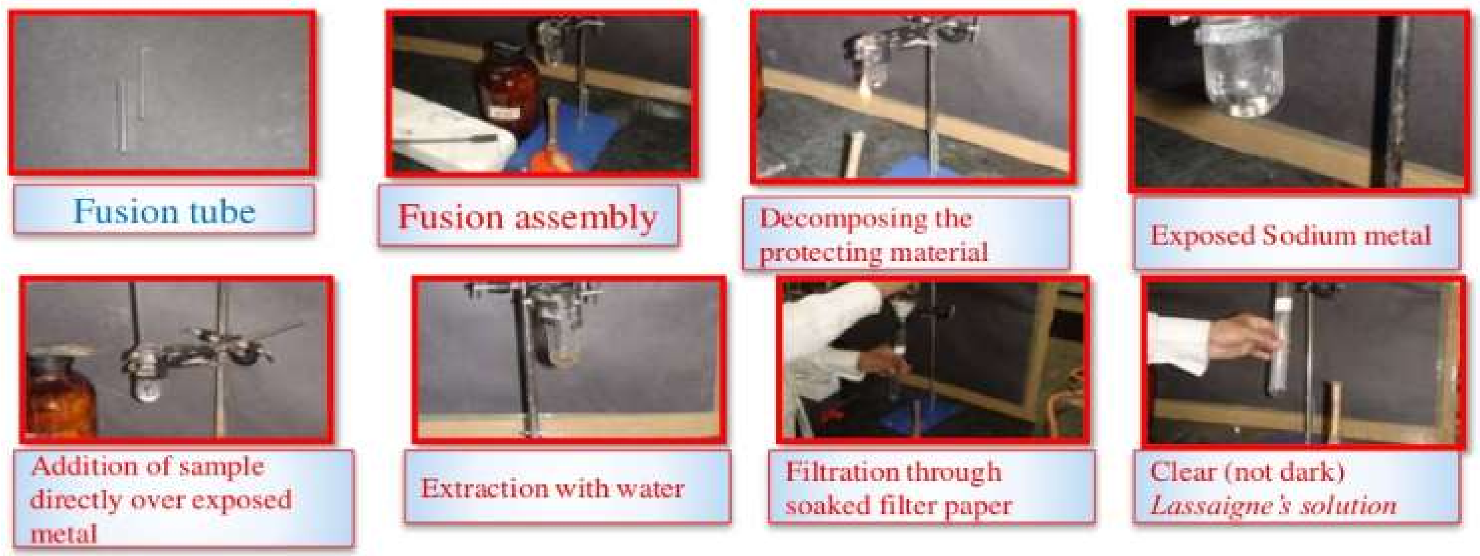
- Use of a large excess of sodium acetate as buffer
- Use of an excess of acetylacetone

Green Procedure:

$$Fe(OH)_3 + 3C_5H_8O_2 \rightarrow Fe(C_5H_7O_2)_3 + 3H_2O$$

Organic Compound Analysis
Preparation of L.E.

Preparation of Lassaigne's Solution



Inorganic Qualitative Analysis

Acid Radicals

Carbonate, Nitrite, Sulphide, Chloride, Bromide, Iodide, Acetate, Oxalate, Nitrate, Sulphate, Phosphate, Borate ions

Basic Radicals

Ammonium, Lead(II), Silver(I), Copper(II), Arsenic(III), Bismuth(III), Antimony(II), Iron(II), Iron(III), Aluminium(III), Chromium(III), Zinc(II) Nickel(II), Manganese(II), Cobalt(II), Calcium(II), Strontium(II), Barium(II), Sodium(I), Potassium(I), Magnesium(II) ions

Let us find a green solution
for every non green problem.


Thank you