

RayDrop®

Cleaning Procedure

Version: September 2025





This document describes the procedure to clean the different parts of a RayDrop: injection insert equipped with a double emulsion nozzle, collection insert equipped with a glass capillary, and RayDrop chamber in which both inserts are laterally introduced.

Safety precautions



safety glasses



adequate gloves



lab coat

WARNING: always use lab goggles and gloves

WARNING: always check the chemical compatibility between the chemicals and the materials in contact with them (syringe, filter, tubing, connectors, RayDrop,...)

WARNING: the procedures described in this document have been successfully tested by Secoya in numerous scenarios. However, this list is not exhaustive, and Secoya makes no warranty, express or implied, as to the success of such procedures. In the event of failure, please contact your reseller, who may arrange for after-sales service.

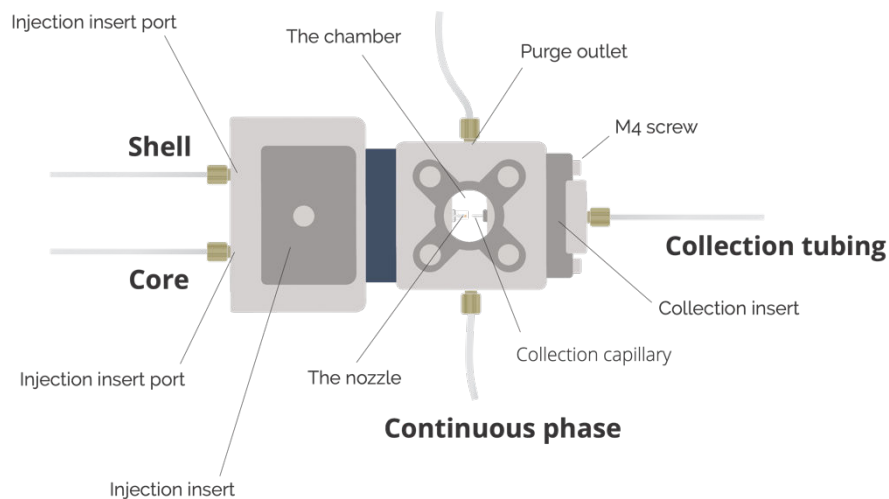
Material needed :

- Luer-lock glass or plastic syringe 5 mL or smaller. Always check the chemical compatibility between the syringe and the fluid in contact.
- Quick connect luer adapter (Upchurch Idex P-624)
- Quick connect luer adapter female luer to 1/4-28 female (Upchurch Idex P-658 or P-678)
- Plug for 1/4-28 flat bottom port (Upchurch Idex P-309)



- Allen (Hex) key M4

Detailed view of the RayDrop device



1. Injection insert

To confirm that the clogging is in the injection insert, slightly unscrew the nut connected to the problematic entry point of the insert (core or shell), apply pressure to the relevant reservoir, and observe the flow rate.

- If it does not increase significantly, this means that the blockage is caused by a problem upstream of RayDrop (clogged tubing or filter, valve in a wrong position).
- If it increases significantly, this means that the blockage is in the injection insert and the procedures described below can be followed.

The nozzle or the capillary connected to it may become clogged by **external contaminants**, such as dust or debris, or by the **chemicals** injected by the user that has reacted to form a more viscous substance that clogs the system. In the first case, only mechanical cleaning will be effective, while in the second case, chemical dissolution (+ mechanical cleaning if needed) will be used.



The procedures described below are listed from the mildest to the most aggressive. We recommend always starting with the mildest procedure and progressing to the next level only if the desired result is not achieved.

External contaminant in the nozzle tip perturbing the droplet formation

If the contaminant is a small particle in the nozzle that only perturbs the right formation of the droplets, a quick flowback of the continuous phase in the nozzle can sometimes be enough to solve the problem by changing the orientation of the particle and allowing it to be flushed by the core or shell phase:

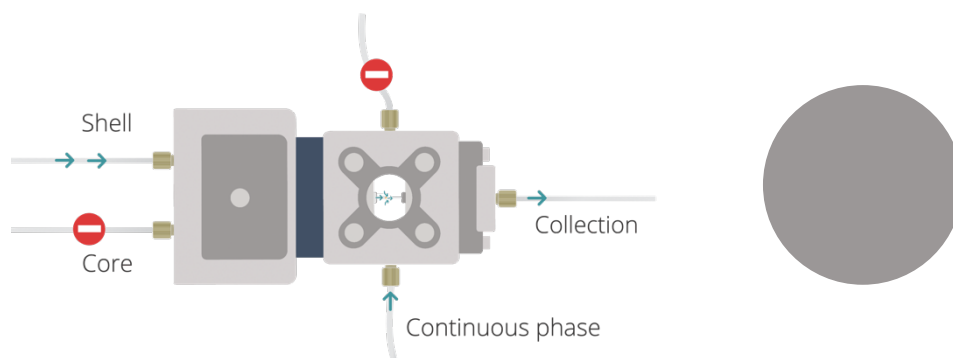
While the Raydrop is running (perturbated droplet formation), slightly unscrew then immediately screw back the fitting connected to the nozzle entry (core or shell) where the particle is located. Repeat several times if needed.

External contaminant clogging the nozzle

In this case, the contaminant severely restricts the flow of fluid, making it impossible to form an emulsion. Several procedures can be used, listed below from the mildest to the most aggressive. We recommend always starting with the mildest procedure and progressing to the next level only if the desired result is not achieved.

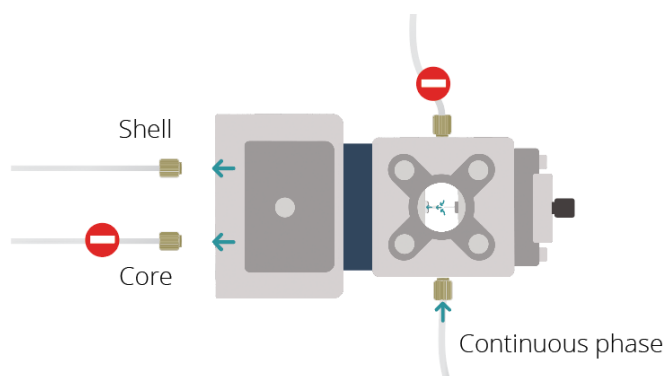
1.1. RayDrop in place on the experimental set-up

- 1.1.1. Increase the nozzle flow rate while adapting the continuous flow rate to ensure that the fluid from the nozzle is extracted by the collection capillary and does not pollute the main chamber.



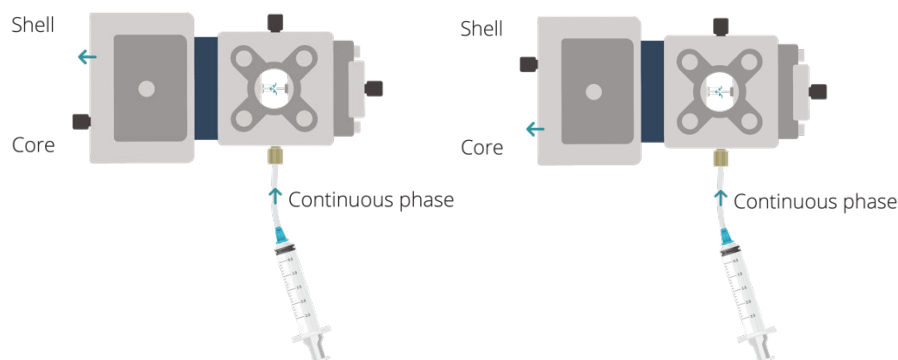


- 1.1.2. Disconnect the tubing connected to the injection insert, then increase the continuous flowrate. To increase the pressure on the nozzle side, you can also close the RayDrop output by disconnecting the output tubing and screwing a plug into the outlet.



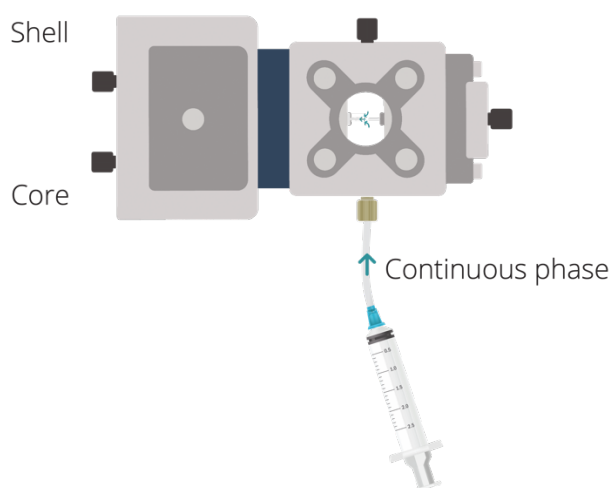
1.2. RayDrop disconnected from the experimental setup

- 1.2.1. Using a luer-lock syringe and a quick connect luer adapter (Upchurch IDEX P-624) fill the chamber with the continuous phase used during the experiment then screw a plug (Upchurch IDEX P-309) on the collection insert port, on the purge port of the chamber and on the unblocked port of the injection insert (core or shell). Press down firmly on the syringe plunger to push the liquid from the chamber into the injection insert. **The smaller the syringe's diameter, the greater the pressure.** Be careful to always use filtered solution to avoid introducing new contaminants in the system.





- 1.2.2. Flush alternatively from the chamber to the insert (syringe connected to the chamber) and from the insert to the chamber (syringe connected to the insert). Note that connecting the syringe to either the top or bottom port of the chamber can make a difference regarding the position of the clog.
- 1.2.3. Fill the main chamber with continuous phase then screw a plug on each port of the RayDrop. Put the RayDrop in the basket of an ultrasonic bath filled with water and sonicate for a few minutes.



⚠ WARNING: Secoya has successfully tested this sonication procedure on numerous occasions without causing any damage to the nozzle, using a Branson E-MT 2510 ultrasonic bath operating at 42 kHz with a power output of 100 W. Secoya makes no representations or warranties, express or implied, regarding the outcome of this procedure when performed with any other type or model of ultrasonic bath.



1.1.2.d Alternate between sonication and flushing.

Chemical Clogging

In this situation, clogging is caused by an undesired solidification of one liquid phases introduced by the user into the RayDrop. For example, undesired gelation, precipitation or polymerization of one of the compounds can lead to a clog forming in the nozzle. All of the above procedures are applicable. However, chemical cleaning can be added to mechanical cleaning by replacing the continuous phase with a solvent that will dissolve the blockage.

The following cleaning agent can be used :

- Acetone
- Ethanol
- Isopropanol
- Ethyl acetate
- Butyl acetate
- NaOH 1 M (10 minutes maximum)
- HCl 1 M (glass nozzle only)
- Dichloromethane (glass nozzle only)



WARNING:

Check first the solvent compatibility with the RayDrop.
If in doubt, contact your dealer.



Cleaning Procedure

2. Collection insert

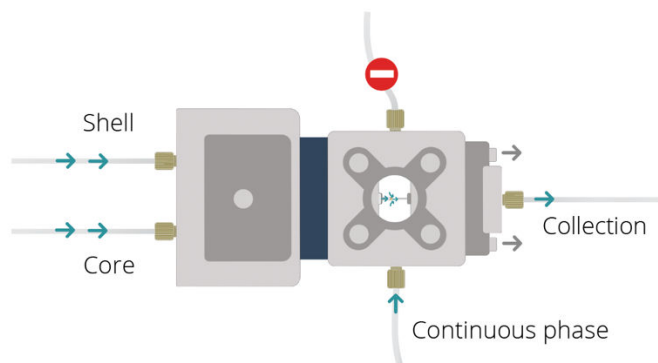
Several situations may arise that require cleaning of the outlet capillary.

2.1. Dust particle stuck between the injection nozzle and the extraction capillary

Due to its elongated shape, which is larger than the space between the nozzle and the capillary, the particle is bent and stays blocked even when the flowrate is increased.

2.1.1. RayDrop in place on the experimental setup

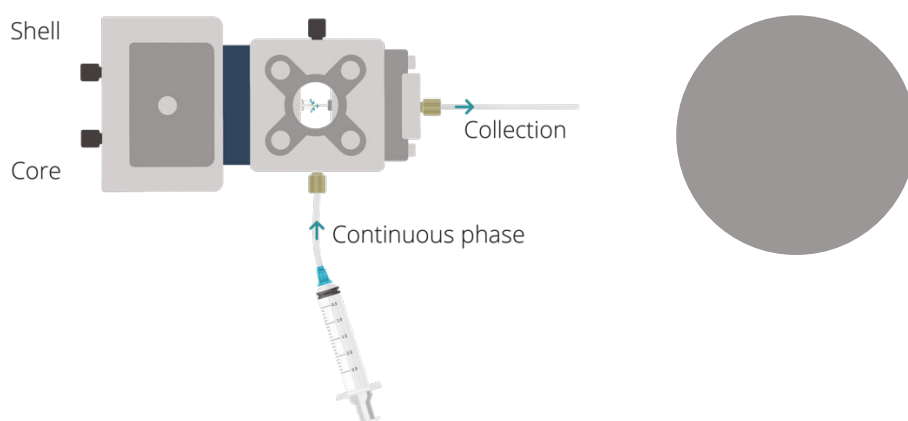
Using an Allen key M4, slightly unscrew the screws pressing the insert onto the chamber in order to increase the distance between the nozzle and the capillary. The dust particle could now have enough room to be aligned with the extraction capillary and flushed away. Don't forget to screw back the insert to ensure a perfect alignment between the nozzle and the extraction capillary.



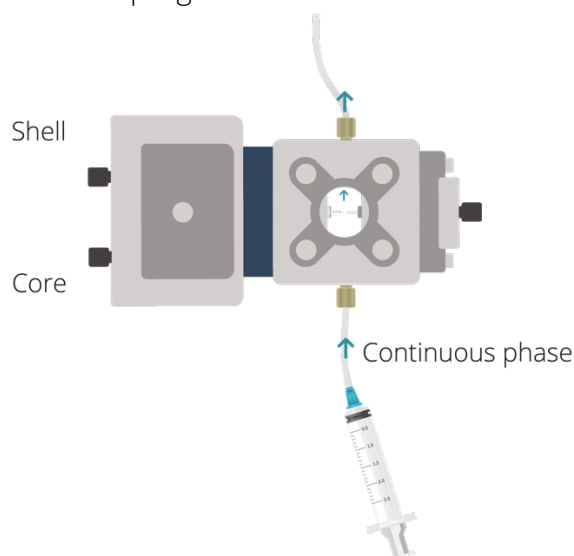


2.1.2. RayDrop disconnected from the experimental setup

2.1.2.1. Using a luer-lock syringe and a quick connect luer adapter (Upchurch Idex P-624) fill the chamber with the continuous phase used during the experiment then screw a plug (Upchurch Idex P-309) on the injection insert ports and on the purge port of the chamber. Press down firmly on the syringe plunger to push the liquid from the chamber to the extraction capillary.



2.1.2.2. If the dust is still present, try to push it to the purge outlet. Using a luer-lock syringe and a quick connect luer adapter (Upchurch Idex P-624) fill the chamber with the continuous phase used during the experiment then screw plugs (Upchurch Idex P-309) on the injection insert ports and removed the plug on the purge port. Press down firmly on the syringe plunger to push the liquid from the chamber to the purge outlet.





2.2. Air bubble stuck between the injection nozzle and the extraction capillary

2.2.1. RayDrop in place on the experimental setup

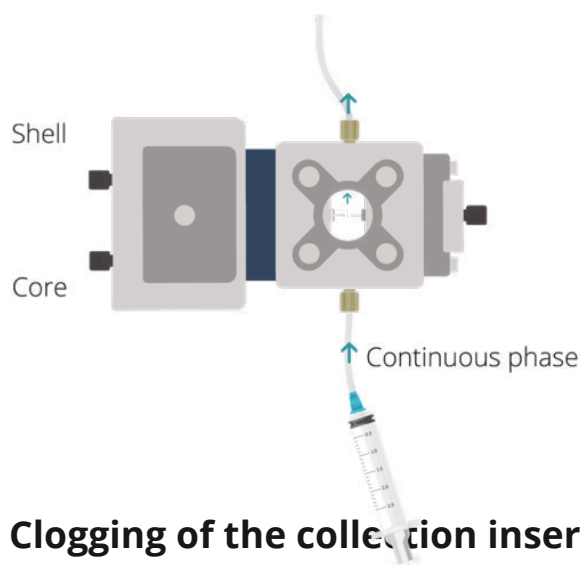
2.2.1.1. Increase the continuous flowrate to push the bubble to the extraction capillary. If it does not solve the problem, slightly unscrew the screws pressing the insert onto the chamber in order to increase the distance between the nozzle and the capillary. Don't forget to screw back the insert to ensure a perfect alignment between the nozzle and the extraction capillary.

2.2.1.2. Stop the dispersed phase (core and shell) and increase the continuous phase. Slightly unscrew then immediately screw back the purge fitting located on the top of the RayDrop chamber. This will create a rapid flow of liquid that can dislodge the bubbles and carry them to the top of the chamber.



2.2.2. RayDrop disconnected from the experimental setup

2.2.2.1. Using a luer-lock syringe and a quick connect luer adapter (Upchurch IDEX P-624) fill the chamber with the continuous phase used during the experiment then screw plugs (Upchurch IDEX P-309) on the injection insert ports and removed the plug on the purge port. Press down firmly on the syringe plunger to push the liquid from the chamber to the purge outlet.



2.3. Clogging of the collection insert

If no fluid is flowing out the outlet tubing of the RayDrop when pressure on the continuous phase is applied, it means that a part of the continuous phase flowpath is blocked. To confirm that the issue is coming from the outlet tubing, slightly unscrew the continuous phase tubing connected to the RayDrop and observe the continuous phase flowrate:

- If it does not increase significantly, this means that the blockage is caused by a problem upstream of RayDrop (clogged tubing or filter, valve in a wrong position).
- If it increases significantly, this means that the clogging is located in the output glass capillary or in the output tubing connected to the insert. To precisely identify the location of the clogging, slightly unscrew the output tubing and observe the continuous flowrate:
 - o If it increases significantly, this means that the clogging is located in the output tubing connected to the output insert. Totally disconnect the



tubing from the RayDrop and flush it using a syringe equipped with a luer-lock connector (Upchurch IDEX or P-658 or P-678). To be able to apply the maximum pressure by hand, use a syringe with the smallest piston diameter (3 mL or 5 mL syringe are recommended). If it doesn't unblock the tubing, install a new tubing.

- If it does not increase significantly, this means that the blockage is located in the glass capillary attached to the output insert. This situation is developed below.

2.3.1. RayDrop in place on the experimental setup

Set the continuous pressure to its maximum (while keeping the nozzle inlets closed to avoid flowback).

2.3.2. RayDrop disconnected from the experimental setup

2.3.2.1. Using a luer-lock syringe and a quick connect luer adapter (Upchurch IDEX P-624) fill the chamber with the continuous phase used during the experiment then screw a plug (Upchurch IDEX P-309) on the injection inserts port and on the purge port of the chamber. Press down firmly on the syringe plunger to push the liquid from the chamber into the collection insert. The smaller the syringe's diameter, the greater the pressure. Be careful to always use filtered solutions to avoid introducing new contaminants into the system.

2.3.2.2. Flush alternatively from the chamber to the insert (syringe connected to the chamber) and from the insert to the chamber (syringe connected to the chamber).

2.3.2.3. Fill the main chamber with continuous phase then screw a plug on each port of the RayDrop. Put the RayDrop in the basket of an ultrasonic bath and sonicate for a few minutes.



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2.3.2.4. Alternate between sonication and flushing

2.3.2.5. Dissolve the clogging using the adapted solvent. In this case the clogging is caused by an undesired solidification of one liquid phases introduced by the user into the RayDrop. For example, undesired gelation, precipitation or polymerization of one of the compounds can lead to a clog forming in the extraction capillary. All of the above procedures are applicable. However, chemical cleaning can be added to mechanical cleaning by replacing the continuous phase with a solvent that will dissolve the blockage.

The following cleaning agent can be used :

- Acetone
- Ethanol
- Isopropanol
- Ethyl acetate
- Butyl acetate
- NaOH 1 M (10 minutes maximum)
- HCl 1 M (glass nozzle only)
- Dichloromethane (glass nozzle only)

⚠ WARNING: Check first the solvent compatibility with



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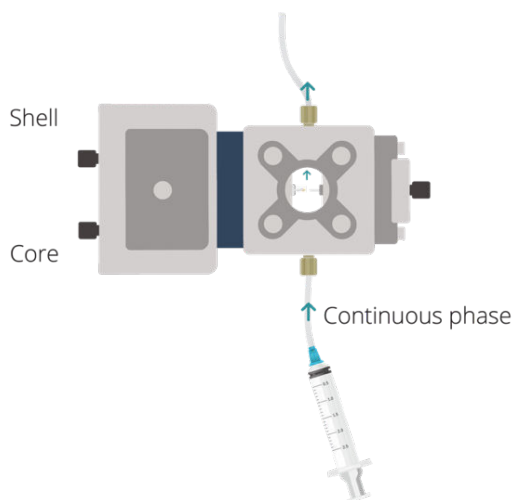
the RayDrop. If in doubt, contact your dealer.

3. RayDrop chamber

In case of pollution of the RayDrop chamber by dust, contaminants or dispersed phase coming from the nozzle, a flush with the continuous phase from the chamber inlet to the purge outlet is the best option. Ultrasonic bath can also be used if necessary.

3.1. Flushing of the chamber

Disconnect the RayDrop from the setup, put plugs on all the ports of the inserts and remove the plug on the purge port. Using a luer-lock syringe and a quick connect luer adapter (Upchurch IDEX P-624) flush the chamber with the continuous phase used during the experiment. Press down firmly on the syringe plunger to push the liquid from the chamber into the purge outlet. Be careful to always use filtered solutions to avoid introducing new contaminants into the system.



3.2. Ultrasonic bath

Disconnect the RayDrop from the setup. Using a luer-lock syringe and a quick connect luer adapter (Upchurch IDEX P-624) fill the chamber with the continuous phase used during the experiment. Put plugs on all the ports (inserts and chamber)



and place the RayDrop in the basket of ultrasonic bath filled with water and sonicate for a few minutes.

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