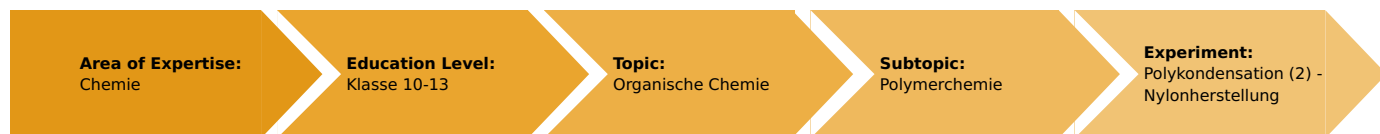


# Polycondensation (2) - Production of nylon (Item No.: P7181300)

## Curricular Relevance



### Difficulty



Intermediate

### Preparation Time



10 Minutes

### Execution Time



20 Minutes

### Recommended Group Size



2 Students

### Additional Requirements:

### Experiment Variations:

### Keywords:

polymers, nylon, polycondensation

## Task and equipment

### Information for teachers

### Learning objectives

- Sebacyn chloride and hexamethylene diamine react with each to form a polymer.
- If the substances are dissolved in solvents of different density, the condensation occurs on the phase boundary. A thread can be continuously pulled out.

### Notes on set-up and procedure

Since sebacyn chloride forms hydrochloric acid in humid air and it is highly corrosive, the solution can also be dissolved in petrol directly before the lesson begins and can be provided to the students as a ready reagent.



### Hazard and Precautionary statements

Sodium hydroxide

- H290: May be corrosive to metals.  
 H314: Causes severe skin burns and eye damage.  
 P280: Wear protective gloves/protective clothing/eye protection/face protection.  
 P301 + P330 + P331: IF SWALLOWED: rinse mouth. Do NOT induce vomiting.  
 P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
 P309 + P310: IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Petrol  
 H225: Highly flammable liquid and vapour.  
 H304: May be fatal if swallowed and enters airways.  
 H411: Toxic to aquatic life with long lasting effects.  
 P210: Keep away from heat/sparks/open flames/hot surfaces. No smoking.  
 P273: Avoid release to the environment.  
 P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.  
 P501: Dispose of contents/container in accordance with applicable local, regional, national, and/or international regulations.

Raw alcohol for burning:

H225: Highly flammable liquid and vapour.  
 P210: Keep away from heat/sparks/open flames/hot surfaces. No smoking.  
 P233: Keep container tightly closed.  
 P240: Ground/bond container and receiving equipment.  
 P403 + P235: Store in a well-ventilated place. Keep cool.

Hexamethylene diamine

H302: Harmful if swallowed.  
 H312: Harmful in contact with skin.  
 H314: Causes severe skin burns and eye damage.  
 H335: May cause respiratory irritation.  
 P280: Wear protective gloves/protective clothing/eye protection/face protection.  
 P302 + P352: IF ON SKIN: Wash with plenty of soap and water.  
 P301 + P330 + P331: IF SWALLOWED: rinse mouth. Do NOT induce vomiting.  
 P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
 P309 + P310: IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Phenolphthalein solution 0.5 % in EtOH

H226: Flammable liquid and vapour.  
 H350: May cause cancer.  
 H314: Causes severe skin burns and eye damage.  
 P210: Keep away from heat/sparks/open flames/hot surfaces. No smoking.  
 P233: Keep container tightly closed.  
 P281: Use personal protective equipment as required.  
 P308 + P313: IF exposed or concerned: Get medical advice/attention.

Sebacoyl chloride

H302: Harmful if swallowed.  
 H314: Causes severe skin burns and eye damage.  
 H335: May cause respiratory irritation.  
 P280: Wear protective gloves/protective clothing/eye protection/face protection.  
 P301 + P330 + P331: IF SWALLOWED: rinse mouth. Do NOT induce vomiting.  
 P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
 P309 + P310: IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.

## Remarks on the students' experiments

Make sure that the addition of hexamethylene diamine solution is done very carefully. There must be no turbulence or mixing. It is recommendable to slowly pour the hexamethylene diamine solution over a glass rod along the inner wall of the beaker. This can be practiced e.g. with water in advanced. The resulting thread breaks relatively easily, the winding up must be restarted with a new thread. Particularly interesting is the winding up on a bobbin e.g. such a self-made reel spool (or 35001-00), which can be attached to the support rod. In this way, a tearing of the thread can be largely avoided by slow and continuous rotation.

## Hazards

- Sebacyn chloride and sodium hydroxide are highly corrosive. Wear protective gloves and protective glasses!
- Petrol is harmful. Use the fume hood whenever possible or air the room well!

## Notes

The interfacial condensation is a industrially hardly used procedure, since the production of polyamides by melting leads to better results. The starting materials used for the condensation can be greatly varied, so that a huge number of different polyamides is produced. The polymer produced under these experimental conditions is called nylon 610 (read: six, ten).

## Remarks on the method

This experiment proves to be extremely attractive, and its evaluation is highly motivating with special regard to the interface effects. A comparison with the formation of polyamide on heating is recommended. In the last years of secondary school can be pointed out to the thermodynamic stability of the molecules originating during the condensation like water or hydrogen chloride which constitute a cause for the reaction process.

## Waste disposal

- Dispose of the reaction mixture in the collective container for non-combustible organic solvents.

# Polycondensation (2) - Production of nylon (Item No.: P7181300)

## Task and equipment

### Task

#### How is nylon made?

Produce a reaction of sebacoyl chloride with hexamethylene diamine.



## Equipment



Position No.	Material	Order No.	Quantity
1	Dish, plastic, 150x150x65 mm	33928-00	1
2	Spoon, special steel	33398-00	1
3	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
4	Erlenmeyer flask 100 ml, narrow neck, PN 19	36418-00	1
5	Glass beaker DURAN®, short, 150 ml	36012-00	1
6	Rubber gloves, size S (7)	39325-00	1
7	Wash bottle, 250 ml, plastic	33930-00	1
8	Tweezers, l = 130 mm, straight, blunt	64610-00	1
9	Grad.cylinder,high,PP,50ml	46287-01	1
10	Graduated cylinder, 10 ml, plastic	36636-00	1
11	Protecting glasses, clear glass	39316-00	1
	Portable Balance, OHAUS CS200E, 200 g / 0,1 g	48910-00	1
	Sodium hydroxide, pellets, 500 g	30157-50	1
	Benzine, tech.gr.,100-140C,1000ml	30037-70	
	Denaturated alcohol (spirit for burning), 1000 ml	31150-70	
	Water, distilled 5 l	31246-81	
	Hexamethylene diamine 25 g	31367-04	
	Phenolphthalein, 0.5% soution in ethanol, 100 ml	31715-10	
	Sebacoyn dichloride f.synth.25 ml	31833-04	

## Set-up and procedure

### Set-up

### Hazards

- Sebacyn chloride and sodium hydroxide are highly corrosive. Wear protective gloves and protective glasses!
- Petrol is harmful. Use the fume hood whenever possible or air the room well!



### Procedure

### Procedure

Pour into the beaker 30 ml distilled water (Fig. 1), add 2.4 g of hexamethylene diamine (Fig. 2) and 0.6 g of sodium hydroxide (Fig. 3). Stir with a glass rod until the substances have been completely dissolved, colour the solution with a few drops of phenolphthalein (Fig. 4).



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Fill the Erlenmeyer flask with 30 ml of petrol (Fig. 5), dissolve in it 1.2 ml of sebacyn chloride (Fig. 6).



Fig. 5



Fig. 6

Carefully pour a layer of sebacoyl solution on over the aqueous hexamethylenediamine solution. Make sure that the substances do not mix (Fig. 7).



Fig. 7

Pull out the skin forming in the interface by means of the tweezers (Fig. 8), wrap it around the glass rod and pull out a thread from the solutions by turning continuously the glass rod (Fig. 9).



Fig. 8



Fig. 9

Insert the thread rolled in the glass rod in the dish filled with methylated alcohol / water-mixture, wash the thread in it (Fig. 10) and then dry it in the dry cupboard.



Fig. 10

## Waste disposal

Dispose of the reaction mixture in the collective container for non-combustible organic solvents.



## Report: Polycondensation (2) - Production of nylon

### Result - Observations

Write down your observations in general form.

.....

.....

.....

.....

### Evaluation - Question 1

Draw the conclusions from your observations.

.....

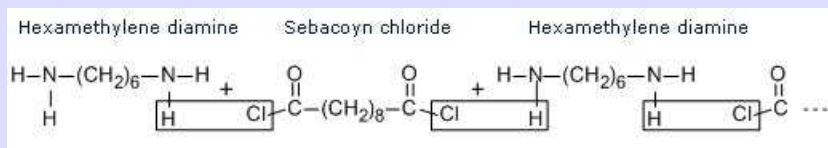
.....

.....

.....

### Evaluation - Question 2

Sebacoyn chloride and hexamethylene diamine have the following structure:



Formulate a statement about the progression of the reaction according to the structure of sebacoyn chloride and hexamethylene diamine .

### Evaluation - Question 3

What type of reaction has taken place? Which substance has been split-off here?

.....

.....

.....

.....