KERONE
Kerone Engineering Solutions Limited

MICROWAVE ASSISTED **SYNTHESIS CHEMISTRY**

In Association with SVCH-Technologii, Moscow (Russia)

ISO 9001:2015 | ISO 14001:2015 | ISO 45001:2018

ABOUT US

KERONE is now renowned for serving the specialized needs of customers with the best quality and economical process of Heating /cooling and drying products, manufactured in a high-quality environment by a trained and qualified workforce (special purpose machinery)

KERONE is a pioneer in application and implementation engineering with its vast experience and team of professionals.

KERONE is devoteded to serve the industry to optimize its operations both economically and environmentally with its specialized heating and drying solutions.

KERONE is having immense expertise in manufacturing and implementing various types of engineering solutions.

KERONE is possessing employee strength of more than 280+ experts continuously putting efforts for happy industrial engineering solutions.

WHY CHOOSE US

> Enhance the value of customer operation through our customer need centric engineering solution.

With decades of expertise, cutting-edge technology, and a customer-centric approach, Kerone Engineering offers tailor-made heating solutions that prioritize quality, flexibility, and cost-effectiveness. Benefit from our commitment to excellence, post-sales support, and innovative solutions for your unique heating needs. Choose Kerone Engineering for reliability, performance, and unmatched value.

MISSION

- To enhance the value of customer operation throughi our customer need centricengineefing solution
- We are cominitted to provide our customers, unique arid best in class products in Industrial heating drying and cooling segment with strategic tie-up for the technical know-how with renowned leader in the industry specific segment

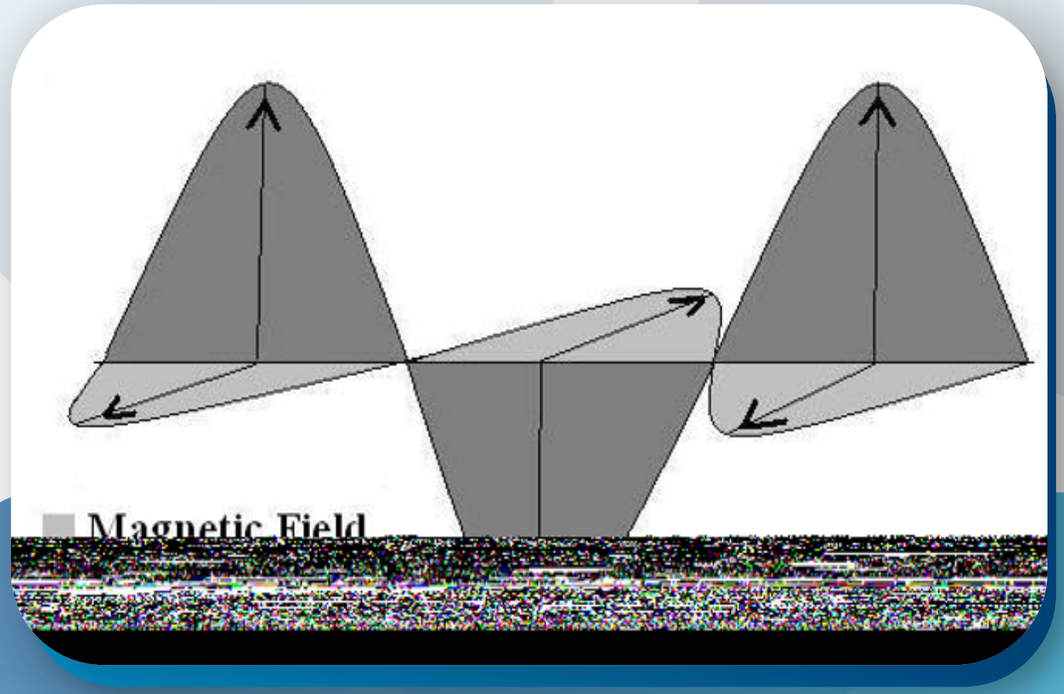
VISION

- Turn into a world leader in providing specialized, top-notch quality and ecological industrial heating, cooling, and drying solutions across the globe.
- To attain global recognition as the best of quality and environment-friendly engineering solution company.

Introduction

Application of microwaves in chemical transformation was published for first time in 1986. Now the MW assisted synthesis has emerged as new green tool in synthesis of organic compounds. As the knowledge and understanding is increasing, new applications are exploring in other fields of chemical science. This presentation is focused upon the understanding of basic mechanisms of MW heating and their utility in chemistry. It also focuses on environmentally benign aspects of microwave heating including our need and responsibility.

Microwaves are electromagnetic waves range from 1 cm to 1 m i.e. 30 GHz to 0.3 GHz.



Energy Comparison

Ionic bond ~ 7.6 eV

Covalent [C-H] ~ 4.28 eV

Hydrogen bond ~ 0.04 – 0.44 eV

Brownian motion ~ 1.7 x 10-2 eV

Microwave 2.45 GHz ~ 1.6 x 10-3 eV

Thus microwave photons are not able to break even hydrogen bond.

How Microwave Heat the Substance?

The molecular dipoles in entire bulk tend to align with electric field of the micro wave and rotate or oscillate to follow the changing field. This Movement of molecules result into the collision and friction between molecules. And the Kinetic energy is lost as thermal energy. This is called dielectric heating which is a collective phenomenon of the bulk.

Ionic Conduction

- Charged particles (ions) oscillate under the influence of oscillating electric field of microwaves and they collide with other molecules and atoms. The kinetic energy of ions is lost in the form of heat.

Not a Quantum Mechanical Event

- Gases cannot be heated by microwave due to larger inter-particle distance (hence no friction).
- In high frequency microwaves the molecular dipole has no enough time to realign and in low frequency microwaves the reorientation is too slow. In both the cases no heating occurs. The frequency 2.45GHz is the optimum frequency, which lies between these two extremes, is usually used.
- In solids, as molecules can not move freely, no heating occurs by microwaves.
- Microwave heating effect is not a property of an individual molecule but a collective phenomenon of bulk.

Super Heating Effect

- Using microwaves solvents can be heated well above their Boiling points for extended time.
- Super heating is probably due to
- (1) Microwaves interact directly with molecules of entire volume of solvent leading to sudden and quick rise of temperature.
- This effect helps Water to act as an Organic solvent.
- (2) Nucleation points on wall of container are likely the coolest part of system hence vaporization (release of energy) is limited to top surface of liquid even on or above the b.p.

Reaction Rate Acceleration Effect

- Reaction time is reduced from hours to minutes when assisted by microwaves.
- Under microwave irradiations, high and intense temperature can be achieved very quickly and liquids are super heated.
- According to Arrhenius equation, $K=A \exp(-\Delta G^{\circ}/RT)$, a simple rule is that higher is the temperature, higher is the reaction rate.

Orientation of Polar Molecules

- While following the oscillations of electric field of microwaves, reagent molecules can arrange in favorable mutual orientation relatively more times per second in whole of the reacting volume.
- This increases the probability of molecular collisions in correct orientation and is related to the factor A in Arrhenius equation:

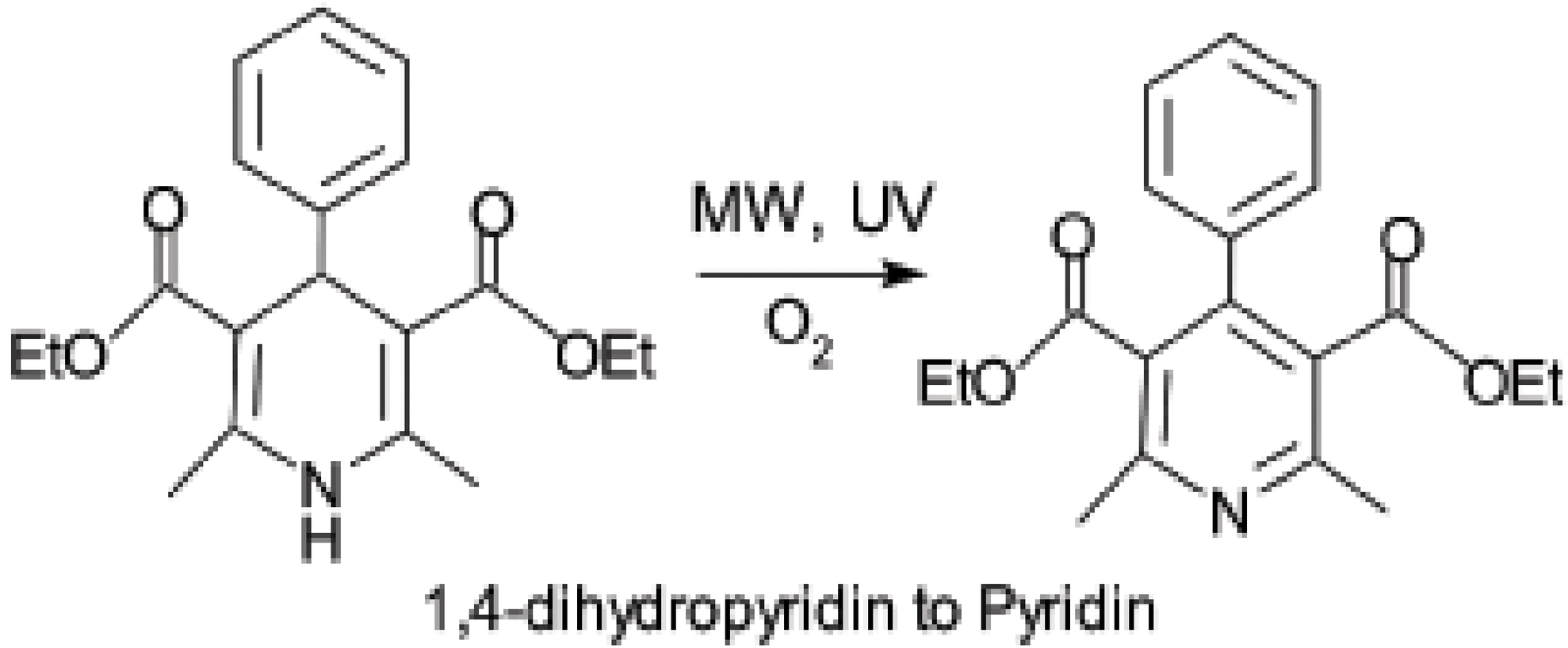
  $K=A \exp(-\Delta G^{\circ}/RT)$,

  This effect can be utilize in photochemistry also.

Selective Heating Effect

- If a solution contains more than one component only that component which can interact with microwave energy is selectively heated.
- By using poorly absorbing solvent, bulk temperature can be kept low despite the reaction proceeds at higher rate at heated **heterogeneous catalyst**.

Dramatic Faster Rate

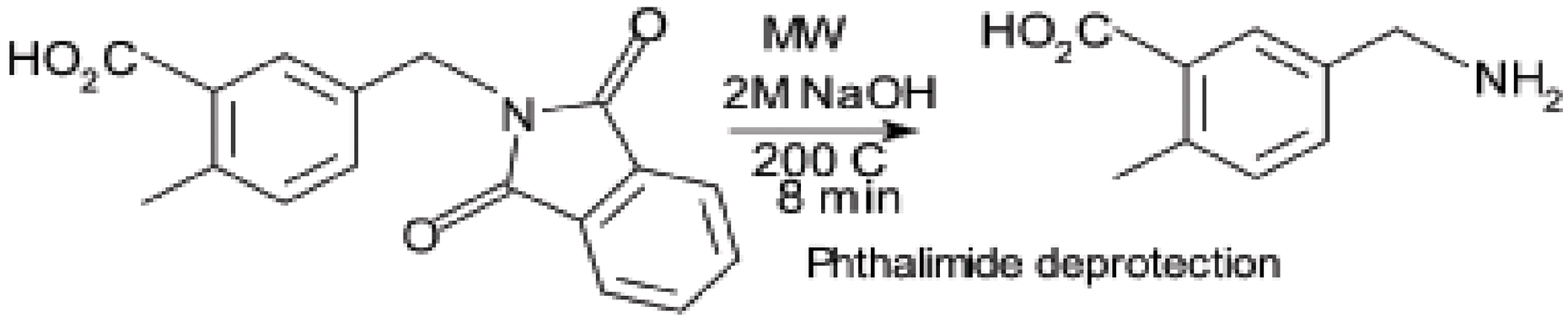


1,4-dihydropyridin to Pyridin

9% to 100%

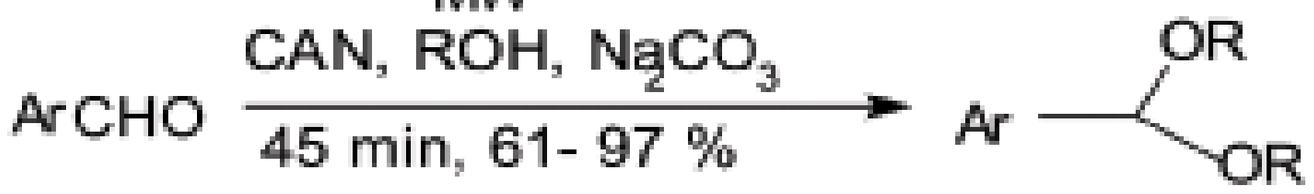
Protection & Deprotection

Faster & milder



Phthalimide deprotection

Conventional: 6M NaOH, 48 hr reflux



Protection of aldehyde

Application of Microwave

- Use of Electrodeless Discharge Lamp in photochemistry.
- Efficient preparation of organometalic compounds.
- Greener, flexible methods to prepare nano -particles of metals and metal oxides.
- Polymer synthesis.
- Enzyme chemistry.

Microwave Synthesis

- Atom economy: Greater yield, lesser wastage.
- Clean reactions: Less byproducts, lesser purification burden.
- Green solvents: H_2O, EtOH and reusable IL.
- Less or no solvent: 0.5 - 5 ml per reaction & neat condition.
- Low energy input: 50W, max 300W and easy to start or stop input of energy into the reacting substance only by a switch.
- Reduced derivatives: Use of blocking agent protection/deprotection require additional reagents .But in MW methods either there is no need of such temporary modifications or milder conditions can be used.

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Reliance Engineering Associates Pvt. Ltd.

TATA CONSULTING ENGINEERS LIMITED

SC Shroff Consultants

STERLING & WILSON

THANK YOU

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