Preparation of Hydrazine Hydrate from Urea and Sodium Hypochlorite


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Abstract

Many methods for production of Hydrazine Hydrate are stated in the literature. The best method was selected (urea process) depending on availability of raw materials in Al-Furat State Co. for Chemical Industries, locally market, method applicability and feasibility. The synthesis of hydrazine from urea and sodium hypochlorite was studied (Urea Process). Concentration of reactants (\(\%\) \(\text{NaOCl, urea (} \text{g}, \text{NaoH (} \text{g}), \text{gelatin ratio (} \text{g})\)), reaction temperature (\(\circ\))\(\text{C}\) were studied to determine their effects on the production of hydrazine in order to obtain higher concentration with mixing rate (\(\%\))\(\text{rpm.}\)Hydrazine detection and determination test has been done in the labs of Al-Furat State Co. using colorimetric method and oxidation with potassium iodate method. Additionally, samples were tested by iodimetric method in the lab of T.P.S. (Treatment Water Unit in Al-Mussayab Power Station). The results showed that highest concentration of hydrazine hydrate of (\(\%\)) was obtained at (\(\%\))\(\text{NaOCl, urea (} \text{g}, \text{NaoH (} \text{g}), \text{gelatin (} \text{g})\), and reaction temp. of (\(\circ\)\(\text{C}\)) at (\(\%\)\(\text{rpm.}\)

Keywords: hydrazine hydrate | raschig process | urea process | hydrazine detection | oxygen scavenger.

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Introduction

Hydrazine, \(\text{NH}_2\text{NH}_2\), the simplest diamine and parent of innumerable derivatives, was prepared in (\(\text{NH}_3\)) by Curtius as the sulfate salt from diazoacetic ester. Thiele (\(\text{NH}_3\)) suggested that the oxidation of ammonia or urea with hypochlorite should yield hydrazine. F.Rasching (\(\text{NH}_3\)) first demonstrated this process, variations of which constitute the chief commercial methods of manufacture today (\(\text{NH}_3\)). Hydrazine is a strong reducing agent, It is used for corrosion control in boilers and hot-water heating systems .It is also an oxidizing agent under suitable conditions. With two active nucleophilic nitro gens and four replaceable hydrogens, hydrazine is the starting material for many derivatives. (\(\text{NH}_3\))

Uses :

Hydrazine comprises of hydrazine anhydride and hydrazine hydrate and the former is only produced for rocket fuel at several tons per year . Therefore, this assessment describes the use of hydrazine hydrate that is more commonly used. (\(\text{NH}_3\)), Hydrazine hydrate and its derivatives play a significant role in various application

- Water treatment: oxygen scavenger, protection of boiler circuits, synthesis of flocculants and coagulants.
- Agrochemicals: phytosanitary synthesis intermediates.
- Polymerization and blowing agents: acrylics, PE, PVC, EVA(Ethylene Vinyl Acetate), rubber, etc…
- Treatment processes, precious of metal purification.
Physical and Chemical properties:

Is a colorless, fuming and basic solution with a peculiar bad smell, soluble in water and alcohol, flammable and corroding glass, rubber and leather, hydrazine hydrate's sever toxicity accumulates and harms blood and nerves \[^\text{[1]}\]. Based on its pKa, hydrazine is a strong base, although slightly weaker than ammonia (Eq. \(^1\)). The second ionization constant pKa\(^2\) (Eq. \(^\gamma\)) is so small that the \(\text{N}_2\text{H}_5^+\) cation will exist at only extremely low pHs \([\gamma, \gamma]\). Because of strong resemblances with hydrazine, hydrazine hydrate is also considered a strong base \([\gamma, \gamma]\). In principle, aqueous solubilities of substances with acid–base properties vary with (pH) but this information is not available for solubilities reported here. However, it is expected that solubilities in water of anhydrous and hydrated hydrazine will be large regardless of the pH of the test solution.

\[
\text{N}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{N}_2\text{H}_5^+ + \text{OH}^- \quad (\gamma)
\]

Hydrazine is reported to be a powerful reducing agent in basic solutions; Equation (\(\gamma\)) represents the half-reaction of the molecule as a reductant. It is much less of a reducer in an acidic medium with an E. (redox potential) decreasing by nearly one volt (Eq. \(\xi, \xi\)).

\[
\text{N}_2\text{H}_4 + 4 \text{OH}^- \rightarrow \text{N}_2 + 4 \text{H}_2\text{O} + 4 \text{e}^- \quad \text{E.} = +1.21 \text{~V} \quad (\xi)
\]

\[
\text{N}_2\text{H}_5^+ \rightarrow \text{N}_2 + 5 \text{H}^+ + 5 \text{e}^- \quad \text{E.} = +3.6 \text{~V} \quad (\xi)
\]

The very similar physico - chemical properties of hydrazine and hydrazine hydrate reflect the equivalence of both forms of hydrazine. Nevertheless the low melting point of hydrazine hydrate (-\(51^\circ\text{C}\)) is consistent with a solid crystal structure that is somewhat different from that of anhydrous hydrazine.\[^\gamma\]

Regarding the decomposition of hydrazine which indicates that elevated temperatures over \((700 \text{~C})\) are required for predicable decomposition to occur. In the absence of decomposition catalysts, the author mentions that liquid anhydrous hydrazine can be heated to >\(700^\circ\text{C}\) without appreciable decomposition. Similarly, Singer indicates that hydrazine reacts with oxygen very slowly at temperatures <\(70^\circ\text{F} (\approx 21\text{~C})\)^[\[\gamma\]]. Above \((75^\circ\text{F} (\approx 24\text{~C})\), hydrazine is decomposed rapidly to nitrogen, hydrogen and ammonia. Hence, depending on the temperatures reached in boiler systems in thermal power plants, the hydrazine used will decompose to a certain degree. [\[\gamma\]]

The principal benefit of hydrazine is its ability to reduce the oxidized forms of copper and iron \([\gamma]\). Copper oxide is reduced with hydrazine at temperatures as low as \((100^\circ\text{F) (\approx 38\text{~C})}\). Iron oxide \((\text{Fe}_2\text{O}_3)\) can be reduced at a temperature of \((25^\circ\text{F}) (\approx 1\text{~C})\). Reactions of hydrazine in the feed water cycle and boiler are:

\[
\text{Fe}_2\text{O}_3 + \text{N}_2\text{H}_4 \rightarrow 2 \text{FeO} + \text{N}_2 + \text{H}_2\text{O} \quad (\xi)
\]

\[
\text{CuO} + \text{N}_2\text{H}_4 \rightarrow \text{CuO} + \text{N}_2 + \text{H}_2 \quad (\xi)
\]

Production of Hydrazine:

Hydrazine is formed in a multitude of chemical reactions. Only a few processes have acquired commercial importance. These all oxidize ammonia or Urea, an ammonia derivative, to hydrazine. Sodium hypochlorite or hydrogen peroxide is used as the oxidizing agent. Certain processes (Bayer-, \(\text{H}_2\text{O}_2\)-processes) operate in the presence of ketones,\[^\gamma\].

Raschig Process: In the Raschig process, ammonia is oxidized with sodium hypochlorite: \(\text{H}_2\text{O}_2\), hydrazine
Sodium hypochlorite is obtained as a ca. (4 mol/L) solution by mixing chlorine and sodium hydroxide with cooling in a molar ratio of 0:2 (see Fig. 1). This is diluted to ca. (0 mol/L) and reacted with an aqueous ammonia solution (ca. 0.03%) at temperatures around (1°C) (with cooling) forming chloramine and sodium hydroxide [1, 7, 8].

\[
\begin{align*}
\text{NaOH} + \text{Cl}_2 & \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O} & (\gamma) \\
\text{NaOCl} + \text{NH}_3 & \rightarrow \text{NH}_2\text{Cl} + \text{NaOH} & (\lambda) \\
\text{NH}_2\text{Cl} + \text{NaOH} + \text{NH}_3 & \rightarrow \text{N}_2\text{H}_4 + \text{H}_2\text{O} + \text{NaCl} & (\delta) \\
\end{align*}
\]

\[
\begin{align*}
\gamma\text{NaOH} + \gamma\text{Cl}_2 & \rightarrow \gamma\text{NaOCl} + \gamma\text{NaCl} + \gamma\text{H}_2\text{O} & (\gamma) \\
\end{align*}
\]

Figure (1): Scheme of the Raschig process [3].

The alkaline chloramine solution is then reacted, at ca. (11°C) under pressure with a (γ-to-γ) fold molar excess of anhydrous ammonia. The excess ammonia then separated from the reaction mixture, is recycled. Water and the hydrazine-water azeotrope (b.p. 111°C) are distilled off leaving solid sodium chloride. The aqueous hydrazine solution obtained is finally concentrated by distillation. Ca. (γ %) of the theoretical yield is obtained. Important side reactions are:

(Γ) Reaction of chloramine with the hydrazine formation:

\[
\gamma\text{NH}_2\text{Cl} + \text{N}_2\text{H}_4 \rightarrow \text{N}_2 + \gamma\text{NH}_2\text{Cl} \quad (\gamma) 
\]

This reaction is particularly catalyzed by copper. A large excess of ammonia and the addition of complexing agents such as ethylenediaminetetra-acetic acid (EDTA) are used as countermeasures [8].

(γ) Decomposition of hydrazine during its evaporation from solid sodium chloride, if hydrazine hydrate is not required, hydrazine can be precipitated out from the Raschig synthesis reaction mixture as the sparingly soluble hydrazine sulfate (N₂H₆⁺ + SO₄⁻, solubility in water: 1.45 g/L) [8].

Urea Process:

In this process a mixture of urea, sodium hypochlorite and sodium hydroxide is converted into hydrazine, sodium chloride and sodium carbonate [1, 3].

\[
\text{H}_2\text{NCONH}_2 + \gamma\text{NaOCl} + \gamma\text{NaOH} \rightarrow \text{N}_2\text{H}_4 + \gamma\text{NaCl} + \gamma\text{Na}_2\text{CO}_3 + \gamma\text{H}_2\text{O} \quad (\gamma) 
\]

The reaction components are mixed cold in the above molar ratios and the mixture rapidly heated to (11°C). The working up is the same as with the Raschig process, giving (γ to γ) % of the theoretical yield of hydrazine. The advantages of this process are the avoidance of a large excess of ammonia and working at atmospheric pressure, which must be set against the serious disadvantage of
using two moles of sodium hydroxide per mole of hydrazine. Furthermore, the production of a sodium chloride-sodium carbonate-mixture poses an additional ecological problem \[1,4\].

**Bayer Process**

Of a number of hydrazine syntheses based on the oxidation of ammonia with sodium hypochlorite in the presence of ketones (acetone, methyl ethyl ketone) (see Fig. 7), only that of Bayer A.G. appears to have graduated to a commercial process \[1,4\]. The two main reactions are the formation and hydrolysis of acetone azine:

\[
\text{NaOCl} + \text{NH}_2 + \chi \text{CH}_2\text{COCH}_2 + \text{acetone azine} \rightarrow (\text{CH}_2)\text{C}=\text{N}-\text{N}=\text{C}(\text{CH}_2)\text{C} + \text{NaCl} + \rho \text{H}_2\text{O} \quad (\chi) \\
(\text{CH}_2)\text{C}=\text{N}-\text{N}=\text{C}(\text{CH}_2)\text{C} \rightarrow \chi \text{CH}_2\text{COCH}_2 + \text{N}_2\text{H}_4 \quad (\xi)
\]

The formation of azine is not a means of trapping the hydrazine formed in the Raschig process with acetone, the reaction proceeding by way of two distinct intermediates: dimethyl oxazirane and acetone hydrazone, as follows:

\[
\text{NaOCl} + \text{NH}_2 + \chi \text{CH}_2\text{COCH}_2 \rightarrow \text{H}_2\text{C} \quad \text{NH} \quad \text{C} \quad + \text{NaCl} + \text{H}_2\text{O} \quad (\mu) \\
\text{H}_2\text{C} \quad \text{NH} \quad \text{C} \quad + \text{NH}_2 \rightarrow (\text{CH}_2)\text{C}=\text{N}-\text{NH}_2 + \text{H}_2\text{O} \quad (\nu) \\
(\text{CH}_2)\text{C}=\text{N}-\text{NH}_2 + \chi \text{CH}_2\text{COCH}_2 \rightarrow (\text{CH}_2)\text{C}=\text{N}-\text{N}=\text{C}(\text{CH}_2)\text{C} + \text{H}_2\text{O} \quad (\nu')
\]

Sodium hypochlorite solution (ca. \(\chi,\mu\) mol/L), ammonia and acetone in a molar ratio of \(1:15 \div \chi:2\) are reacted together at \((\chi^\circ - \chi^\circ)\). A solution results consisting of \((\chi \div \chi^\circ)\) by weight of acetone azine together with sodium chloride and excess ammonia. This ammonia is distilled off and returned to the reaction. Next, the acetone azine-water-azeotrope (b.p. \(\chi^\circ \circ \circ \circ \) \(\text{C}\)) is distilled off leaving the sodium chloride solution. Herein lies the essential difference from the Raschig process in which the
hydrazine water mixture has to be separated from solid sodium chloride \([\text{solid} NaCl]\). Finally, the acetone azine is hydrolyzed with water in a reaction distillation tower into acetone (head product) and aqueous hydrazine solution (sump product) at temperatures up to \(\sim 100^\circ\text{C}\) and pressures of \(\sim 10\) bar. The hydrazine solution is concentrated to its azeotrope composition of \(64\%\) by weight of hydrazine. The hydrazine yield is \((\sim 90\sim 91)\%\), based on the hypochlorite utilized \([5]\).

**H₂O₂ Process**

This process is similar to the Bayer process except that hydrogen peroxide is used as the oxidizing agent and the ketone used is methyl ethyl ketone:

\[
\begin{array}{c}
\text{H}_2\text{O}_2 + \gamma \text{NH}_2 + \gamma \text{C}_2\text{H}_5\text{COCH}_3 & \rightarrow & \text{C} = \text{N} - \text{N} = \text{C} \\
\text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5
\end{array}
\]

Since the reaction with hydrogen peroxide is too slow, an activator is added as a catalyst, which in the process variant published by ATOCHEM company is a mixture of acetamide, ammonium acetate and sodium hydrogen phosphate. Other catalysts can also be used. The presumed reaction mechanism is similar to that of the Bayer process:

\[
\begin{array}{c}
\text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5 \\
\text{C} = \text{O} & + & \text{H}_2\text{O}_2 & + & \gamma \text{NH}_2 & \rightarrow & \text{C} - \text{NH} & + & \gamma \text{H}_2\text{O} \\
\text{CH}_3 & & \text{CH}_3 & & \text{CH}_3 & & \text{O}
\end{array}
\]

\[
\begin{array}{c}
\text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5 \\
\text{C} - \text{N} - \text{NH}_2 & & \text{O} & & \text{C}_2\text{H}_5 \\
\text{CH}_3 & & \text{CH}_3 & & \text{CH}_3
\end{array}
\]

\[
\begin{array}{c}
\text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5 & & \text{C}_2\text{H}_5 \\
\text{C} = \text{N} - \text{N} = \text{C} & & \text{CH}_3 & & \text{CH}_3 & & \text{CH}_3
\end{array}
\]

The methyl ethyl ketone azine formed, which is poorly soluble in water, is separated and hydrolyzed to hydrazine and ketone. The catalyst-containing aqueous solution is returned to the synthesis \([1^*, 5]\). This process is operated commercially by ATOCHEM in France and in a very similar process by Mitsubishi Gas Chemicals in Japan. The advantage of this process over the Bayer and Raschig processes is that sodium chloride is not formed as a byproduct \([5]\).

**Experimental Part**

**Materials:**

\(\downarrow\) - Urea, local markets.

\(\uparrow\) - Sodium hypochlorite, Al-Furat State Co.

\(\Uparrow\) - Sodium hydroxide, Al-Furat State Co.

\(\Rightarrow\) - Gelatin, local markets.

\(\Rightarrow\) - Distilled water.
Equipment and Devi

- Fume hood
- Magnetic stirrer
- Conical flasks
- Beakers
- Chiller
- Watch glass
- Electrical Heater
- Funnel
- Thermometer
- Stirring rod
- Electrical scale
- Burette
- Colorimeter (Neo-arator / Lovibond / England).

Procedure

The synthesis of hydrazine from urea and sodium hypochlorite was studied. In this research it has been taken different concentrations of reaction materials and studying there effects on the production of hydrazine in order to obtain the higher concentration as shown in results.

A- Preparation of NaOCl/NaOH Solution:

1. Place (10 mL) of (10 %) NaOCl solution in conical flask and cool to at least (30 °C) (10 °F).
2. Using a magnetic stirrer mix in (NaOH) to the cooled (NaOCl) solution (4 g), then chill to (40 °C).

B- Preparation of Urea / Gelatin Solution:

1. Place (1 mL) of water in a (10 mL) beaker. Sprinkle in the (4 g) of gelatin, breaking it up and dispersing it with a stirring rod. Add 10 mL of boiling water and stir the gelatin until dissolved.
2. Add (1 mL) of hot water to a (10 mL) beaker. Then add (1 g) of urea and stir until dissolved.
3. Pour the gelatin solution into the urea solution and stir until mixed.

C- Preparation of Hydrazine Solution:

This is to be done in the hood as hydrazine is toxic.

1. Place the stir bar in the 1-liter flask and place on the magnetic stirrer/hotplate. Insert the funnel in the flask.
2. When the hypochlorite solution has warmed to (30 °C), set the stir bar at (100 rpm) and pour the hypochlorite solution into the flask. Install the funnel in the flask. Then pour in the urea/gelatin solution through the funnel. Immediately raise the stir bar speed as required.
3. Cover the funnel with watch glass. The reaction initiates immediately and a snow white foam will rise to fill the flask to about the (10 mL) level. After a few minutes the foam will begin to subside and the solution will turn translucent orange, and heat up. Turn down the stir rate to prevent foam generation. Apply heat steadily to drive the solution to boiling(approximately (100 °C)). The color will fade to a pale yellow then to almost clear. The clear color indicates the endpoint of the reaction. At this point heating is stopped.
4. Remove the overflow funnel and place a small watch glass over the mouth of the flask to exclude air. The watch glass will allow any (CO2) to escape and also prevent a vacuum from forming [4].

Detection and Determination of Hydrazine Hydrate:

1. Detection and determination of hydrazine by Colorimetric method:

P- Dimethyaminobenzaldehyde with hydrazine produce yellow colored, stable hydrazones in acid solution.

Procedure

Place (0.5 mL) of the sample into (20 mm) trough, add (0.5 mL) of reagent I(Reagent I:- dissolve 1 gm of p-Dimethyl amino benzaldehyde in (10 mL) of 1N sulphuric acid ) and mix by means of glass rod.

Insert it into the right-hand compartment of the Neo-comparator.

Fill the other trough with mixture of (0.5 mL) of the distilled water and (0.5 mL) reagent I ( if the hydrazine sample is turbid use dist. Water only for compensation ).

Compare the color by revolving the standard disk. The number appearing at the lower peep-hole will directly indicate the (mg/L) of (N2H4).

If the colored solution is darker than standard (10 mg/L), transfer colored solution and compensation liquid into trough (20 mm) liquid depth, compare colors, and multiply by (4) the values read from the disk.
In case if hydrazine concentration above (\( \gamma \) mg/L), the hydrazine sample should be pre diluted with distilled water, values from the disk have to be multiplied by a factor corresponding to the dilution \(^{11}\).

Calculation:
\[
\text{Hydrazine conc. mg/L} = \text{hydrazine conc. %} \times \text{volume from Burette} \times 1000 / \text{s}.
\]

1) Determination of Hydrazine by oxidation with Potassium Iodate

Procedure:
Measure exactly (\( \gamma \) mL) of the sample from the burette into a stoppered flask dilute to (\( \gamma \) mL), add (\( \gamma \) mL) HCL conc. A.R. \& (\( \gamma \) mL) of CCl\(_4\), titrate slowly with (\( \gamma \) M) KIO\(_5\) until the violet color changes to colorless \(^{11}\).

Calculation:
\[
(\text{consumed ml} \times \gamma \times \gamma \times \gamma) / \gamma = \text{g/l Hydrazine as N}_2\text{H}_4
\]

2) Determination of Hydrazine by Iodimetric Method in the lab of T.P.S. (Treatment Water Unit in Al-Mussayab Power Station)

Procedure:
1) Take (\( \gamma \) mL) from the sample.
2) Add (\( \gamma \) mL) from (\( \gamma \) %) sodium bicarbonate solution.
3) Add some drops from starch indicator.
4) Titrate the sample with (\( \gamma \) M) Iodine solution.
5) End point with blue-violet color.

Calculation:
Hydrazine conc. In ppm = volume from Burette \* (\( \gamma \times \gamma \times \gamma \) / s).

\[
(\text{Hydrazine conc. ppm} = \text{hydrazine conc. %} \times \text{volume from Burette} \times 1000 / \text{s}.
\]

Results
Firstly, quantitative analysis for our prepared samples has been done using colorimetric method by Colorimeter in Al-Furat Co. lab. Obviously, the result was positive where they showed a yellow color that indicate the formation of hydrazine compounds.

Studying of effects of gelatin amount which using as percentage of hydrazine production was studied. Different amount of gelatin has been taken and in the end of any experiment the amount of hydrazine produced as shown in table no.\(^{1}\).

<table>
<thead>
<tr>
<th>Gelatin used in gram</th>
<th>Hydrazine %*</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td>( \gamma )</td>
</tr>
<tr>
<td>( \gamma \times \gamma )</td>
<td>( \gamma )</td>
</tr>
<tr>
<td>( \gamma \times \gamma \times \gamma )</td>
<td>( \gamma )</td>
</tr>
<tr>
<td>( \gamma \times \gamma \times \gamma \times \gamma )</td>
<td>( \gamma )</td>
</tr>
</tbody>
</table>

Studying of effect of hypochlorite concentration on the hydrazine produced percentage. different amount of hydrazine produced has been examined as shown in table no.\(^{2}\).
Table (1) The effect of concentration NaOCl % on hydrazine% product.

<table>
<thead>
<tr>
<th>NaOCl%</th>
<th>Hydrazine%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\frac{1}{4})</td>
<td>(2)</td>
</tr>
<tr>
<td>(\frac{1}{2})</td>
<td>(4)</td>
</tr>
<tr>
<td>(1)</td>
<td>(4)</td>
</tr>
<tr>
<td>(\frac{1}{8})</td>
<td>(7)</td>
</tr>
<tr>
<td>(\frac{1}{6})</td>
<td>(7)</td>
</tr>
</tbody>
</table>

* Determined in the lab of T.P.S. (Treatment Water Unit in Al-Mussayab Power Station).

**Discussion**

Table no. 1 shows different amount of gelatin has been taken to obtain high concentration of hydrazine hydrate and noticed that the effectiveness of gelatin on the reaction it has been demonstrated clearly by using of \((\cdot,\cdot,\cdot)\) g from gelatin where it gave the higher concentration of hydrazine hydrate which is \((\cdot,\cdot,\cdot)\) and when using of \((\cdot,\cdot,\cdot)\) g gelatin in the reaction the concentration of hydrazine was stable \((\cdot,\cdot,\cdot)\), when using less amount of gelatin \((\cdot,\cdot,\cdot)\) g lead to giving less concentration of hydrazine \((\cdot,\cdot,\cdot)\). Gelatin works as inhibitor for side reaction. Table no. 1 shows different concentrations of sodium hypochlorite has been taken and noticed that higher concentration of hydrazine \((\cdot,\cdot,\cdot)\) was obtained using higher concentration of sodium hypochlorite \((\cdot,\cdot,\cdot)\), implying that the concentration of hydrazine decreases with decreasing concentration of sodium hypochlorite, sodium hypochlorite works as oxidizing agent for urea to produce hydrazine.

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تحضير الهيدرازين المائي من اليوريا وهايبوكلوريت الصوديوم

الخلاصة

توجد طرق عديدة لإنتاج مادة الهيدرازين المائي وكما مذكور في الأدبيات. أفضل طريقة تم اختيارها (urea process) اعتمادا على توفر المواد الأولية في شركة الفرات العامة للصناعات الكيمياوية والبيوتيدات، السوق المحلي، سهولة التطبيق العملي للطريقة. لقد تم دراسة تحضير مادة الهيدرازين المائي من مادة اليوريا وهايبوكلوريت الصوديوم (urea process ) (14 % NaCl) (60 % NaOH) (47.8 g) (341 g) (500 g) (75 g) (4244 g) (1432 g) (74 g) (207 g) في مختبر وحدة المعالجة في محطة كهرباء المسيب (T.P.S. ) وعينت النماذج أن أعلى تركيز للهيدرازين المائي المحضر هو (52 %) تـُمـ الحصول عليه باستخـدام (14 %) هايبوكلوريت الصوديوم (441 g) (747 g) (478 g) (400 g) جيلاتين ودرجة حرارة (100 °C) وسرعة خلط (120 rpm).

الكلمات المفتاحية : الهيدرازين المائي | طريقة راشنك | طريقة اليوريا | الكشف عن الهيدرازين | طارد الأوكسجين.