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GreenApproach–SolventfreeSynthesisandItsAdvantage

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ABSTRACT
Issues inthepastdecade demonstrateseveralmethodologies that protecthuman health and theenvironment in an economically beneficial manner that is green chemistry. The introduction of green chemistry is often consideredaresponse tothe needtoreduce environmental damage causedby manufacturedmaterials and their production processes. In this study, our main attention is drawn to theuseof green chemistry concepts in daily life, work, laboratory and education. A brief introduction and prospects for green chemistry are also presented. Green chemistry is a new approach to the synthesis, processing and usage of chemicals, thereby reducing harm to humanhealth and environmental pollution.Anastas has preparedtwelve importantpoints ofgreenchemistry that can help prevent environmental pollution and ensure environmental friendliness. During laboratory studies,turning offfumehoods whennotinuse, conductingmicro-experiments toreducewaste, etc. In this review Some of the important green tools used in medicine and drug synthesis are described such as microwave-assistedsynthesis, organic synthesis inadry environment, useof computer-aided drug design, ionic liquid and water mediated reactions, use of green catalysts, etc.
Keywords:Greenchemistry,Eco-friendly,Microwavesynthesis,GreenSolvents.

I. INTRODUCTION

The term "green chemistry" was first introduced by Anastas in 1991 as a specific guideline created by the U.S. EnvironmentalProtection Agency(EPA)topromotethedevelopmentof chemistry andchemicaltechnology.[1,2]Green chemistry includes new methods for synthesizing, processing and using chemicals that will minimize harm to human healthand environmental pollution. [3] Green chemistry can be an important tool in promoting new technologies that reduce or eliminate the use or production of hazardous substancesinthedesign,manufactureanduseofchemicalproducts.[4]Advances inscienceandtechnologyinthe secondhalf of the twentieth century ledtoeconomicgrowth andimprovements in infrastructure in the world.[5]Many forward- thinking companies areadopting green practices not only to protectthe environment andcreate good public relations, but also because they are often beneficial to the bottom line. Based on available data, it is estimated thattheUSeconomyspendsbetween$100and$150billionannually tocomply withenvironmental regulations. The greatest success of green chemistry is in the petrochemical and pharmaceutical industries. However, theseindustries areoftenaccusedof polluting theenvironment.Thechallenge forthepharmaceutical industry today is to continue to deliver the applications and health benefits available through green chemistry in an environmentally friendly manner.

II. PRINCIPLESOFGREENCHEMISTRY

Therearetwelveprinciplescontributingthegreenchemistry.Theseareelaboratedasfollows:

1. Prevention:Itisbettertopreventwastethantotreatorcleanupwasteafterithasbeencreated.
2. Atom Economy: Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. Less Hazardous Chemical Syntheses: Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. Designing Safer Chemicals: Chemical products should be designed to affect their desired function while minimizing their toxicity.
5. Safer Solvents and Auxiliaries: The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
6. Design for Energy Efficiency: Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should beminimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
7. Use of Renewable Feed stocks: A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
8. Reduce Derivatives: Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
9. Catalysis:Catalyticreagents(asselectiveaspossible)aresuperiortostoichiometricreagents.
10. Design for Degradation: Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
11. Real-time analysis for Pollution Prevention: 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. Inherently Safer Chemistry for Accident Prevention: Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Greenchemistryapproachplaysavitalrolein:

- Pollution prevention can be improved operational practices by lowering energy consumption and improving yields.
- Development of greener processes to manufacture unchanged chemical products by avoiding the use of chlorinated compounds or solvents if chlorine is not in the final product.
- Useofalternativechemicalsforthesameapplication.
- Avoidance of chemicals and also use of chemistry for improved environmental performanceby designing chemical sensors for better observation of environmental quality. Less hazardous chemical syntheses/inherently safer chemistry for accident prevention

The main goal of green chemistry is to make the environment safe not only for the peoples but also for production or laboratory workers through the use of safe materials and processes. Synthetic methods should be prepared and designed to ensure that the usage and production of chemicals are as non-toxic to human health and the environment as possible. The chemicals used in the chemical process must be carefully selected to reduce therisk of chemical injury/explosion and fire. Doctor's usepoisons all the time becausethesesubstances form kinetically and thermodynamically favorable substances. It's easy to not worry about all the other "stuff" that goes into theglass andfocus allour energy onthesynthetic methodthat deliversthedesired product.Toxic products will continue to increase unless newdrugs and new synthetic methods are developed. Chemists must expand their horizons and try to use especially environmentally benign and less lethal materials for chemical reactions. Otherwise we need toto pay for the damage caused to the environment.

Greenchemistryhasmanyadvantageslike

1) Nontoxic
2) EnvironmentFriendly
3) Simple
4) Sustainable
5) Economical
6) Safe
7) AvoidWaste

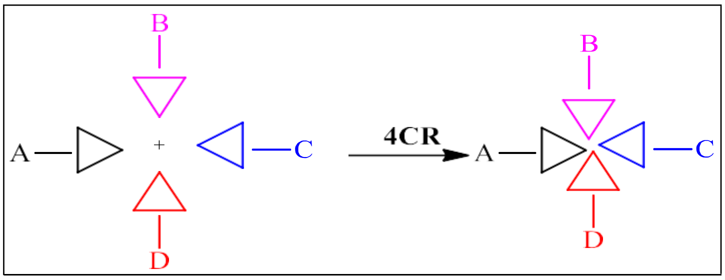
ResearchMethodology:Thepresentstudiesespeciallyinvolvetheapplicationofthefollowingtoolsof GreenChemistry:

- ❖ Reactions:(i)Multi-componentreactions
  (ii)Onepotreaction
- ❖ Catalysis:(i)Biocatalysis
  (ii)Synergisticcatalysis
- ❖ Useofenvironmentallybenignsolvents:Ionicliquids
- ❖ Energyconservation:Useofmicrowaveirradiationasaenergysource
- ❖ Chemicalfeedstocks:Useofreadilyavailableorrenewablestartingmaterials

Green synthesis of organic Compound by using different techniques

1) Multi-ComponentReactions(MCR's)

Multicomponentreactions(MCRs)areconvergentreactions,wherethreeormorestartingmaterialsreacttoform a product and generally all or most of the atoms contribute to the newly formed product (Scheme 1).



Scheme1

MCR strategies provide significant advantages over conventional syntheses in terms of diversity, speed and efficiency[6]Themajorchallenge istoconductMCR in suchaway thatthenetworkofpre-equilibratedreactions channel into the main product without generation of side products. The outcome of MCR reactions are clearly dependent on the reaction conditions: temperature, solvent, concentration, catalyst, functional groups and the kind of starting materials. MCRs have greatcontribution in the synthesis of complex organic molecules starting from simple and readily available starting materials, paticularly heterocyclic scaffolds can be used for the creation of diverse chemical libraries of "drug-like" molecules for biological screening.

2) One-potreactions:

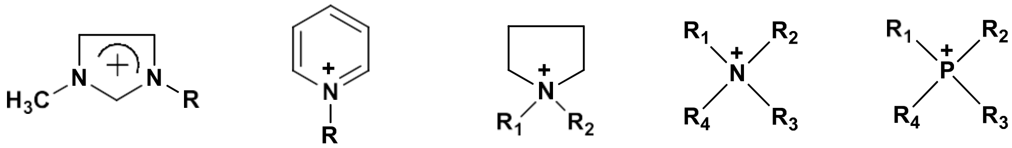
It is generally said that chemists tend to clean up the organic synthesis utilizing one pot reactions. During one-pot synthesis all the reactants are subjected to successive chemical reactions in just one reactor. Organic synthesis involving the manufacturing of drugs and agrochemicals till date utilizes multi step synthesis. Some sophisticated multi-step reactions may require weeks to complete. And henceforth, it becomes an environmentally non-benign which besides generating the desired productproduces tons of toxic waste. This is partially because each step requires different conditions of temperature, pressure, catalyst and solvent. And before nextstep, eachsteprequires workup generating waste.But due toenvironmentalconcerns, thechemical industry are forced to look for cleaner methods

3) GreenSolventinOrganicsynthesis:

Green Solvents are easily biodegradable, having high boiling point, low miscibility in water and less or no toxicity. Here,wedescribedthe ionic liquid as greenand environmentally benignsovents and their importance. Ionic Liquiḍ- Solvents areauxiliary materials that are used during chemicalsynthesis to facilitate mass transfer. However, the excessive use of offensive organic solvents like toluene, dichloromethane, benzene and chloroform etc for various organic reactions is a major concern in today's chemical processing industries due to their harmful impact on environment and human health. Due to above concern there is an urgent need to minimizethe usage of organicsolvents during achemicalsynthesis or tofind an alternatefor halogenated toxic solvents which is one of the key concern of green chemistry. Some of the strategies include reactions on solid support, use of supercritical fluids or water as solvents etc. Recently, ionic liquid (IL) have attracted much attention [Anastas and Warner (1998) [7]

ILs generally refers to those salts, which have melting points below 100°C. "Room temperature ionic liquids" (RTILs) are the salts that melt at room temperature. This distinction of IL based on temperature does not have any physical or chemical significance and is just an indicator to differentiate the ILs from high-temperature molten salts. Generally, ILs consists of relatively large organic cation such as imidazolium based or pyridinium based cation, whereas anion can be organic as well as inorganic such as Br^-, Cl^-, PF_6^-, BF_4^-, NO_3^-, $[AcO]^-$, $[CF_3CO_2]^-$, $[N(CF_3SO_2)_2]^-$, $[CF_3SO_3]^-$ and $[SCN]^-$ etc Some of the commonly used cations and anions used for the synthesis of ILs are depicted in Figure 13.

Some common cations:



1-alkyl-3-methyl-imidazolium	1-alkyl-pyridinium	1,1-dialkyl-pyrrolidinium	tetraalkyl-ammonium	tetraalkyl-phosphonium
$[C_n mim]^+$	$[C_n Py]^+$	$[C_m C_n pyr]^+$	[Nijkl]+	[Pijkl]+

Where, n = number of carbon atoms in the linear alkyl chain
indicies i, j, k and l indicate the length of the corresponding linear alkyl chains

Some common anions:

Water-immiscible ⟶ Water-miscible

PF_6^-	BF_4^-	[CH3COO]-, [CF3COO]-
$[(CF_3SO_2)_2N]^-$	$[CF_3SO_3]^-$	Br-, Cl-, I-, $[NO_3]^-$, $[Al_2Cl_7]^-$

Figure13Examplesofcommonlyusedcationsandanionsofionicliquids

4) Energyconservation:

Traditionally, in most commonly used heating sources such as oil bath, heating mantle, Bunsen burner, heater or electric plate heater, the transfer of heat energy into the reaction system depends on convection currents beside thermal conductivity of various materials of the reaction pot. Consequently, the temperature of the reactionvesselis always higherthanthatof thereactionmixturewhichinturncanleadtothedecompositionof reactants, reagent or product due to development of temperature gradient. In the above context, microwave irradiation (MW) as a non conventional energy source has become very popular and useful technology in organic synthesis [Lidstrom et al[8]

5) Microwave(MW):

Microwaves are electromagnetic radiations which fall in the frequency range from 300 Hz to 30 GHz that corresponds to the wavelengths of 1m to 1cm. In order, to avoid the interference with radar and telecommunications, most of the MW appliances operate at fixed frequency of 2450 MHz. In contrast to traditional heating sources, MW irradiation couple directly with the component of reaction mixture[9]

TheoryofMicrowave:

HeatenergyofMWistransferredtothereactionmixturebythefollowing twomechanisms

(i)Dipolarpolarization(ii)Ionicconduction

(i) Dipolarpolarization:

In the dipolar polarization mechanism, electric field component of MW interacts with polar molecules of reaction mixture.

When a molecule possessing dipole moment is irradiated with MW it tends to align itself with the field by rotation (Figure 15). However, the frequency of therotating dipole is not high enough to accurately follow the alternating electric field of MW. So as the dipole re-orients to align itself with the electric field, the field is already changing and generates a phase difference between the dipole and the orientation of the field which generates excess of friction which leads to intense internal heating.

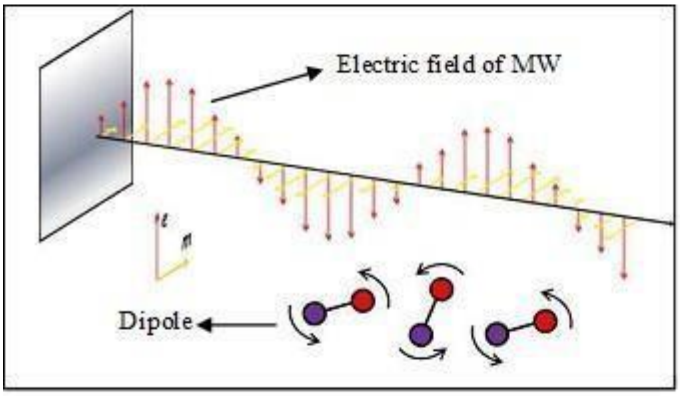


Figure 15. Interaction of the electric field of MW with dipole moment [Gagnon (2008)]

(ii) Ionicconduction:

According to the ionic conduction mechanism, the charged particles of the sample (usually ions) oscillate back and forth under the influence of electric component of MW irradiation and subsequently collide with their neighbouring molecules or atoms and resulting into agitation or motion, creating heat. The ionic conduction principle is a much stronger effect than the dipolar rotation mechanism with regard to the heat-generating capacity. That's why themedia containing ions are heated more efficiently by MW than just polar solvents.

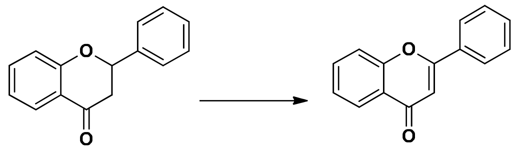
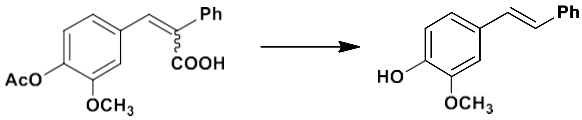
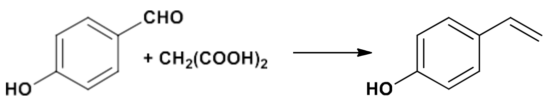
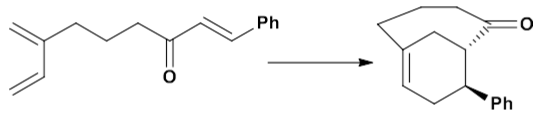
SinceMW energy is imparteddirectly tothereaction medium rather than throughthewall of reaction vessel,it is an efficient energy source compared with conventional steam wherein heating the entire furnace oroil bath consumes lot of time and energy.

Microwave-assistedorganicsynthesis[MAOS]:

MAOS is considered as an important approach towards green chemistry. The MAOS technique has been accepted to reduce the reaction time besides increasing yield of product compared to conventional synthesis since its first report in 1986. Additionally, MW heating in a pressurized system rapidly increases the reaction temperaturefar above the boiling point of thesolvent and leads to auniform energy transfer to thereactants ofthe chemical reaction.

Some of the examples of microwave-assisted organic reactions and their comparison withconventionalmethods are given in Table 1.

Table1Someexamplesofmicrowave-assistedreactionsandtheircomparisonwithconventionalconditions

Reaction	Activation mode	Time	Yield	Reference
	Conventional	16 h	61%	Zhou et al. (2006a)
	MW	10 min	88%	
	Conventional	5 min	27%	Martin-Aranda et al. (1997)
	MW	5 min	75 %	
	Conventional	16 h	62%	Kumar et al. (2007b)
	MW	20 min	87%	
	Conventional	6 h	12%	Sinha et al. (2007b)
	MW	5 min	61%	
	Conventional	10h	0%	Cleary et al. (2011)
	MW	1 h	73%	

Recent trends in microwave assisted organic synthesis (MAOS) are the use of environmentally benign ILs in conjunctionwithMW. Thiscombination has beengaining momentum as ionic liquids being salts (feature polar and ionic character) interact more efficiently with MW irradiation through both polarization and ionic conduction energy transfer mechanisms. Thus, ILs are considered as an ideal solvents for MAOS..

6) SonicationinOrganicSynthesis:

It brings out the chemical reaction by using sound energy. The ultrasound frequencies for chemical reaction ranges between 20 – 100 KHz. It accelerate the chemical reaction by acoustic cavitation phenomenon. It increases the reactivity of catalyst and reagent. Most of the chemical reaction done by sonication are at room temperatureinsteadof conventionalheating andtime requiredundersonication tocompletethereaction isvery low as compared to classical processes. It is non-classical form of energy andeco-environmental technology in green synthesis.

7) GreenCatalysisinOrganicSynthesis:

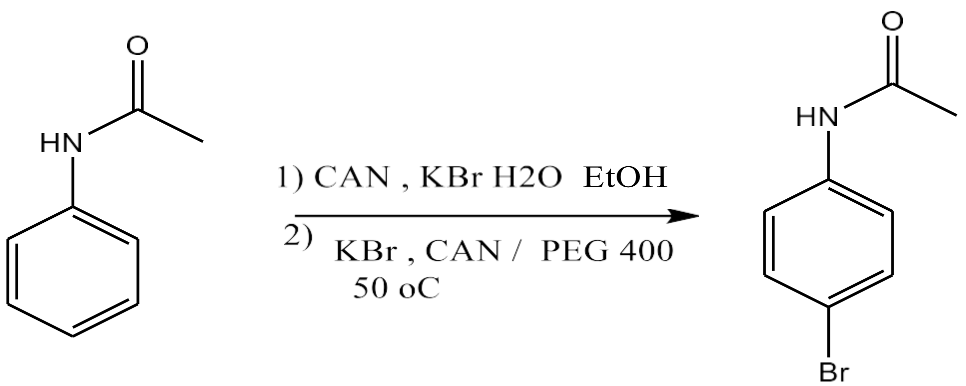
Use of catalyst in organic synthesis is a important part of green synthesis. Catalyst accelerates the reaction and lower the energy required to complete the reaction. Use of catalyst avoids the use of reagent in stoichiometric quantity. Green catalyst has high catalytic efficiency, environment friendly nature, such catalysts are Zeolites, Clays and biodegradable acids which may replaces the hazardous catalyst which are in use. Enzyme catalysis is example of homogenous green catalysis.

III. LITERATUREREVIEW

We, mention some of the reactions where toxic reagents have been replaced by environmentally friendly/safe reagents.

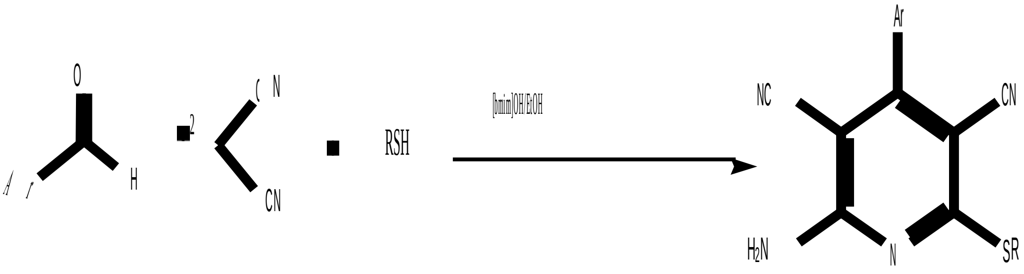
Brominationofacetanilideusingcericammoniumnitrateandpotassiumbromide

Traditional bromination processes involve theuseofcorrosivebromine, achemicalthat cancauseseverebums. Its usecreateserious problems inhandling and disposal, especially in large andcommercialsectors whereit has been replaced by new bromination chemicals (ceric ammonium nitrate and potassium bromide).[10]It also has the following advantages: greatersolubility in water, lower cost, environmental protection, easyhandling, high reactivity and easy finishing. Additionally, bromination is done in green media.

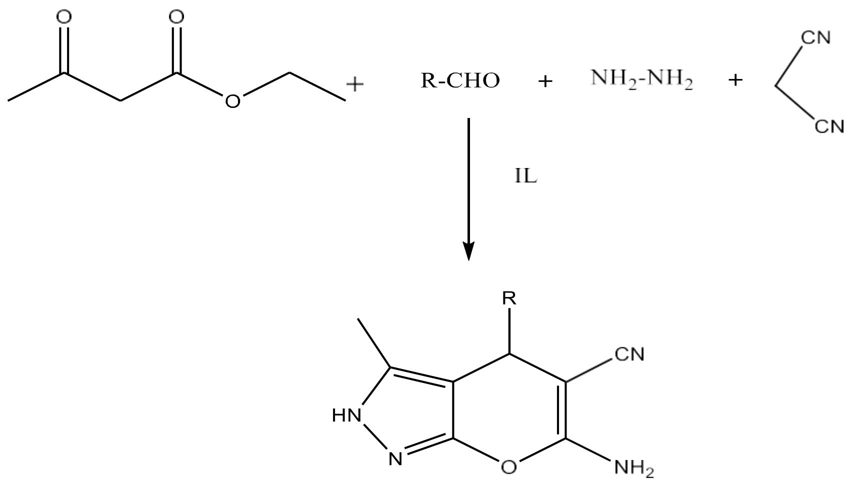


A rapid, environmentally friendly and regioselective bromination method for aromatics was developed, where ceric ammonium nitrate (CAN) was used as Lewis acid catalyst to produce Br + insitu from potassium bromide (KBr) in PEG-400 (polyethylene glycol) and the product was obtained at excellent yields without further purification.

A literature review shows that a number of heterocyclic compounds with a fused ring system have different types of physiological activities. Condensed triazolopyrimidines and N-benzylidene derivatives exhibit antifungal, anti-inflammatory, antibacterial, herbicides and anticancer effects. Recently, B. C. Ranu et al.[11] reported animproved andgreenprotocol for thesynthesis of highlysubstitutedpyridines viathe one-potthree-component condensation of aromatic aldehydes, malononitrile, and thiophenols using the basic ionic liquid [Bmim]OH at room temperature. This reaction does not involve any hazardous organic solvent and the toxic catalyst and ionic liquid are recovered and recycled for subsequent reactions.



S.M.Deshmukhetal.[12] Ionicliquidcatalyzedonepotsynthesis ofpyranpyrazolesfromhydrazine hydrate,ethyl acetoacetate and malano nitrile.



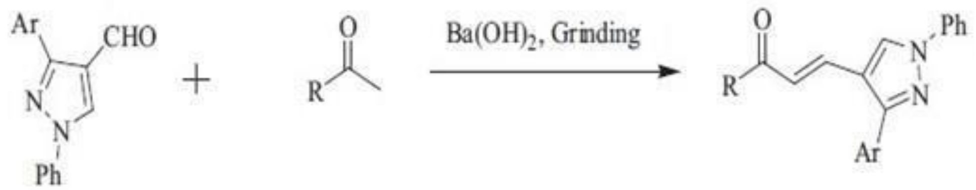
SynthesisofPyrazolescompoundsbygreenApproach

3Solventfreemethod:

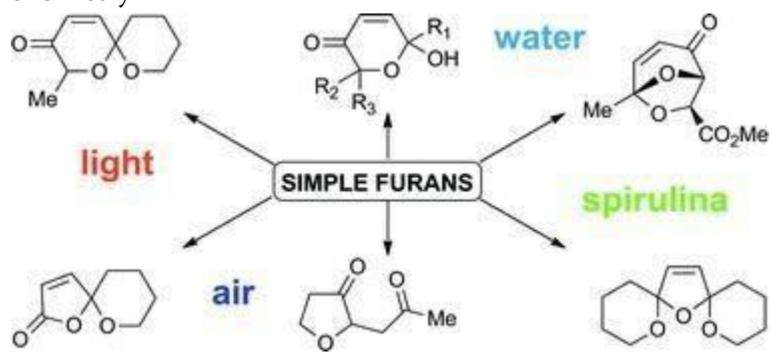
We described a few reports where no use of solvents for synthesis of compounds Generally, chalcones can be synthesized by Claisen Schmidt condensation between ketones & aryl halides using catalysts like alkali metal hydroxide or sodium ethoxide. It has disadvantages include use of harmful organic solvents & difficultextraction process.

Solventfreemethod

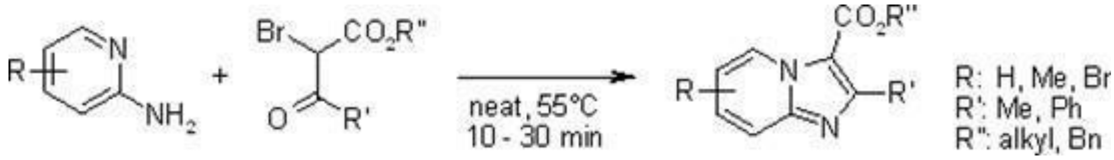
This process involves the grinding of a mixture of pyrazole aldehydes, acetophenones & activated barium hydroxide(C-200) in a mortar & pestle for 5-10minsin the absence of any solvent. It was proposed by P.Kumar et al. the advantages are less reaction time, high yield, reaction is carried out at room temperature & mild reaction conditions[13]



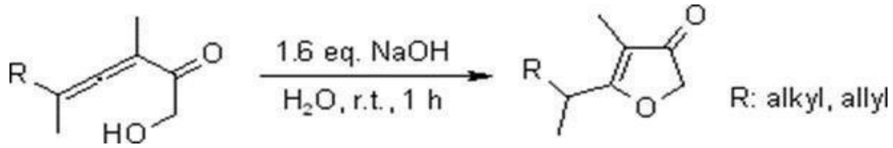
A greener way of utilizing air,sunlight, water andspirulinato transformreadily available furanderivatives into awiderange ofsyntheticallyuseful polyoxygenatedcompoundswhicharecommonly foundinnaturalproducts is now possible with green chemistry[14].



Temperature Controlled microwave heating of aminopyridines and α-bromo-β-keto esters has been usedforthe synthesis of highly substitutedimidazo[1,2-a]pyridines under solvent-free conditions. This method gives the highest yields of products inreaction times of less than two minutes comparedto thetraditional way of heating i.e.thermal heating[15].



A simple, cost efficient and effective method of synthesis of 3(2H)-furanones by cycloisomerization of allenic hydroxyketones has been carried out in water. This method eliminates the use of any expensive metal catalyst[16].

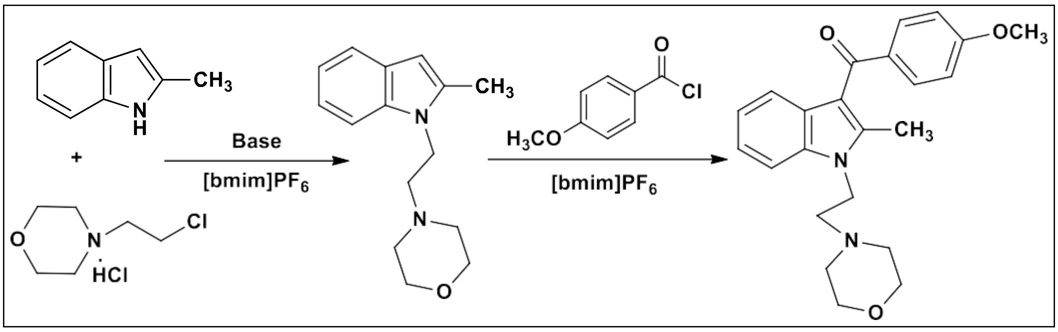


Applicationofionicliquids:

In synthetic organic chemistry, ILs have successfully been explored for various reactions such as Diels-Alder, Knoevenagel, Mannich, Aldol condensation, Heck, Friedal-Craft reaction etc besides their applications in synthesis of pharmaceutical intermediates

Forexample,

Earle et al.[17] synthesized Pravadoline, NSAID in ionic liquid [bmim]PF_6 without employing any Lewis acid (Scheme 25). The use of IL not only not only eliminated the waste disposal problems associated with conventional Friedal-Craft reaction but can also be recycled.



Scheme25

In 2002, the first successful example of an industrial process utilizing IL technology, was theBASIL™ (Biphasic Acid Scavenging utilising Ionic Liquids) process [18]. The use of IL in BASIL process increased the yield of their alkoxyphenylphosphine(photoinitiator precursor)by afactor of 80000comparedwiththeconventionalprocess Although, the research in the field of IL is expanding day by day, however there are certain restrictions pertaining to the use of ILs which needs to be resolved.

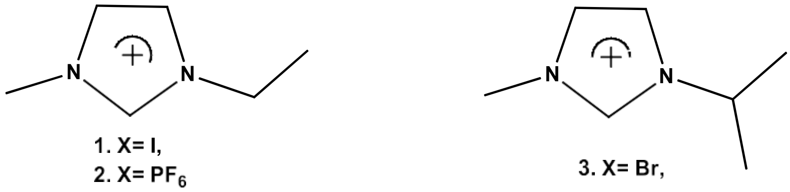
Applicationofionicliquidsinmicrowaveassistedorganicsynthesis:

Many reports on the use of ILs as solvents, heating aid, co-solvents, additives and catalysts in MAOS has beenfurnished in literature. Some of the selected applications of ILs inMAOS are described below:

Ionicliquidsasheatingaidundermicrowave:

Leadbeater et al. investigated the role of ILs during MW heating of non polar solvents such as hexane, THF, toluene and dioxane etc [19] and found that such non polar solvents can be heated far above their boiling points with the help of small amount of an IL. Some of theinvestigated ILs in the study along with comparison of the attained temperature in the presence or absence of these ILs is depicted in Table 2.

Table2:



1. X= I,
2. X= PF_6

3. X= Br,

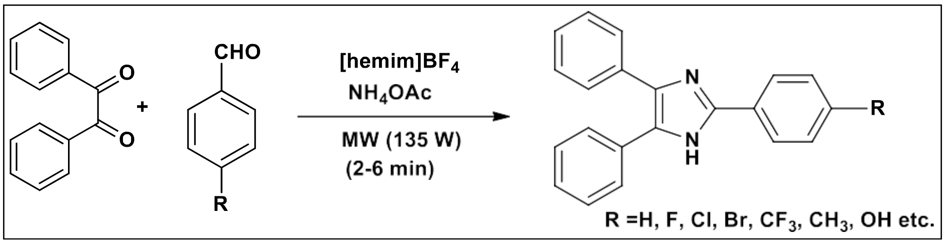
Solvent	L added		IL		iling point (°C)
Hexane	1	217	10	46	69
	2	279	20		
	3	228	15		
Toluene	1	195	150	109	111
	2	280	60		
	3	234	130		
THF	1	268	70	112	66
	2	231	60		
	3	242	60		
Dioxane	1	264	90	76	101
	2	149	100		
	3	246	90		

1.3.5.1.3.2Ionicliquidsasbenignreactionmediumundermicrowave:

Someof theorganicreactionswhereinILs havebeenusedasreactionmediaarediscussedbelow:

1.3.5.1.3.2.1 For synthesis of 2,4,5-trisubstituted imidazole derivatives:

Xia et al.[20] employed neutral ionic liquid, 1-methyl-3-heptylimidazolium tetrafluoroborate ([hemim]BF_4) underMWtocarryoutathreecomponentsynthesisof2,4,5-trisubstitutedimidazolederivatives(Scheme 27) .The reaction completed within 2-6 min of MW irradiation whereas conventional heating (oilbath) required 2 h for its completion besides the low yield product.



Scheme27

Applicationsofionicliquidsandmicrowavecombinationforsomeoftheorganicnamereactions:

The application of synergism of IL-MW technology for various namereactions is summarised inTable 4[Palou (2010)].

Table4.Applicationsofionicliquidsandmicrowaveforsomeselectedorganicreactions

S.No.	Name of the reaction	Catalyst/IL-MW conditions	Reference
1	Diels-Alder cycloaddition	Organotungsten catalyst/[bmim]PF_6 Mineral supports/[hmim]BF_4	Chen *et al*. (2004) López *et al*. (2007)
2	Fisher esterification	[bmim]HSO_4	Arfan and Bazureau (2005)
3	Mannich condensation	CuCl/[*i*-ProMIM]PF_6	Leadbeater *et al*. (2003)
4	Knoevenagel condensation	[bmim]BF_4	Ma *et al*. (2006)
5	Biginelli	[bmim]HSO_4	Arfan *et al*. (2007)
6	Tsuji–Trost	$Pd(OAc)_2$/[emim]BF_4/H_2O	Liao *et al*. (2005)
7	Friedel–Craft (acylation)	Bis{(trifluoromethyl)sulfonyl}amine ($HNTf_2$) or BF_3-Et_2O/[bmim]BF_4	Hakala and Wahala (2006)
8	Pechmann	[bmim]HSO_4	Singh *et al*. (2005)
9	Beckmann Rearrangement	In(OTf)/[bdmim]PF_6	Sugamoto *et al*. (2011)
10	Morita–Baylis–Hillman	H_2O/DABCO/[bmim]PF_6	de Souza *et al*. (2008)
11	Heck coupling	Pd/C/[omim]BF_4	Xie *et al*. (2004)
12	Pictet–Spengler	[bmim]Cl–$AlCl_3$	Srinivasan and Ganesan (2003)

Microwaveheatingcanhavecertainbenefitsoverconventionalheating:

- Drasticreductioninreactiontimesi.e.accelerationinrateofreaction
- Improvedchemicalyields
- Higherenergyefficiency
- Possibilityofsolventlessreactions
- Operationalsimplicity
- differentreactionselectivities

Most ionic liquids are salts of organic cations with high temperatures above 100o C, chemical and thermal stability, inflammability and electrochemical ability. In general, ionic liquids act as organic solvents and catalysts. In this chemical process, not only desired products are produced, but also many undesirable and negative products in the form of solids, liquids and gases. They have become the most difficult thing that chemistry hasto face. So we need to learn the problem and reduce the amount of chemicals.We have done alot of work in this direction in the last decade. The aim is to develop drugs and chemical processes that are less harmful to human health and the environment. Chemists, scientists, and pharmaceutical companies should consider the principles of green chemistrywhen designing reaction mechanismsand selecting catalysts. With the use of green chemistry, we can reduce waste, reduce chemical use, control the atomic industry and protect the environment,which isourfuture. Thisresearchfocuseson the synthesisofheterocycliccompoundsin ionic liquidsand thecharacterization and evaluation of the biologicalactivities oftheseheterocyclic derivatives.

IV. CONCLUSION

Green chemistry principles has gained much popularity. It is one of the best techniques in green chemistry by which many important compounds can be synthesized in an efficient & environment friendly manner.In that Solvent free synthesis, MW-assisted,ionic liquidcatalysed reactions,water mediated reactions plays a vital over the classical method of synthesis. Some of the important advantages are as follows -

1. Preventionofwaste/by-products.
2. Designingofsaferreactions.
3. Maximumincorporationofthereactant(startingmaterial&reagents)intothefinalproducts.
4. Preventionorminimizationofhazardousproducts.
5. Productsobtainedaremostlybiodegradable.
6. Energyrequirementforsuchsynthesisisminimum.
7. Preventionofharshreactionconditions.
8. Highyieldsofproducts.
9. Shorterreactiontime.
10. Highselectivityinmanyofthereactions.
11. Preventionoftheuseofharmfulsolvents.
12. Easyextractionprocess.

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TYPESOFBLOCKCHAIN

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Abstract

Blockchaintechnologymostusefultechnology.Blockchainhasrecentlygainedalotofpopularity,which hasled to a high demandfor the adaptation of this technology.A Blockchainis a decentralized database that is shared among computer networknodes. Transactional data fromnumerous sources may bereadilycollected,integrated,andsharedusingblockchaincloudservices. Dataisdividedintocommon blockslinkedtogetherusingcryptographichashesasuniqueIDs.Itmakestransactionsmucheasier.Mostimportant itremovestheroleofathirdPersonmakingtransactionsdirectlybetweenthesenderand receiver.IthasfourdifferenttypesofblockchainPublicBlockchain,PrivateBlockchain,consortium blockchain,andhybridblockchain.Itiseasierthanbankingtransactions.ItEstablishestrustamongparties doingbusinesstogetherbyofferingreliable,shareddata.Itenablesseamlesstrackingandtracingofgoods and services across the supply chain. Blockchain technology solves the drawbacks of centralization, but initself,itbringsalotofotherproblemstosolvewhenitcomestoapplyingblockchaintechnologyto different scenarios.

Keywords:-Blockchaintechnology,DigitalLedger,Transaction,DAPP,BusinessArea.

Objective:

Introduction

The David chaum was first proposed a blockchain-like protocol in his 1982 dissertation “Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups”. Further work on a cryptographically secured chain of blocks was described in 1991 by Stuart Haber andW.ScottStornetta Blockchain is decentralized network. Isdefined as a ledgerofdecentralized storedata securelyand shared. Blockchain technology enables a collective group of select participants to share data. With blockchain cloud services, transactional data from multiple sources can be easily collected, integrated, and shared. Data is broken up into shared blocks that are chained together with unique identifiers in the formofcryptographichashes.Blockchainprovidesdataintegritywithasinglesourceoftruth,eliminating data duplication and increasing security.Blochchain having four types Public, Private, consortium andHybrid. In blockchain for transaction use different currencies like bitcoin, litecoin, Ether. The bitcoin is most of the use for transaction. These are largest currency in blockchain worlds. The bitcoin is use in public blockchain. The blockchain is use in business area there will be produce digitalorganization

The currency used in blockchain for transaction but in Ehereum have the ether currency there will also producesdifferentsmartcontractusingsoliditylanguagealsowecanproducetheApplication.Blockchain is secure

2000: In the year 2000, Stefan Konst published his theory of cryptographic secured chains, plusideasfor implementation.

Introduction

TypesofBlockchain

1. PublicBlockchain

Inpublic blockchain technology, everynode can jointhat blockchain but its mining is necessarymining is done by a miner. One of the first public blockchains that were released to the public was the bitcoin publicblockchain.Itenabledanyoneconnectedtotheinternettodotransactionsin adecentralized manner.Thistypeofblockchainservesthemainadvantageofitsuncontrollability,which denotes that nobodywill be able to completely controlthe network. As a consequence, it safeguards the data's securityand supports the information's immutability. A completelydistributed public blockchain will arise from the equal power of all nodes connecting to it.

2. PrivateBlockchain

InthePrivateBlockchain,onlylimitedblocksareinvolvedherethatarenotaccessibletoeveryone.Which is having limitedaccess.it is limitedtoonlyoneorganizationoutoftheorganizationblockthat cannotbe involved in that blockchain. These blockchains may be governed and supervised by an individual who canguaranteethat theadministratorsareguidingparticipantssincetheyare morecentralized. Depending ontheblockchainowner'schoices,thesechainsmayormaynotincludeatoken.Participantandvalidator accessis restricted. To distinguish between open blockchains and other peer-to-peer decentralized databaseapplicationsthatarenotopenad-hoccomputeclusters,theterminologyDistributedLedger (DLT) is normally used for private blockchains.

3. ConsortiumBlockchain

The Consortium Blockchain More than one organization is combined making it one blockchain that blockchain involves block only those who are combined. Only that combined organization can make transactions between them. Consortium blockchains are commonly used in industries where multiple organizations need to collaborate on a common goal, such as supply chain management or financial services. The advantage of consortium blockchains is that they can be more efficient and scalable than public blockchains, as the number of nodes required to validate transactions is typically smaller.

4. Hybridblockchain

As per the name suggested here more than one blockchain is combined. A hybrid blockchain has a combination of centralized and decentralized features the hybrid blockchain is a combination of public and private blockchain. Which has features of public and private blockchains. A blockchain network where the consensus process (mining process) is closely controlled by a preselected set ofnodes or by a preselected number ofstakeholders. Atransaction in a private network ofa hybrid blockchain is usually verified within that network.

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SMARTCONTRACTINBLOCKCHAIN

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Abstract

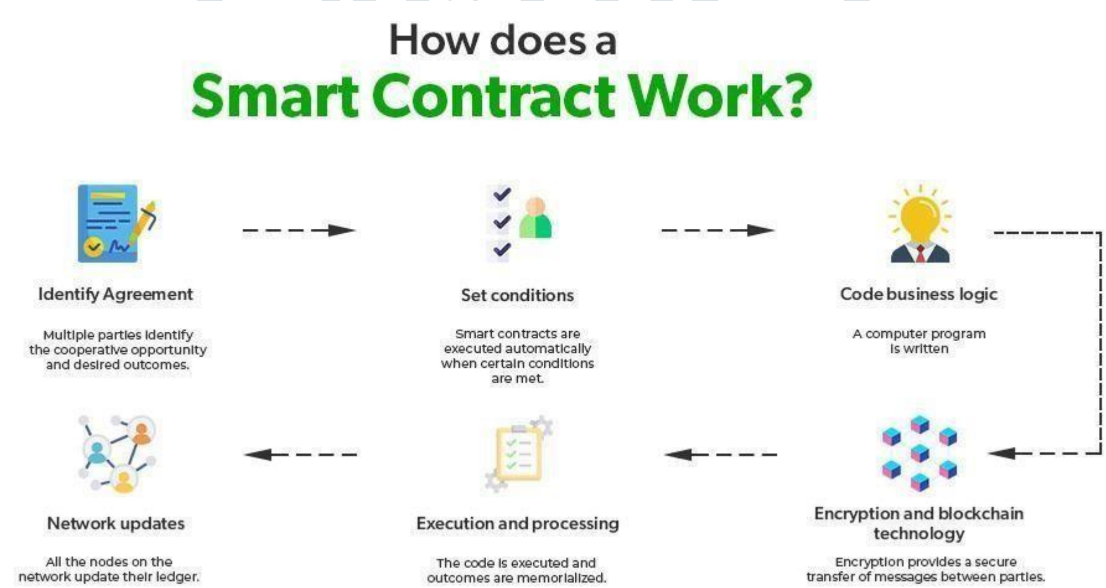
Inblockchainweusedsmartcontractfunctionality.Thecontractisnothingbutasmall agreementdonebydigitalway.Asmartcontractisaself-executingprogramthatautomatesthe actions required in an agreement or contract. Once completed, the transactions are trackable and irreversible. Thecontract is moresecurethantheagreementonpepper. This issmallcodeprogram. Contract design by node who are buy any asset on blockchain this contract is visible to all nodes. Who are agree on that contract interact that node and successfully implement that contract. This contractaredonebetweentwoparties removetheintermediater. Smartcontracts workbyfollowing simple "if/when…then…" statements that are written into code on a blockchain. A network of computers executes the actions when predetermined conditions have been met and verified.

Keywords:BusinessArea,security,highspeed,transparency.

Introduction

Smartcontractswerefirstproposedin1994byNickSzabo,anAmericancomputerscientistwhoinvented a virtual currency called "Bit Gold" in 1998, 10 years before Bitcoin was introduced. Infact,SzaboisoftenrumoredtobetherealSatoshiNakamoto,theanonymousBitcoininventor,which hehas denied.Smartcontractspermittrustedtransactionsandagreementstobecarriedoutamong disparate,anonymouspartieswithouttheneedforacentralauthority,legalsystem,orexternal enforcement mechanism. While blockchain technology has come to be thought of primarily as the foundationforBitcoin,ithasevolvedfarbeyondunderpinningavirtualcurrency.Smartcontractare immutableinnature.Itisjustagreementbetweentwopartieswithoutanyintermediater'sItexecute the smallcode programwhich is write anyprogramming language like solidity, JavaScript etc. The parties involved mustalsodecidehowthesmartcontractwillwork, includingwhatconditions must bemetforthecontracttoexecuteandwhetheritwillexecuteautomaticallycreatingasmartcontract can be simple, but it's important to note that a poorly designed smart contract is a major security risk. It's critical to fully verify the smart contract's security during this step. That last part is important. Deploying a smart contract to a blockchain is like buying an item and intentionally throwing away the receipt.There are no returns,no refunds,and no exchanges—no exceptions.A smart contract works by monitoring the blockchain or other credible information source for certain conditions or triggers. These triggers can include almost anything that can be verified digitally—a date reached, a payment completed, a monthly bill received, or any other verifiable event. Trigger conditionsmayalsobemetwhenoneormorepartiestothecontractperformaspecificaction.When the triggerconditionsaresatisfied,thesmartcontractexecutes.Asmartcontractthatexecutes automaticallymayperformoneorseveralactions,suchastransferringfundstoasellerorregistering a buyer’sownershipofanasset.Thesmartcontract’sexecutionisimmediatelybroadcasttothe blockchain.Theblockchainnetworkverifiestheactionsperformedbythesmartcontract,recordsits executionasatransaction, andstoresthecompletedsmartcontractontheblockchain. Therecordof the smart contract is generallyavailable for review byanyone at anytime.

SmartcontractProcessinBlockchain



Step1:-Insmartcontractmultiplepartiesareinvolvedcontractthepartiesareinvolvedinthereisno intermediate between them direct between two parties.

Step2:-Whowantstobuyanyassistwritesmartcontractonherblockwithhelpofprogramcode.Step3:- In that small program code just determine the Term and condition regarding this.

Step4:-executethiscodethatnotneedtobeexecuteagainexecuteonlyonce.Thatareavailableforall nodes in given blockchain.

Step5:-whoareacceptthattermandconditionsgivenincontractcontactwiththatnodeandInteractdirectly between two parties.

Step6:-Contractaredonebetweenthatnodeswithoutanyintermediater.

BENEFITSOFASMARTCONTRACT

Smartcontractsofferanumberofbenefitstothepartiesinvolved:

- **Independence:**theparticipantsmakethearrangementsthemselves,i.e.theinvolvementof intermediaries can be dispensed with.
- **Reliability:**thecontractissecurelystoredinadistributednetworkandisvirtuallyimpossibleto alter or forge.
- **Security:**beinginadistributednetwork,thecontractisduplicatedinallnodesofthenetworkand cannot be lost.
- **Savings:**bycuttingout intermediariesand commissions, thereisareductionincostsforall parties involved.
- **Accuracy:**thistypeofcontractreducestozerothepossibilityoferrorsinthetermsorprocessing.
- **Sustainability:**contractseliminatetheuseofpaperinoffices,notariesandregisters,andpollution is reduced as a result of less travel.

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