**MICRORREACTOR FABRICATION FOR THE SYNTHESIS OF MAGNETITE NANOPARTICLES**

***Version 1.0***

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# OBJECTIVE

It is intended to assemble a reactor that can produce magnetite on a nano-scale.

# REQUIREMENTS

To assemble the reactor following this guide, it is necessary to have knowledge in preparing solutions at a given concentration.

# EQUIPMENT REQUIREMENTS

"Laser cutter" present in Ml 304. Cole-Parmer dual syringe pump present in ##. 10 ml syringes.

# STEP BY STEP

# CORTADO LASER

The first step in the production of the reactor is the laser cutting process, in which the pieces are cut. This particular reactor consists of three pieces: two covers and the reaction volume. This part of the process is not explained in this guide as it is necessary to go to the biomedical laboratory with a student who has been trained to use the equipment during their studies.

*Pieces obtained in laser cutting:*

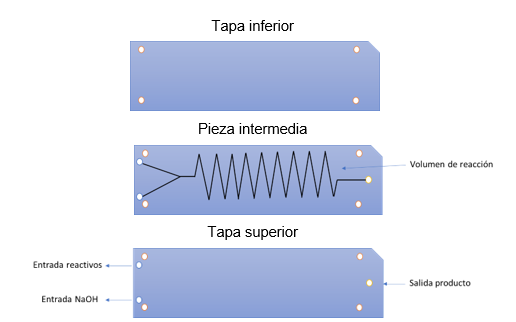


Figure 1: Reactor parts

*Where the colors of the spaces in the diagrams represent:*

Screw holes space

Chemical input (reactants and pH control)

Product output

## ASSEMBLY

To assemble the reactor, the following materials are required:

• Top reactor cap

• Middle reactor piece

• Bottom reactor cap

• Methylene chloride (acrylic adhesive)

• Screws with their respective nut diameter of the screw space X4

• Plastic tubes with the diameter of the reactor inlet and outlet X3

• Metal container larger than the reactor pieces, 5 cm long

• Metal tweezers

• Weight (metal bar of more than 1 kg)

• Liquid silicone

• Metal rivet X3

The steps are as follows:

1. Remove excess acrylic pieces from cut spaces (such as screw spaces and reaction volume. For the reaction volume, it was found that it is better to puncture the corners or tips of the volume with a pin)
2. Place the screws in the screw spaces of the bottom cap.
3. Place the bottom cap with the screws on the table, with the screw heads facing up.
4. Take the metal container and pour enough methylene chloride onto it so that the entire base contains adhesive. The following steps need to be done quickly as methylene chloride evaporates.
5. Take the tweezers and grab the middle reactor piece, then place it on the adhesive. Leave it there for a minute.
6. Place the middle piece on the bottom piece so that the screws also fit into the screw spaces.
7. Place the weight evenly on the pieces. Leave the weight for two minutes.
8. Take the reactor cap with the tweezers and repeat the same procedure, making sure that the inlet and outlet spaces of the reactor match the other pieces.
9. Store the remaining adhesive in the adhesive jar.
10. Tighten the screws with the nuts.
11. Apply liquid silicone on the bottom side of one of the plastic tubes, being careful not to cover the orifice, and place it in the reactor outlet hole. Press it with your hand for one minute.
12. Repeat the previous step for the inlets.
13. Place a metal rivet on the output of each tube.

*Note: If there is any doubt regarding the language related to the reactor spaces, please refer to Figure 1.*

To finish assembling the reactor, it is necessary to check for any leaks, so the following steps must be followed.

1. Grab a syringe.
2. Add a volume of water greater than 5 mL.
3. Connect the syringe to one of the rivets.
4. Slowly empty the syringe to observe if water leaks out.

If the water leaks out, it's necessary to perform a gluing procedure with methylene chloride just like the one already done, but in order to glue all sides of the reactor.

The assembled reactor should look something like this.



Figure 2: Microreactor obtained where the colored spaces have the same meaning as in figure 1, and the tubes represent the plastic tubes with their respective rivets.

## PREPARATION OF REAGENTS

For this procedure, it is necessary to follow the protocol for the synthesis of magnetic nanoparticles by the chemical co-precipitation method.

## SET-UP OF THE SYRINGE PUMP

The syringe pump is a crucial equipment for the operation of the nanoparticle reactor, as it ensures a constant flow for extended periods of time, which cannot be achieved by manually operating a syringe. This experiment requires a dual-syringe pump, as it needs both a reactant inlet and a pH control inlet.

To start the set-up of the syringe pump, first fill the 10 mL syringes with the respective reagents and NaOH, and connect them to the corresponding fittings on the reactor. Once this is done, the process of assembling the pump can be started, as shown below.

1. First, it is necessary to mount the syringes on the pump, so first, you need to loosen the upper right screw of the pump by turning it to the left.



Figure 3: Top part of the syringe pump.

1. Once this screw has been loosened, it is necessary to position the two syringes in such a way that the end of the syringe plunger and the end of the syringe tube fit between the metal grooves of the pump, as shown in Figure 4.

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Figura 4: Top view of the syringe pump.

1. In Figure 4, it can also be observed that two syringes can fit, although only one is currently installed.
2. Once the syringes have been positioned, the pump can be aligned for operation. Figure 5 shows the main menu of the pump.



Figura 5: Main menu of the syringe pump.

1. As seen in the previous figure, there are 4 important steps in the Set-Up that need to be considered. The first step, highlighted in orange, is to determine the type of operation to be performed. When this button is pressed, the following is displayed.



Figure 6: Syringe pump operation type.

1. In Figure 6, it can be observed that this pump can perform four types of operations, where "infuse" refers to injecting fluid and "withdraw" refers to extracting fluid. In this particular case, we only want to inject fluid into the reactor, so "infuse only" was selected and "entr" was set.
2. For the second step, shown in yellow, it is necessary to choose the type of syringe. For this case, a 10 ml plastic syringe was selected.



Figure : syringe size

1. The third step, highlighted in green, involves setting the flow rate of fluid to be injected per minute, so the desired flow rate in ml is selected and "entr" is set.



Figure : Flow rate selection.

1. The fourth step, highlighted in blue, is not necessary for this experiment, but in case you do not want to empty the entire syringe, you can set a desired volume to be injected.
2. Finally, once everything else has been set, press the "RUN" button, highlighted in purple in the guide (Figure 5). A summary of the selections should appear on the screen. To stop the process for any reason, press the stop button, as shown in Figure 9.



Figura : Resumen del proceso.

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