Synthesis of Nitroisobutylglycerol, Quinamide, Alanine and Decitabine in Laboratory Scale

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Abstract: *This paper is established how to synthesize chemical compounds in the laboratory, especially nitrating groups (-NO_2) which can be mainly used in manufacturing explosives and medicines. All the chemicals used in these experiments are not yet harmful to the surroundings. On the other hand, they are wicked human beings who field-test in lab room. The significant risks in lab include high voltages, high or low pressures and temperatures, corrosion and toxic chemicals and biohazards. Therefore, the prevention of laboratory accidents requires great care and constant vigilance. Experimenters or students must follow lab safety rules or instructions and have to manipulate glass wares, chemicals and devices. Occupational health hazards are the factors arising in or from the occupational environment that adversely impact health. Thus, the purpose of this paper is to summarize and generalize the various nitrating substances, health hazards in the workplace and environmental problems especially specific to the industrial scale. Guidelines are involved in it for the management and disposition of chemicals used in chemical laboratories.*

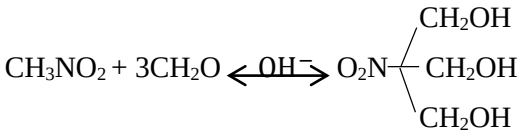
Keywords: *Synthesize, Explosives, Risks, Hazards, Environment.*

1. INTRODUCTION:

The chemical engineering field is one of the leading branches of the modern chemical industry. It consumes a large number of raw materials, water and energy. Enterprise today inevitably discards a number of wastes that are harmful to the environment and human organization. The pollution of the environment with chemical industrial waste leads to a change in the human environment, threatens its survival as a species. Among the numerous solutions for solving technological problems, it is possible to single out systems for purification of industrial waste water and gas emissions, recovery of useful substances and elements from them, as well as combined production processes that ensure the full and integrated use of natural resources, raw materials and materials. At present, nature protection and rational use of natural resources become one of the most important environmental and social tasks. Thus, the task of creating and implementing environmentally sound low-waste production with a thorough assessment of environmental consequences and taking into account possible environmental factors becomes one of the main tasks that must be addressed in the near future.

1. EXPERIMENTAL PROCEDURE:

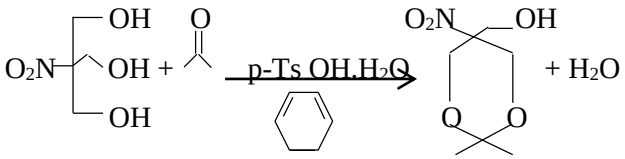
2.1. Synthesis of Nitroisobutylglycerol



To a solution of 75g of paraformaldehyde in 400ml of white ethyl acetate was added a few drops of alcohol solution (KOH 2g, EtOH 5ml) as a catalyst. The mixture was heated with a reverse cold on a water bath. After the formaldehyde vapor had dissolved, 275ml of ethyl acetate was removed from the mixture on a rotary evaporator. The precipitated crystals of Nitroisobutylglycerol were filtered. Evaporation of the mother liquor received an additional amount of product. The reaction mass is filtered by Buchner flask. Total received is 83g (74%).

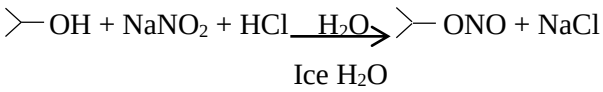
The product sample (NIBG) and unknown substance were applied with a capillary tube onto a TLC plate. This graph was sunk in the eluent (EA 3- Hexane 1).

2.2. Synthesis of Quinamide



Benzene (1.5L), Acetone (70ml) and p-Toluenesulfonic acid monohydrate (1.25g) are added into a flask (2L). The solution was heated with a counter cold in a water bath. Finally, Nitroisobutylglycerol (200g) was added into that flask. A few minutes later,the product vapor is dissolved and benzene is flown down into the flask. After 30mins, 1ml of water is distilled. Then it was received 3ml of water in 1.5hours. After next 50mins, 5ml of water is received. Finally, it was received 12ml of water which is theoretical required amount. And it was received 65g of reaction mass (75.6%). If so, turn off the heating.

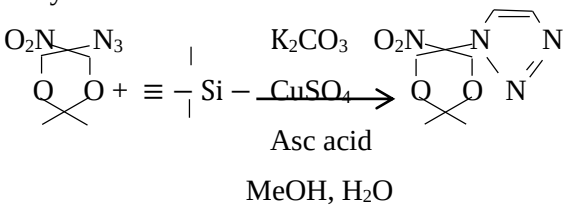
2.3. Synthesis of Alanine



First of all, 1L of water and 345g of sodium nitrate are added into a three-neck round bottom flask. Then a mixture of isopropyl alcohol (382ml) and ice-water (450ml) was poured into that flask. And a mixture of hydrochloric acid (30ml) and ice-water (50ml) was added into it. Finally, the mixture from flask was poured into a separating funnel to separate low density product and high density water. In the end, It was received golden-yellow 2-Amino propanoic acid 364.2g (81.8%).

Caution: To use both isopropyl alcohol and HCl with only ice-water.

2.4. Synthesis of Decitabine



As a first step, a mixture of water (200ml), potassium carbonate (17.25g) and ascorbic acid (3.5g) was added into a round bottom flask. Then a mixture of methanol (400ml) and nojirimycine tetrazole (20.2g) was added into that flask. And a mixture of water (200ml) and copper sulfate pentahydrate (2.5g) was poured into that flask. Then a mixture of methanol (400ml) and tms acetylene (11.76g) was added into it. After that, stir the final mixture its orange color turn to brown.

3. RESULTS AND DISCUSSIONS:

3.1 Brief Description of Work Performed

3.1.1Rotary Evaporator

It is a device used in chemical laboratories for the efficient and gentle removal of solvents from samples by evaporation. The sample was evaporated under reduced pressure. The modern style instrument features a digital heating bath and a motorized lifting jack. The evaporation flask has been detached. There are hazards associated even with simple separations such as evaporation. Explosions may occur from concentrating unstable impurities during evaporation. Users of rotary evaporation equipment must take precautions to avoid contact with rotating parts, particularly entanglement of loose clothing, hair, or necklaces. Under these circumstances, the winding action of the rotating parts can draw the users into the apparatus resulting in breakage of glassware, burns, and chemical explore. Extra cautions must also be applied to operations with air reactive materials, especially when under vacuum. A leak can draw air into the apparatus and a violent reaction can occur. Even less volatile solvents can be removed by rotary evaporation under high vacuum and with heating.

3.1.2 Distillation

It is used to separate compounds based on difference in boiling point. Compounds with a boiling point lower than 150℃ on typically be distilled without reduced pressure. Using a fractionating column in the set-up improves the separation of mixtures, and can allow separation of compounds with similar boiling points.

3.1.3 Thin Layer Chromatography:

1. Carefully use a pencil to draw a faint line 0.5cm above the bottom of a TLC plate and mark two spots, equally spaced along this line.

2. Use a capillary tube to apply a tiny drop of each solution to a different origin spot and allow the plate to air dry.

3. Add approximately $10cm^3$ of ethyl acetate and 3.3ml of hexane to a development chamber (suitable container with a lid).

4. Place the TLC plate into the developing chamber, making sure that the level of the solvent is below the spotting line. Replace the lid and make sure it is a tight seal.

5. When the level of the solvent reaches about 0.5cm from the top of the plate, remove the plate and mark the solvent front with a pencil. Allow the plate to dry in the fume cupboard.

6. Place the plate under a UV lamp in order to visualize the spots. Draw around them lightly in pencil.

7. Calculate the R_f values of the observed spots.

3.1.4 R_f value, solutes and solvents

The retention factor (R_f) may be defined as the ratio of the distance travelled by the solute to the distance traveled by the solvent. It is used in chromatography to quantity the amount of retardation of a sample in a stationary phase relative to a mobile phase. R_f values are usually expressed as a fraction of two decimal places. If R_f value of a solution is zero, the solute remains in the stationary phase and thus it is immobile. If R_f value = 1, then the solute has no affinity for the stationary phase and travels with the solvent front.

For example, if a compound travels 9.9cm and the solvent front travels 12.7cm, the R_f value = (9.9/12.7) = 0.779 or 0.78. R_f value depends on temperature and the solvent used in experiment, so several solvents offer several R_f values for the same mixture of compound. A solvent in chromatography is the liquid the paper is placed in, and the solute is the ink which is being separated.

TLC provides the means of surveying constituents of plants and for their separation and identification and explosion of activity.

3.2 Occupational Safety and Health

The main physical, chemical, toxic fire and explosion hazard properties of the substances used in the work

For each substance are indicated:

a) Physical and chemical properties

b) Toxicity

c) fire-explosive properties

Conditionally denoted:

$MPC_{w.a}$ = maximum permissible concentration in the air of working area

$MPC_{Max.P}$=MPC in the atmosphere of human settlements, maximum single concentration

$MPC_{c.c}$ = maximum permissible concentration

CLI = concentration limit of ignition

LCLI & UCLI = lower & upper concentration limits of ignition, respectively

1. Acetone $(CH_3)_2$ CO

It is a colorless liquid with a sharp specific odor and soluble in water, ether and alcohol. It is a good solvent.

Physical and chemical properties

Molecular weight 58.08 g/mole

Density 790.8 kg/m^3

Vapor density (by air) 2 kg/m^3

Toxicity – it acts narcotially, affects the central nervous system.

Fire and explosion hazard properties – It is a flammable liquid.

Flash point 18 ℃

Self-ignition temperature 465 ℃

2. Ethyl acetate ($C_4H_8O_2$) –it is a colorless liquid.

Physical and chemical properties

Molecular weight 88.1 g/mole

Density 881 kg/m^3

Melting point 83.6 ℃

Boiling point 77.1 ℃

Vapor toxicity (by air) 3.04 kg/m^3

Solubility in water 8.5% (weight) at 15 ℃

Toxicity – it has a narcotic effect. Vapors irritate the mucous membranes of the eyes and respiratory tract.

Fire and explosion hazard properties_ it is a flammable liquid.

Flash point 2 ℃

Self-ignition temperature 400 ℃

3. Isopropyl alcohol $(CH_3)_2$ CHOH

It is a colorless liquid with a characteristic odor and unlimitedly soluble in water.

Physical and chemical properties

Molecular weight 60.09 g/mole

Density 785 kg/m^3

Melting point 89 ℃

Boiling point 82.4 ℃

Toxicity – it has a narcotic effect, similar to the action of ethanol and strong. Vapor irritates the mucous membranes of the eyes and respiratory tract. Lethal intoxication when ingested more than 400 ml.

4. Sour Sodium (NaOH) – It is a white, transparent highly hygroscopic substance and soluble in water. It is a strong base, in the air if gradually turns into sodium carbonate.

Physical and chemical properties

Molecular weight 40 g/mole

Density 2.13 kg/m^3

Melting point 320 ℃

Boiling point 1378 ℃

Toxicity – The skin and eye act cauterily, dissolving the proteins with the formation of alkaline albumins. After burning NaOH, scars remain. Danger of even the smallest amounts in the eyes, affects not only the cornea, but also the deep parts of the eye.

5. Hydrochloric acid (HCl) – it is hydrogen chloride solution in water. It is a colorless liquid with a sharp odor, a strong monoacid. It is chemically very active. HCl acid dissolves with the liberation of hydrogen, all metals that have a negative normal potential, which indicates its corrosion.

Toxicity – HCl acid is highly toxic. The cause of poisoning is not usually gaseous hydrogen chloride, but a fog of HCl acid formed by the interaction of gas with water vapor. At high concentration, it irritates the mucous membranes, up to their burns, especially the nose, conjunctivitis, opacity of the cornea, hoarseness, choking and coughing.

Chlorine poisoning cause catarrhal dentition pathways of tooth decay, the manifestation of a bacterial nose, gastrointestinal disorders.

Fire hazard properties – HCl acid is a non-flammable liquid.

6. Ethyl alcohol – it is a colorless, lightly mobile fluid with characteristic odor and beetle taste. It is miscible in all proportions with water, alcohols, diethyl ether, glycerin and chloroform.

Molecular weight 46.069 g/mole

Melting point 78.39 ℃

Density 0.78927 kg/m^3

Toxicity – Ethyl alcohol is extremely hygroscopic, at a concentration above 70%, it cauterizes the skin and mucous membranes, when administered orally depress the centers of inhibition of the brain, causes intoxication, with repeated use of alcoholism.

Fire hazard properties

Ethyl alcohol is a highly flammable liquid.

Flash point 13℃

Self-ignition temperature= 404℃

7. Paraformaldehyde – it is a white crystalline solid formed by polymerization of formaldehyde. Formaldehyde kills most bacteria and used as a disinfectant and as a preservative and fixative for pathologic specimens. Formaldehyde cross-links amino groups. In industry, formaldehyde is used in the production of thermoset resins, functional polyols, explosives, hexamine and other chemicals. Commercially available formaldehyde solutions contain 10-15% methanol, which prevents the formaldehyde from forming the polymeric paraformaldehyde.

8. Methyl alcohol (MeOH) – it is a colorless liquid and unlimitedly soluble in water. Oxidation forms formaldehyde, formic acid and carbon dioxide.

Molecular weight 32.04 g/mole

Density 0.791 g/cm^3

Boiling point 67.7 ℃

Toxicity – Methanol is highly toxic. Strongly acts on the central nervous system, is a poison for blood vessels. It has a pronounced cumulative effect. When ingested, it causes blindness or death; insufficient oxygen saturation and acidosis play an important role in the picture of poisoning, speeding up this process. The CH_3OH vapor strongly irritates the mucous membranes of the eyes and respiratory tract. Danger of taking even 5-10ml of alcohol, and 30ml can be fatal.

9. Nitro methane (CH_3NO_2) – It is the simplest nitro compound and a polar liquid commonly used as a solvent in a variety of industrial application such as in extractions, as a reaction medium and as a cleaning solvent. As an intermediate in organic synthesis, it is used widely in the manufacture of pharmaceuticals, pesticides, explosives, fibers and coating.

Molecular weight 61.04 g/mole

Melting point -28.38℃

Boiling point 101.19 ℃

Flash point 35℃

10. Benzene – it is an important organic chemical compound and its molecule is composed of six carbon atoms joined in a ring with one hydrogen atom attached to each. As it contains only carbon and hydrogen atoms, benzene is classed as an aromatic hydrocarbon. Benzene is a natural constituent of crude oil and is one of the elementary petrochemicals.

Molecular weight 78.11 g/mole

Melting point 5.53℃

Boiling point 80.1 ℃

Flash point -11.63 ℃

Auto-ignition temperature 497.78℃

Hazard_ It is a colorless and highly flammable liquid with a sweet smell. As benzene has a high octane number, it is an important component of gasoline. As benzene is a human carcinogen, most non-industrial applications have been limited.

11. pTsOH – Paratoluenesulfonic acid is an organic compound and a white solid that is soluble in water, alcohols and other polar organic solvents. pTsOH refers to the monohydrate, $pTsOH.H_2O$.

Molecular weight 172.2 g/mol

Density 1.24 g/cm^3

Melting point 38 ℃

Boiling point 140℃

12. Sodium nitrate – it is an inorganic compound and a white to slightly yellowish crystalline powder that is very soluble in water and is hydroscopic. It is a useful precursor

To a variety of organic compounds, such as pharmaceuticals, dyes, and pesticides, but it is probably best known as a food additive to prevent botulism.

Molecular weight 68.9953 g/mole

Density 2.168 kg/m^3

Melting point 271 ℃

Auto-ignition temperature 489 ℃

13. K_2CO_3 – it is a white salt, which is soluble in water but insoluble in ethanol.

Density 2.43 g/cm^3

Melting point 8.91 ℃

Boiling point decomposed

Flash point non-flammable

14. Copper (II) sulfate ($CuSO_4$) –it is highly soluble in water and therefore is easy to distribute in the environment. Copper in the soil may be from industry, motor vehicle and architectural materials. According to studies, copper sulfate exists mainly in the surface soil and tends bind organic matter. The more acidic the soil is, the less binding occurs.

Molecular weight 159.609 g/mole

Density 3.6 g/cm^3

Melting point 110 ℃

15. Ascorbic acid – it is a six carbon compound related to glucose. It is found naturally in citrus fruits and many vegetables. It is a natural water-soluble vitamin C and has a pH value of 1.0-2.5. Found in citrus and other fruits and in vegetables, vitamin C cannot be produced or stored by humans and must be obtained in the diet. The ascorbic acid in supplements is often derived from corn starch, corn sugar, or rice starch and is chemically dependent upon volatile acids. The methods for vitamin C synthesis using two-step fermentation were developed by China in the 1960s.

Molecular weight 176.124 g/mole

4. CONCLUSIONS:

The basis of this paper is the optimization of the synthesis of NIBG, Quinamide, Alanine and Decitabine and the study of their chemical properties. All these substances belong to the category of substances of increased danger. Therefore, in accordance with the safety instructions for working with explosives, the maximum amount of one-time receipt and use of these compounds is limited.

Also, very dangerous situations can arise when preparing various nitrating mixtures and when working with them. If the procedure for performing the synthesis is not adhered to, a spontaneous sudden increase in temperature and a release of the reaction mass may occur. Chromatographic methods of analysis and separation of products, as well as their purification and recrystallization are associated with the use of various organic solvents, which can lead to possible exposure of their vapors to the body.

5. RECOMMENDATIONS:

Despite the fact that these chemical substances are not present in natural products, they are of great importance in medicines, explosives and in the natural science. All these works are experimental and does not contain a technological part. During the synthesis in addition to the main products, washing waters and mother liquors are formed, as well as gaseous products (vapors). All the substances involved in the process are not harmful to the environment but experimenters. A chemical engineer must know the things Do's and Don'ts. It is important to keep in mind, that chemicals can exhibit more than one hazard or combinations of several hazards. All the wastes can be divided into the following groups according to the methods of their utilization: gaseous waste, acids, alkalis, salts and organic solvents.

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