



DR10 Operating Manual
DR10 Decarboxylation Reactor Operation

Version: 1.2



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SECTION 1: INTRODUCTION

OPERATING PRINCIPLE

Decarboxylation is the process of removing impurities such as solvent residuals, terpenes, and sugars (carbohydrates) from your crude material in order to prepare it for your wiped film. Decarbing your material will ensure a cleaner final product after distillation and minimize the amount of impurities that can collect in your wiped film distillation.

The Decarb step is done after you have recovered a majority of your solvent in a falling film evaporator such as an AutoVap. You should have no more than 10% solvent (even this is a high amount) left in your crude material after your solvent recovery process. By heating your crude material up to 240-265°F (115-130°C), you will be able to remove impurities through evaporation and “caramelize” the sugars (carbohydrates). The sugars will form into small “clumps” that you will most likely want to filter out with a 100 micron filter after you have full decarbed.

The DR10 was not designed to recover large amounts of solvent from your crude material. This is the job of your falling film evaporator. The DR10 will be able to slowly purge off the last 3-5% solvent without issues, but any higher percentage of solvent can add time to the purging process. You will be spending hours recovering solvent, at a lower temperature, before you even reach the decarb step, which normally takes about 30 minutes.

The DR10 uses the combination of heating, cooling, mixing, and vacuum to evenly decarboxylate the “crude” material. The heat is provided by a high temperature oil heater which pumps hot oil through the jacket of the DR10 tank. The chiller pumps a cold mixture of glycol and water through the jacket of the condenser arm. The mixer is mounted on top of the tank and is used to stir the crude material which provides more uniform heating and a faster rate of evaporation. The vacuum pump pulls vacuum from the condenser arm which increases the efficiency of both heating and evaporation.

The procedures throughout this manual are the suggested ones from TruSteel, however, your facility may have a different theory on how you want to decarboxylate your material. Also, keep in mind that crude material may vary from batch to batch and that decarb times can vary as well.

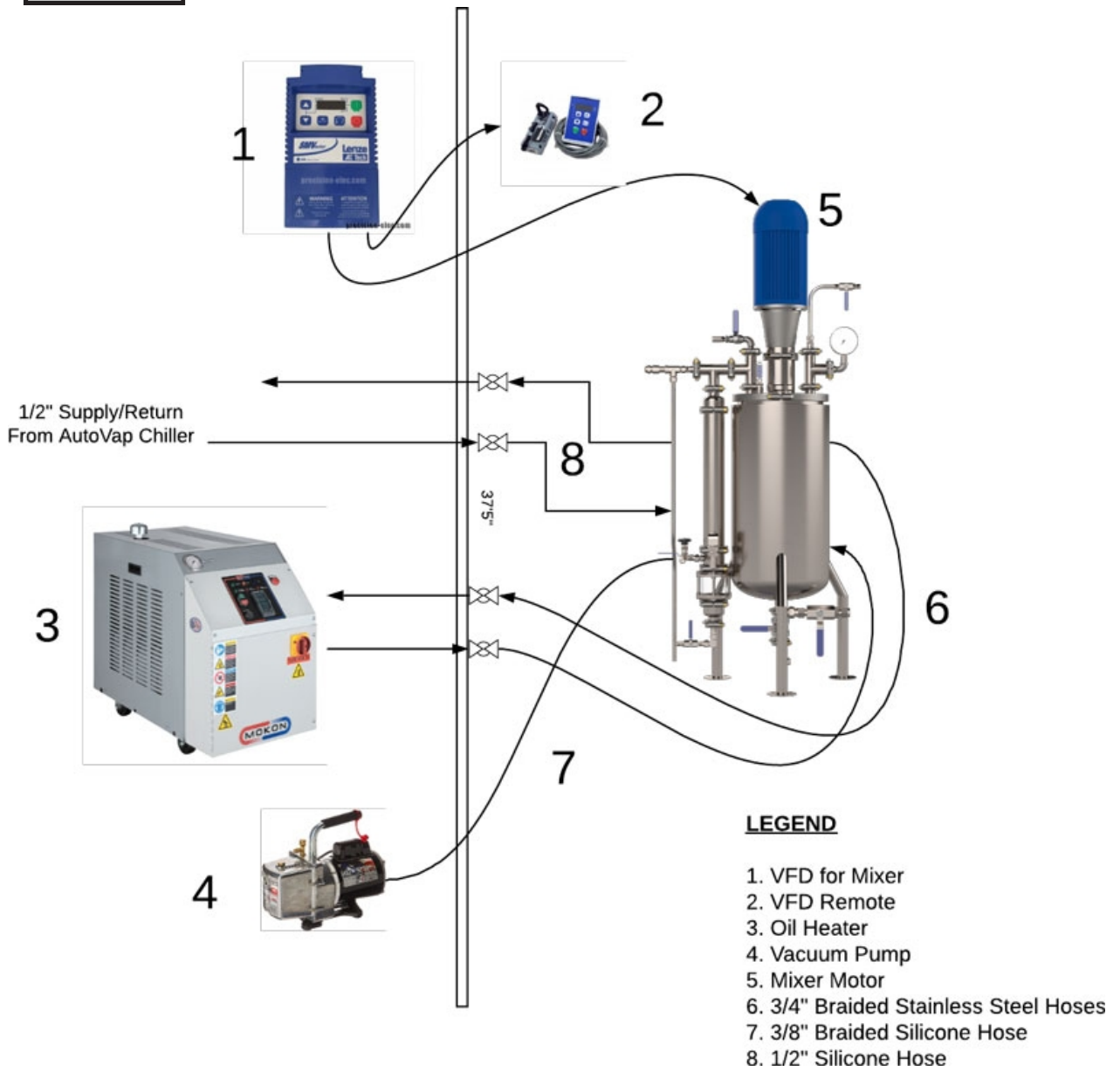
The ancillary equipment provided (heater, chiller, vacuum pump) are sufficient when working under the parameters suggested throughout this operating manual. If you feel necessary, you can use your own ancillary equipment. We do not suggest replacing the heater, as this piece of equipment is rated for the high temperatures you need to reach in order to decarboxylate.

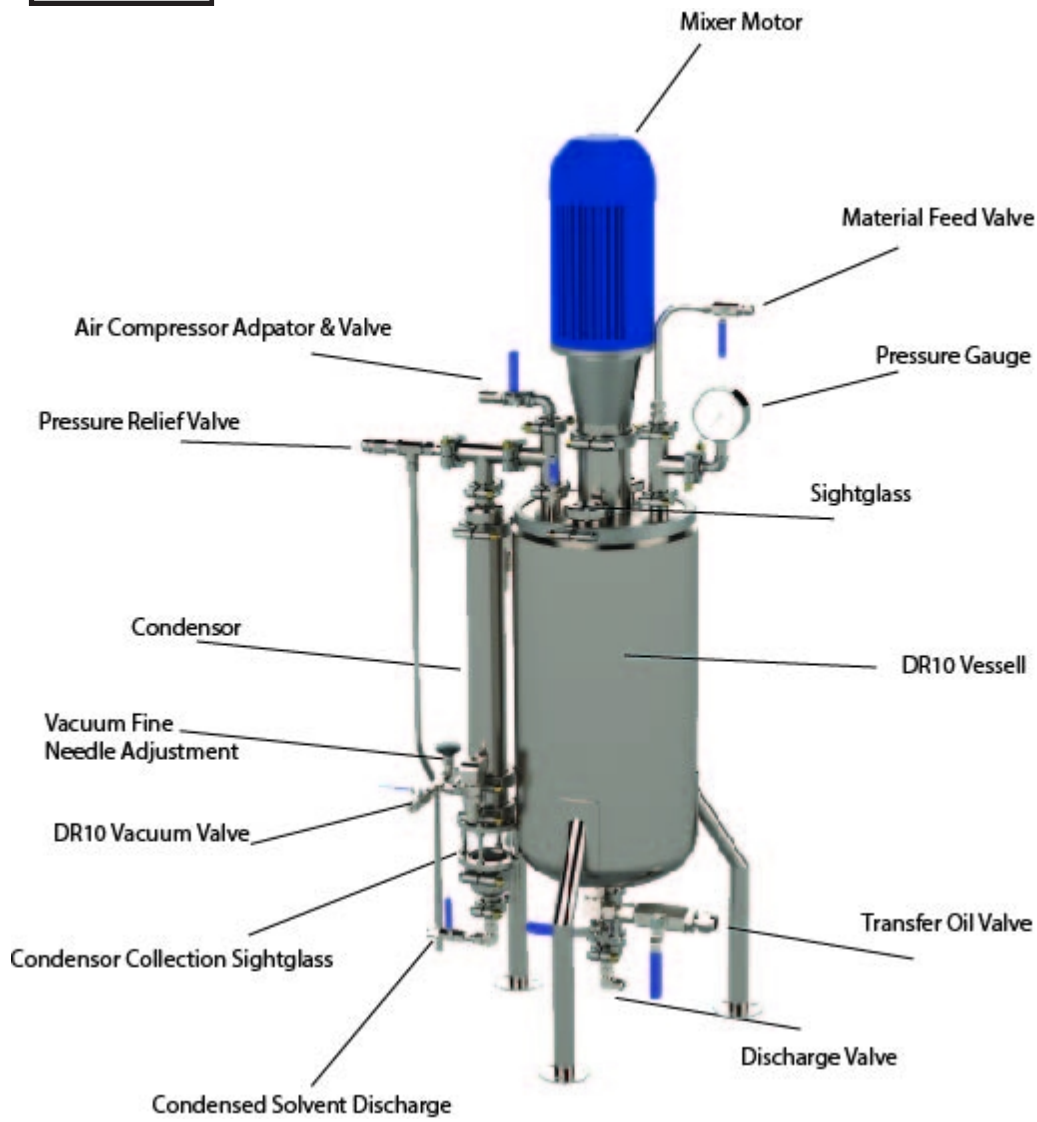
GENERAL DESCRIPTION AND CONSTRUCTION

Materials	Stainless Steel, PTFE, & Borosilicate
Batch Capacity	Maximum 10 Gallons
Plumbing Connections	1/2"-1"
Pressure Operating Range	Full Vacuum to 14.5 PSIG
Vacuum Operating Range	0 to Full Vacuum
Operating Heat Range (vessel)	32 to 302 °F (18-132 °C)
Operating Cool Range (condenser)	14 to 302 °F (0-10 °C)

The DR10 system requires ancillary equipment to work with the DR10 machine. The main components to the system are:

- 1) The DR10, including (1) 13 Gallon (10 Max. Capacity) Stainless Steel, Jacketed Tank, (1) Condenser Arm, Pressure/Vacuum Gauge, Air Compressor Adapter, Feed Line, Discharge Line, Thermocouple
- 2) Cooling System – Chiller
- 3) Heating System – Oil Heater (9-12Kw)
- 4) Mixer/Motor with Variable Frequency Drive
- 5) Vacuum Pump
- 6) Thermocouple Data Logger





SECTION 2: OPERATING PROCEDURES

The following procedures for operation are suggested by TruSteel from our own experiences in decarboxylation. The user may have their own theory of what parameters they feel they want to decarboxylate their material at (temperatures and length of time). In no way is TruSteel responsible for the degradation of material if the DR10 is operated outside of the suggested parameters throughout this operation manual.

The DR10 was designed specifically for the decarboxylation process, and not for solvent recovery. It is capable of purging off trace amounts of solvent left from solvent recovery, but too much solvent recovery will put too much of a load on the condenser.

The DR10 requires manual operation and supervision throughout the process. The operator will be constantly checking the “froth” to make sure the heat levels and vacuum levels are maintaining an even balance as to not “bump” material over into the condenser, but rather just keep an even evaporation of impurities.

STEP 1: Start Ancillary Equipment

START CHILLER

Set your chiller to the desired operating temperature.
Recommended starting Temperature range: 0-10°C (32-50°F)

Verify the chiller is cooling the condenser arm. (The condenser arm should feel cool to touch).

START OIL HEATER

Set the oil heater to 150F (65.5°C)

Verify the heater is pumping the oil through the vessel jacket.

STEP 2: Solvent Purge Process

This step in your DR10 process is to purge off your residual solvent. This process can potentially put a heavy load on the condenser arm and the AI C20 chiller so it is important to follow these steps.

We have developed a procedure that slowly raises the temperature of the DR10, while gradually introducing vacuum.

1. Prepare the DR10 for Processing

Make sure the discharge ball valve on the bottom of the DR10 is closed.

Fill the DR10 with material. You must fill the DR10 up to the thermocouple or the temperature will not register.

While filling the DR10, start your mixer. This is controlled at the VFD or the VFD remote control.

Set the mixer VFD between 7.0-15 Hz.

6 gallons is a good starting point for filling your DR10. You can gradually increase to 8 gallons as you get more comfortable with the process and your material.

Once the DR10 is full, **close all ball valves** (feed valve, air pressure valve, vacuum valve)

Notes: The colder the crude oil is, the faster the mixer needs to spin. The warmer the crude oil is, the slower the mixer has to spin.

The more crude oil in the vessel, the faster the mixer must spin. Adjust the VFD speed as needed though the decarb process.

Monitor through the sight glass.

Make sure the crude oil is pulling off the walls and mixing slowly

Avoid heavy mixing or splashing.

Again, adjust the speed of the VFD as necessary

2. Begin Purge Process

Note: During this step you will NOT be pulling any vacuum on the system.

First, slightly open the condenser arm ball valve to relieve any pressure that may have built up while filling the DR10.

Then close the ball valve.

Note: You should have a process to collect the discharged material from the condenser arm. Either a collection vessel, or a hose that runs into a collection vessel.

Raise the oil heater temperature to 175°F (80°C)

As the heater is heating up, you should start to see solvent being condensed through the condenser sight glass.

Discharge the condensed solvent from the sightglass by opening the condenser arm ball valve.

TIP: You can leave the condenser valve open throughout the initial purge process while you are NOT pulling any vacuum.

After a while, you might not be evaporating as much solvent and it will be time to raise the oil heater temperature

3. Raising Oil Heater Temperature to 190°F-210°F



Now that you have a majority of the solvent removed, you can raise the oil heater temperature to do a deeper removal.

Begin to raise the temperature of the oil heater up to 190°F in small increments of 5°F-10°F. You can start to introduce a small amount of vacuum to the system (see next step).

4. Introduce Vacuum

Before introducing vacuum, make sure the condenser arm ball valve is closed.

With the vacuum ball valve closed, power on the DR10 Vacuum Pump.

Open the vacuum needle valve about 1/4-1/2 way to fully open.

Slowly open the DR10 vacuum ball valve all the way.

Monitor the vacuum/pressure gauge and monitor your material.

Description of what you should be observing:

You want to create a bit of froth but not too much too fast, or you risk the chance of pulling over crude oil into your condenser arm.

The bigger the bubbles the better because if the froth is too small it creates a surface tension that does not allow the ethanol to evaporate. This observation will let you determine how much vacuum you can pull at one time.

Your crude oil can froth and bubble up more than double your batch size if you pull vacuum too quickly, so be very careful when adjusting vacuum pressure.

Now go back and forth between the black needle valve and the DR10 sightglass and adjust the vacuum down slowly while looking back at the crude oil in the DR10 sight glass.

We suggest pulling vacuum down in small increments of 1-5 PSI.

You can increase vacuum as you observe your level of “froth” decreasing.

Keep doing this until you evaporate all the solvent, and/or fill the condenser arm.

*Note: If you fill the condenser arm up with solvent you must manually drain it.

4. Manually Draining the Condenser Arm

As you purge solvent and other components, you will need to periodically drain the condenser arm.

First, close the DR10 Vacuum Ball Valve to cut off vacuum to the system.

Slowly open the condenser arm ball valve to discharge the material.

When fully discharged, close the condenser arm ball valve and slowly open the DR10 Vacuum ball valve.

Repeat this process throughout your purging process

5. Raising Oil Heater Temperature to 220°F-250°F

During the purging process, as you see most of your solvent purging off, you can set the temperature of the oil heater to your preferred setting for decarboxylation.

As the temperature rises, continue to monitor the material through the sight glass.

Repeat step 4: Manually Draining the Condenser Arm as needed.

Continue to increase vacuum as needed to continue to purge as much as possible before your Decarb step.

Once you are able to pull vacuum down to 20-21Hg you should notice very little to no frothing.

Temperature should be at your preferred decarboxylation temperature (220°F-265°F)

You are now ready to start your DECARBOXYLATION PROCESS

STEP 3: Decarboxylation Process

It is important to note that the parameters suggested by TruSteel are only suggestions and you may have your preferred parameters for this Decarboxylation Process. Temperature ranges and lengths of time may vary on your particular product. It is important to test your material to see what is the correct parameters to reach your desired goal of decarboxylation.

1. Decarboxylation Process

As stated above, you should have a preferred decarboxylation temperature. Somewhere from 220°F-265°F is standard.

This process should take anywhere from 45-90 minutes.

It is suggested to time this process to find your preferred amount of time and then set a timer for future batches.

Allow the oil heater to continue heating, while mixing, at your preferred temperature with vacuum set at 20-21Hg.

When your timer goes off your crude should be decarboxylated.

2. Collecting material from condenser arm

You should either have a line connected to the hose barb/ball valve at the bottom of the condenser or have a vessel ready to collect.

3. Raise Temperature of Heater

Set the temperature of the heater to 175°F (79.4°C)

As the heater is heating up, you should start to see solvent being condensed through the sight glass. You should not be pulling any vacuum yet.

After awhile, you might not be evaporating as much solvent so you need to start raising the temperature of your heater up to 190-210°F (87.7-98.8°C)

Do this in small increments, 5-10°F at a time, until your thermocouple readout of your crude oil is 190°F

Now you will start to evaporate more solvent once again.

NOTE: Throughout this temperature raising process, you should start pulling vacuum. Be careful with how “deep” you pull vacuum as the material can “bump”.

Also monitor that you are not pulling solvent through to your vacuum pump.

4. Decarboxylation

Now that you have evaporated most of the solvent at this time, it is time to raise the heater temp up to your desired decarb temperature. (recommended, 220-250°F)

The heater temperature setpoint will need to be set a bit higher than your decarb temp to adjust for heat loss through the system.

Also, as the crude oil temperature raises up around 190°F on the thermocouple readout you will need to introduce vacuum.

*Note: We want to reiterate that decarb temp and times are up to the client so it's always best to test a few batches at a lab to make sure your product is properly decarbed. Then you can adjust your decarb parameters as needed.

5. Finish Decarb



Stop the mixer

At this time you can stop the mixer by pressing “Stop” on the VFD.

Close Off Vacuum

Close the DR10 Vacuum Ball Valve

Release Vacuum

Slowly open the vacuum release ball valve (located on top of the DR10 vessel) and watch the vacuum gauge equalize to 0.

6. Discharge Decarbed Oil

To discharge your crude oil attach a NO2 line via the air chuck and ball valve assembly.

Set the regulator on the NO2 tank down to 10 PSI, if possible.

Get appropriate collection vessel to collect crude and put under drain spout.

Note: You should wear protective gloves during this process as the crude oil is HOT!

Open the bottom ball valve on the DR10 vessel to release crude oil

Slowly open the top ball valve with the airline attached to pressurize the vessel to 1-3 PSI

Look through the sight glass and watch as the crude oil is being discharged

Note: Be sure not to add too much pressure when the crude oil is fully discharged or you may risk getting hot crude oil splattered on you

When all the crude oil is safely collected, close the ball valve attached to the airline.

Close the bottom drain ball valve.

7. Running the next Batch

The DR10 vessel will still be very hot at this time and you will not want to add new oil to the vessel at this time.

Some hot oil units, the SHINI and MOKON, have cooling options. If you have connected the oil heater to a cooling unit, you can run the cooling option and your unit will get back down to starting temperature (below 150°F) before adding more oil.

8. Finishing for the Day

If you are finished for the day, you must run through a cleaning cycle. See the next process: CLEANING CYCLE

STEP 4: Cleaning Process

Before beginning your cleaning cycle, make sure the DR10 vessel is cooled down enough so you are not just evaporating the solvent you are using to clean with.

It is suggested you clean with the same type of solvent that you use in your crude oil as not to mix solvents in your equipment.

1. Fill DR10 with Solvent

Once the vessel has cooled enough, fill the DR10 up with as much solvent as it takes to reach some of the props on the mixer.



2. Begin Mixing

Turn on the VFD to mix around the solvent to clean as much as possible
Also, take off the top sight glasses and spray solvent down the whole inside of the vessel to clean the sides of the vessel.

*Note: If you have filled the DR10 with too much crude during the decarb process, you might also need to take the lid completely off the vessel and clean as needed.

3. Drain and Rinse with Solvent

Drain and rinse with solvent or keep cleaning as necessary.
Once cleaned, drain all remaining solvent and you are ready for the next batch.

4. Shutdown all Equipment

The DR10 is now clean, just be sure to shut down the heater properly and turn the chiller off.

SECTION 3: MAINTENANCE & SAFETY

Safety

1. WARNING: Hot Surfaces

The DR10 is designed to reach temperatures up to 300F (149C). The surfaces of the DR10 are extremely hot. Use caution operating this equipment and it is strongly advised to use PPE such as heat resistant gloves and eye wear.

The plumbing from the oil heater is extremely hot. It is strongly advised to insulate this plumbing to protect from potential injury. Also, use caution when operating near the DR10 plumbing.

2. WARNING: Hot discharge material

The material discharged from the DR10 is extremely hot. Use caution when discharging the material. It is strongly advised to use PPE it is strongly advised to use PPE such as heat resistant gloves and eye wear.

3. Do not open the system while under operation.

Under operation, the system could be under positive or negative pressure. Before opening any high pressure clamps, ensure that the mixer is off and pressure is stabilized.

4. Inspect for leaks.

Always inspect the system for leaks before operating. This includes ancillary equipment. Ensure all leaks are sealed before operating.

Maintenance

To get the most production out of your DR10 and increase the life all the parts, please review these maintenance suggestions:

1. Deep cleaning your DR10

You should be following STEP 4: Cleaning Process as outlined in the OPERATING PROCEDURES. In the event that you will not be using your DR10 for an extended period of time (a few days, weeks, months), you will want to do a more thorough cleaning.

This will involve removing the mixer from the DR10 vessel and cleaning the mixer shaft/props.

You can also open the DR10 lid to deep clean the vessel.

When opening the lid and replacing the lid, take care of the gasket. Make sure the gasket is set flush before clamping down the lid.

2. Changing Vacuum Pump Oil

You should always have extra vacuum pump oil on hand to change out. While processing in your DR10, you will be pulling terpenes and other oily substances. Some of this can end up in your vacuum pump oil. You should change this oil every few weeks. After operating for a long time, you will get a better sense of how often you need to change it.

3. Temperature Probe Calibration

It is suggested to have the temperature probe calibrated every 6-12 months.



4. Pressure Gauge Calibration

It is suggested to have the temperature probe calibrated every 6-12 months.

4. Vacuum Test

A vacuum test should be performed every 1-2 weeks to ensure all clamps and gaskets are secure.

5. Oil Heater oil

Please check the oil heater manufacturers manual on how to test your oil heater oil and how often it is advised to change it.