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Survey in Hydrazine and its Preparation, Reactions, and Their Applications

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Abstract

This review concerned with hydrazine derivatives; Hydrazine is an important chemical compound used in jet engine and rocket fuel. Therefore, the European Union prohibits its sales to the developing world at 100% concentration and only permits its sales at 20-25% concentration. It is also used in industry to produce chemicals for textiles, agriculture, photographic development materials, and blowing agents used in the manufacture of foam rubber. It is also used to absorb dissolved oxygen in water to prevent corrosion in high-pressure and high-temperature steam boilers, such as in power plants. Hydrazine derivatives are used to regulate plant and weed growth. Its salt (hydrazine sulfate, [N2H5] HSO4) is also used as a promising treatment for some cancers and for treating weakness and emaciation. Its compound, hydrazine peroxide, is considered one of the most powerful and rapid explosives. Hydrazine has a strong smell and is a colorless liquid. It is an effective reducing agent. This substance has the chemical formula NH2NH2, boils at 114°C, and blends readily with alcohol and water. It ignites easily in air, producing a lot of heat that forms water and nitrogen gas. Drug Synthesis: The pharmaceutical industry uses hydrazine hydrate to make medications for diabetes and some forms of tuberculosis. Hydrazine hydrate is frequently utilized as a major raw material in drug production because of its potent lowering capabilities. For instance, hydrazine hydrate is essential to the synthesis of anti-tuberculosis medications like benzyl sulfonyl hydrazide and isoniazid. They are essential to the synthesis of dyes, especially triphenylmethane and azo dyes. Because of their excellent durability and vivid hues, these dyes are commonly employed in sectors including leather and textiles. Another essential ingredient in the creation of some organic color goods is hydrazine hydrate.

Keywords: Hydrazine, chalcone, hydrazone, cycle, heterocycle, compound

INTRODUCTION

It has several uses in the chemical and industrial domains and is a colorless liquid with potent reducing qualities. It is a crucial chemical intermediate that is essential to many significant businesses. To help you understand how hydrazine hydrate can be used to solve problems in a variety of sectors, this article will outline its primary applications. Hydrazides are known to be very effective against tuberculosis bacteria. Isoniazid (isonicotinyl hydrazide) is still used as an effective chemotherapeutic agent against Mycobacterium tuberculosis. It is used at very low concentrations (0.4-0.8 mg/ml MIC) and has a therapeutic rate of approximately 100%, despite its toxicity reaching (LD50 = 0.35 mg/kg) [1]. Salicylic acid hydrazide, 4-aminosalicylic acid hydrazide, isonicotinyl salicylidene, and salicyldehyde hydrazone have also been used as effective compounds against

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Mycobacterium tuberculosis and are like isoniazid. It was found that the condensation of hydrazides with aldehydes or ketones gives hydrazone derivatives (Schiff bases), which play a major role against tuberculosis bacteria, with low toxicity, as it is less than hydrazides that contain a free amine group (-NH2), as in the compound benzalidine isonicotinyl hydrazone [2]. Considering the use of condensed cinnamic acid derivatives with 2-(5-nitrofurfuraldine) hydrazide due to the importance of the double bond on the tuberculosis bacterium, it was found that p-methoxy and p-chlorosynamoyl hydrazide are very effective against this bacterium at concentrations (MIC = 2 mg/ml) [3]. It was found that the importance of acid hydrazides is limited to their ability to have many biological effects, as they could inhibit enzyme-catalyzed reactions, Figures (1, 2).

Preparation Methods of Hydrazine Derivatives

Hydrazine was first discovered in 1887 by Curtius. Many hydrazine compounds and their derivatives were prepared, including benzoyl hydrazine, p-nitro benzoyl hydrazine, and many other hydrazides [4]. There are many methods for preparing hydrazides, the most common of which is treating esters with hydrazine hydrate using ethanol solvent [5–10]. The other method of preparation includes the reaction of acid halide with hydrazine hydrate, as shown in the equation (1).

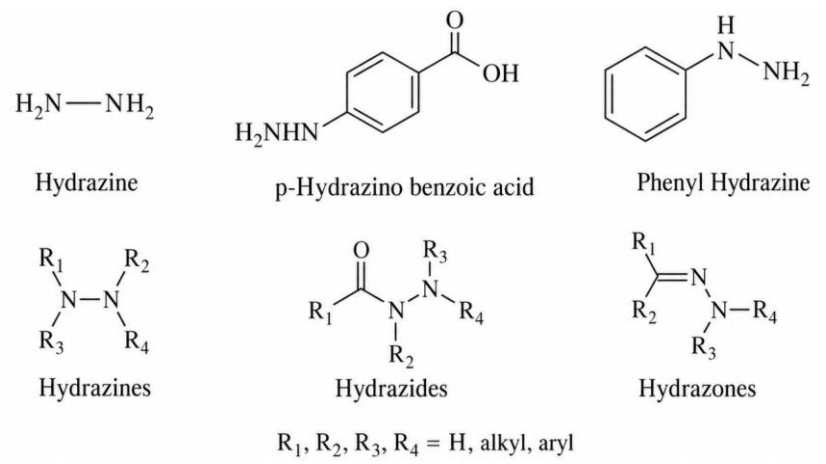


Figure 1. Structures of hydrazine derivatives.

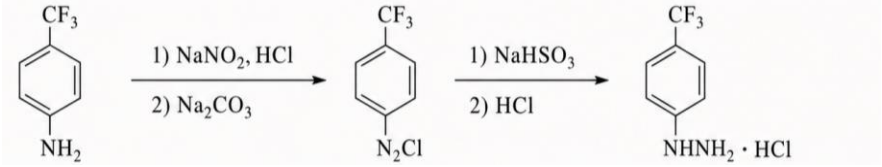
Figure 2. Tautomerism of hydrazine derivatives.

$$RCOOR + NH_2NH_2 \cdot H_2O \rightarrow RCONHNH_2 + ROH + H_2O$$

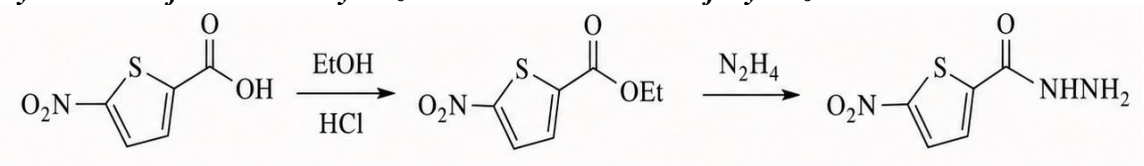
$$RCOX + NH_2NH_2 \cdot H_2O \rightarrow RCONHNH_2 + HX + H_2O$$

Equation 1. Reactions of hydrazine.

By Diazotation of Primary Aromatic Amine



By Reaction of Ester with Hydrazine to Yield Derivatives of Hydrazine



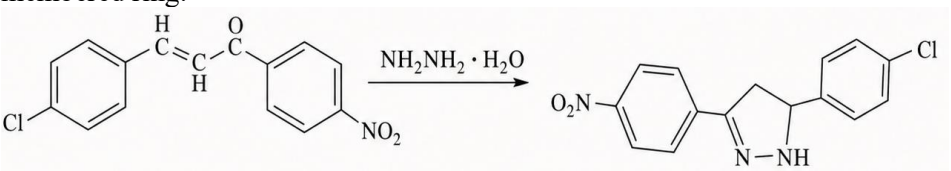
Reactions of Hydrazine Compounds

Hydrazine is a significant chemical multiple exploited in jet and career engine fuels. Manufacturing also utilizes it to construct substances for materials and agriculture, photographic developing agents, and blowing agents used in the manufacture of foam rubber. Hydrazine derivatives are used to regulate plant growth, such as weeds along roadsides, as these chemicals inhibit rapid weed growth, reducing the need for constant maintenance. Hydrazine is a colorless, pungent, corrosive liquid. It is a nitrogen-containing base and a powerful reducing agent. It has the chemical formula H_2NNH_2, boils at 114°C, and is easily miscible with alcohol and water [11–15].

It ignites readily in air, producing a large amount of heat and producing nitrogen gas and water. It is manufactured in various ways from hydrazine hydrate, which has the chemical formula $H_2NNH_2 \cdot H_2O$.

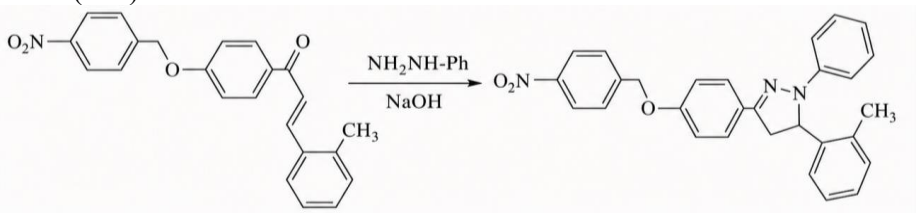
Reaction of Hydrazine with Chalcone Compounds

Reaction of Hydrazine with Chalcone Compounds to formation cyclic compounds as a five membered ring:



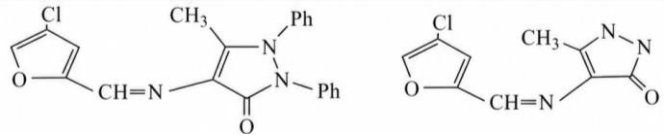
Reaction of Phenyl hydrazine with Chalcone derivatives

Reaction of Phenyl hydrazine with Chalcone derivatives in basic medium like sodium hydroxide about (5 %).



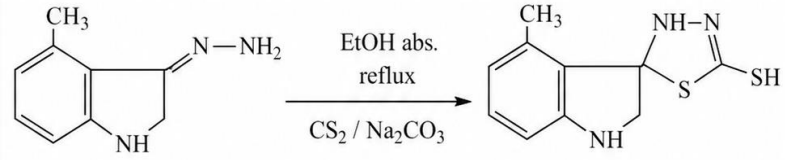
Reaction of Hydrazine Derivatives in Ring Closure Reactions

Reaction of Hydrazine Derivatives to Formation Cyclic compounds.

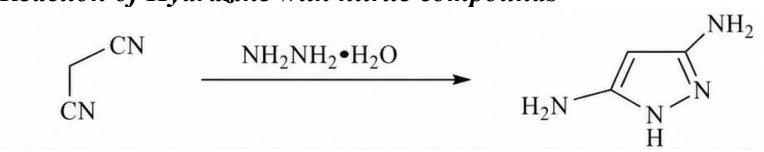


Reaction of Hydrazine in Cyclization Reaction

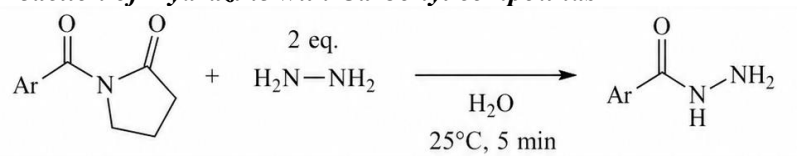
Reaction of Hydrazine with carbon disulfide to formation five membered ring of thiadiazole derivatives in presence of sodium carbonate and basic medium.



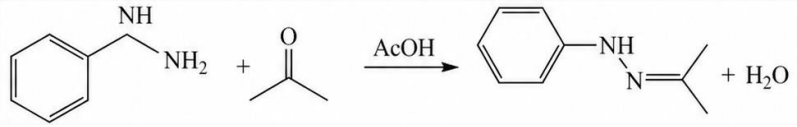
Reaction of Hydrazine with nitrile compounds



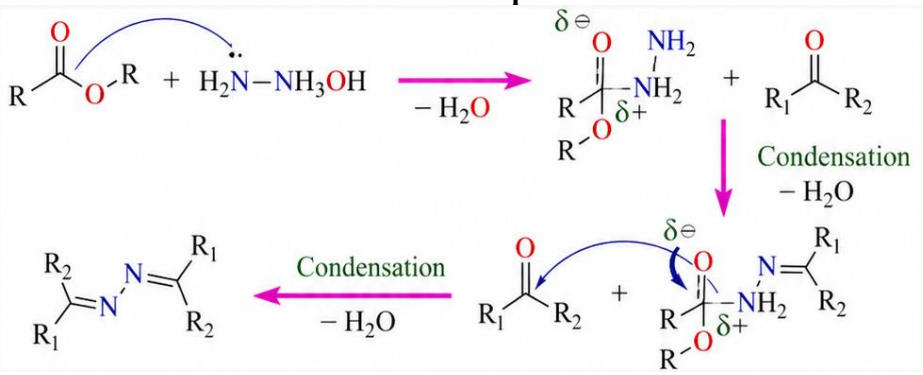
Reaction of Hydrazine with Carbonyl compounds



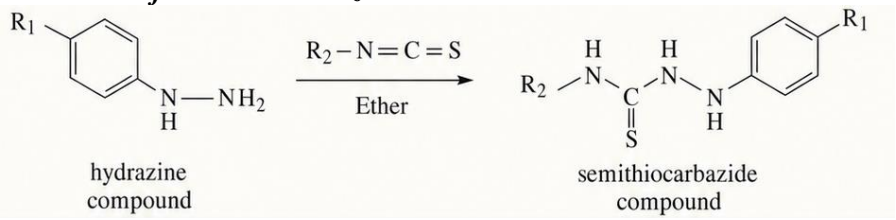
By formation of Imine compounds or Schiff base



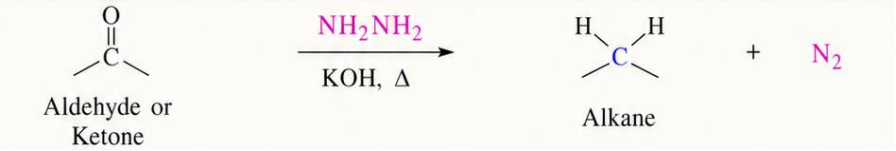
Mechanism for Formation of Imine Compounds



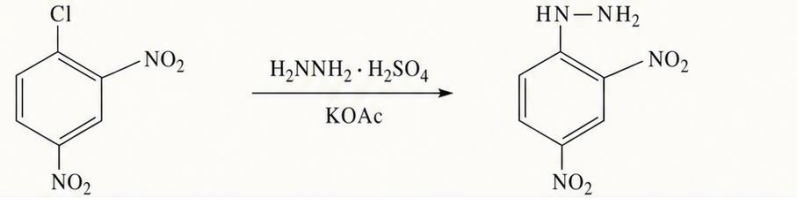
Formation of Thiosemicarbazide



Reaction of Hydrazine as a reduction Agent



Reaction in Substitution Reactions



Biomedical and Chemo-Industrial Applications of Hydrazine Derivatives

Pharmaceutical Intermediates

Hydrazine hydrate is also used in the manufacture of a variety of pharmaceutical intermediates. For instance, some antibiotics and cancer medications are synthesized using hydrazine hydrate or its derivatives. Applications for Pesticides: Hydrazine hydrate is utilized in the pesticide industry to create a variety of insecticides, fungicides, herbicides, plant growth regulators, and rodenticides. For instance, plant growth regulators and rodenticides like nitro phenyl hydrazine can be made from hydrazine hydrate. Agricultural chemical intermediates: Hydrazine hydrate or its derivatives serve as the basis for the active components of numerous pesticides. One important step in several pesticides, for instance, is aminoguanidine bicarbonate [16–20].

Hydrazine and its derivatives are used in several applications and fields. They are used in the pesticide industry to produce herbicides, plant growth regulators and sterilizers, insecticides, and rodenticides [21-25]. In addition, it can also be used to produce rocket fuel, diazo fuel, and rubber additives, figures (3–5)

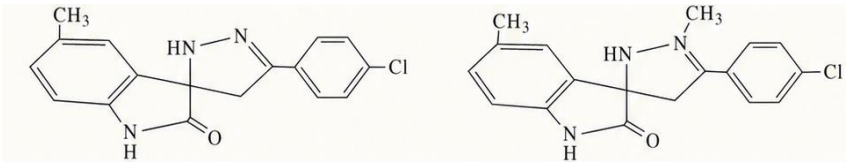


Figure 3. Hydrazine derivatives as antibacterial compounds.

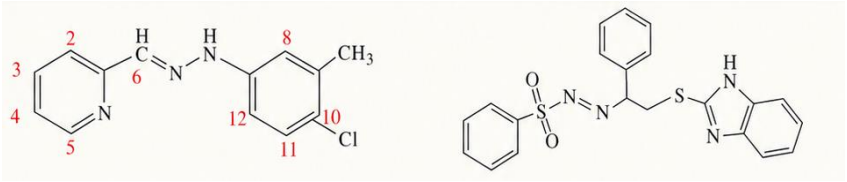


Figure 4. Hydrazine derivatives as antimalaria compounds**.**

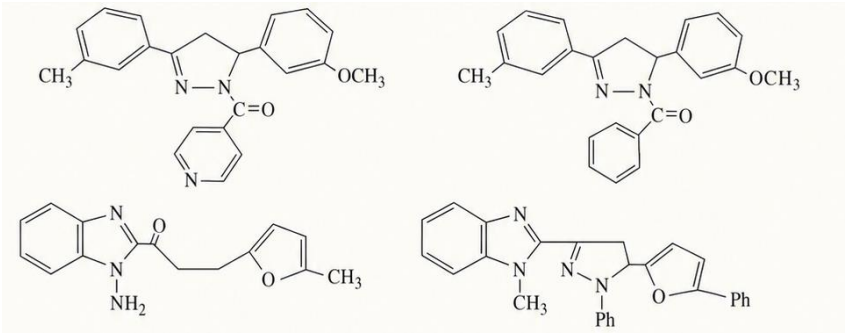


Figure 5. Hydrazine derivatives as antitumor compounds.

Applications of Hydrazine Derivatives

Hydrazine hydrate derivatives are distinguished by their wide range of applications across all fields of chemistry and other sciences. They play a crucial role in dye manufacturing, particularly in the production of azo and triphenylmethane dyes. Because of their excellent durability and vivid hues, these dyes are commonly employed in sectors including leather and textiles. Another essential ingredient in the creation of some organic color goods is hydrazine hydrate. It takes part in the processes that create the dye molecule's fundamental structure. Additionally, it is utilized as a foaming agent, acting as a raw material for foaming agents employed in the manufacturing of different kinds of rubber and foamed plastics. These foaming agents, such azodicarbonamide (AC), are extensively utilized in a variety of industries, including packaging, transportation, and construction [26].

Hydrazine hydrate and its derivatives are employed as activators and catalysts in rubber processing to increase the vulcanization process's effectiveness and quality. Hydrazine hydrate is sometimes employed as a propellant because of its stability and simplicity of handling, even though hydrazine monomer is more frequently used as rocket fuel. Hydrazine hydrate is used to purify several kinds of refined sulfuric acid in the treatment of metal and electronic surfaces [27].

Metals (nickel, cobalt, iron, chromium, etc.) and plastics are also inlayed with it. Hydrazine hydrate is utilized extensively in numerous sectors as a crucial chemical raw material and reducing agent. Hydrazine hydrate is essential in many different applications, including colors, rubber additives, medicines, insecticides, and other synthetic compounds [28]. As a result, the chemical industry will continue to place a high value on hydrazine hydrate applied research and development (Figure 7).

It is made by oxidizing ammonia with either sodium hypochlorite or hypochlorous acid.

It is a colorless, fuming liquid that melts at 1.8°C and boils at 114°C. It behaves as a base by acquiring one or two protons when it reacts with acids, forming two types of salts ($N2H6^{++}$, $N2H5^{+}$), but it is less basic than ammonia. Salts containing $N2H6^{++}$ ions are stable only in acidic media due to their liquefaction.

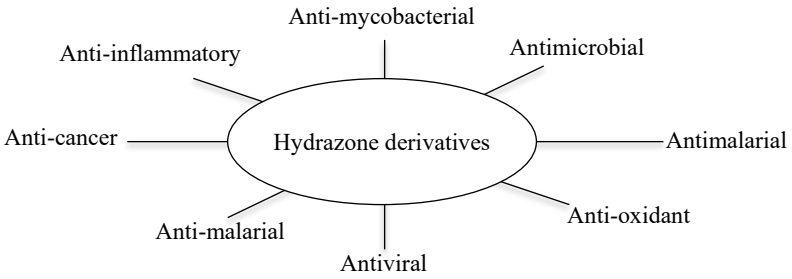


Figure 7. Bio-applications of hydrazine.

Hydrazine is widely used as an anti-corrosion agent in thermal engineering and in other fields, figure (8). During equipment protection and decommissioning, a large volume of wastewater is generated after chemical cleaning operations with a high concentration of hydrazine (approximately 100 mg/dm³). Because it is a highly toxic substance of hazard class II, it is prohibited to discharge this wastewater directly into sewer headers and natural reservoirs. The amount of hydrazine in wastewater must be reduced to the desired levels before discharge. A "hydrazine estimation" of wastewater is carried out beforehand in order to detect these circumstances. The amount of hydrazine in the water may be found using this analysis, and after the required neutralization is completed, the discharge procedure can start [29–31].

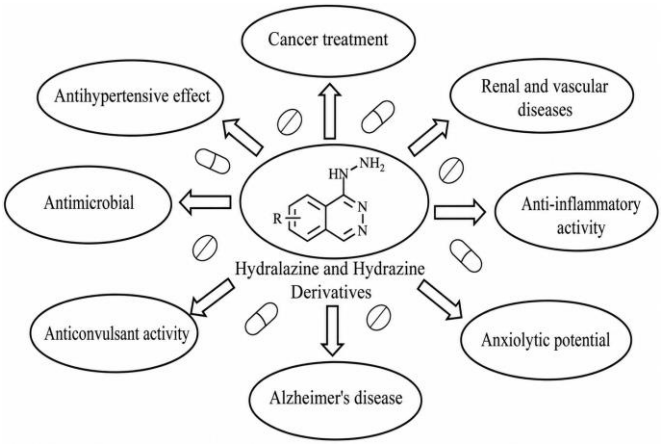


Figure 8. Other applications of hydrazine.

CONCLUSIONS

Hydrazine hydrates have significant uses in a variety of industries, however because of their extreme toxicity and flammability, it is crucial to closely adhere to safe operating practices.

When storing and handling hydrazine hydrate, appropriate protective measures must be taken, such as wearing protective gloves and goggles, and working in a well-ventilated environment. Additionally, make sure the container is firmly sealed during storage and transit to avoid leaks and unintentional fires.

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