Pilot user guide

and technical document

03-2022

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The *Pilot* is a versatile and modular, sturdy, and full stainless-steel still/extractor carefully developed and built in Canada (QC). This unit has been specially designed for production tests, small scale production of essential oils, hydrolats and plant extracts as well as education and research. With this apparatus, you can perform almost all types of plant distillation (detailed in this guide), large scale infusions, decoctions, extraction, and evaporation of organic solvents.

This unit is a unique piece because it is hand-crafted (some minor differences may occur between two *Pilots*, even from a same batch) but also because a unique identifier is engraved on the top of the lid (PL1-0010). This identifier may be useful if you need replacement parts, optional accessories, or analyses.

And before going into technical details, a few personal words:

There are plenty of botanical treasures all around the world and in everyone's living environment. Aromatic plants, medicinal plants, toxic plants, plants we fell connected with, plants we do not... A vast and fascinating world that provides healing substances… and dangerous ones. So, learn as far as you can from reliable sources about the plants around you. Be careful of misidentifications. Grow and/or harvest them with respect and consciousness. Always let enough for others (humans and animals), for next years and for next generations, enjoy the magic of distillation and plant extraction, develop your skills, learn how to use your own essential oils and plant extracts safely and efficiently and if you have any question regarding distillation/extraction and your Pilot, please contact us. We are here to support you in your projects and your quest leading you out in your garden, the fields, and the forests.

Benoit ROGER Ph. D.

Table of content

About this document

This document contains the technical information about the *Pilot* and describes how to use it safely and efficiently. It also contains in *italic grey font* some general information about distillation that should help you to get a better understanding of what happens in the still and how the distillation method and parameters may affect the quality and yield of the products you are looking for crafting.

Safety first

The *Pilot* is primarily designed to be used with a propane burner. However, an electric heating source or an external boiler (with minor adjustments) can be used in some conditions. We do not recommend using this unit on a direct wood/plant fire as it is much less easy to control and less stable.

For distillation, we recommend using a propane burner like the one we propose (65 000 Btu/h). Do not use an oversized propane burner (potentially dangerous for the user and the still if you push too hard). You can use a less powerful burner but the warm-up phase as well as the distillation may be too slow, and the quality of final products may suffer. Finally, never use a distillation flow higher than 10 L per hour.

In all cases, be sure you work on a very stable and levelled burner, stand or surface, and that your stand or burner can stand the weight of the apparatus (approx. 35 kg empty) with plant and water inside (up to 80 additional kg for water distillation or 35 kg for steam distillation).

Do not modify the system, do not overload it, and never block the outlet of the condenser during warming-up, distillation/reflux extraction or cool-down phases! Boiling water or any other solvent in a closed system makes the inside pressure rise and this is very dangerous if the system is not designed for that purpose, which is the case for the *Pilot*. Be careful to hot surfaces and use suitable gloves during and after operation. Be sure the condenser gets much more that enough cold water when condensing flammable solvent (distillation or reflux mode) and never use direct fire to heat the unit when using/distilling flammable solvents (ethanol or other). If you use a propane burner, be sure you have a good combustion (blue flame), use it outdoor and protected from the wind or in a very well-ventilated place and stay far from any flammable substance (solvent, gas, wood, tissue…).

The *pilot* contains 3 outlets preventing the inside pressure to rise during operation:

- The large column and condenser which is the only outlet that steam should take during a distillation. To keep this outlet free, be careful to not overload the unit, especially with plant material that tent to swell or foam. This is even more important if you use stainless-steel or copper rings in the column.

- The cohobation tube connected at the bottom of the unit (see the *Pilot* overview) that would act as a safety outlet if the column happened to be blocked

- The safety plug on the lid (picture 7) that would also act as a safety outlet if the column happened to be blocked. Here the plug must be able to pop easily if the pressure rises in the unit, thus the rubber stopper should not be pushed hard in the outlet. A very thing pressure is enough to avoid a team leak from this outlet.

In the following text you will see some warning pictograms (see in the margins). They indicate some safety reminders or additional explanation in the text.

Precautions and maintenance

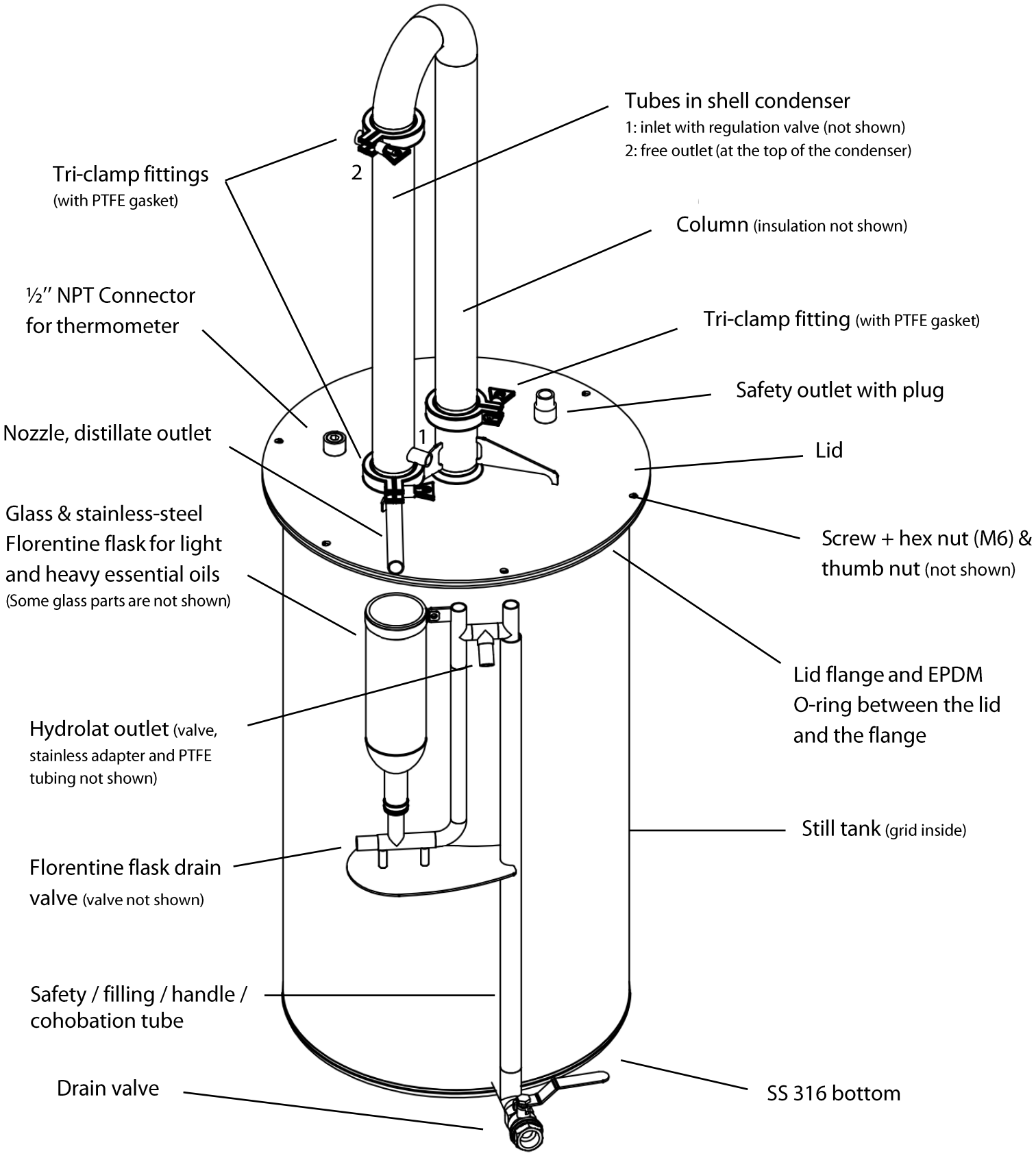
The whole unit is built in 304L and 316L stainless-steel. It has been carefully cleaned and passivated to improve the corrosion resistance. However, a few precautions must be taken to keep its aspect close to the initial one: do not use strong base or acid, sodium hypochlorite (bleach) and/or steel wool to clean it! Most of the times, dish soap or isopropanol and microfiber cloth are fine. Avoid contact with salt and non-stainless steel. Wash it and dry it right after each use and do not put it on direct fire without any water in, it could result in a permanent deformation of the unit bottom.

Each part of the unit can be replaced separately but each part including seals, O-rings and valves should last for years if properly used. Contact us if you need anything.

Technical information

- Full construction in 304L stainless-steel (316L for the bottom), TIG welded
- Passivated and cleaned before shipping
- Only high-quality material: Glass, EPDM, FDA approved Viton and PTFE
- Empty weight: approx. 35 kg
- Total volume of the tank and volume above the grid: approx. 109 L and 80 L
- Tank dimensions: approx. 42 cm of diameter, 79 cm high
- Still height in operation (tank + lid + column/condenser): 149 cm
- Column insulation: fiber glass and cotton wrap
- Up to 30 kg / 80 L of plant per batch

Overview of the *Pilot*



Unpacking and installation

Here is the list of components you should find in the still or in the expedition crate:

- The still tank with a ¾'' drain valve and its lid attached inside-out
- A large EPDM O-ring (already installed between the flange of the tank and the lid)
- An insulated column, a condenser with a needle valve, two barbed fittings and two hose clamps for the water hoses fastening (1/2'' OD), and a nozzle (distillate outlet)
- A 19 cm high grid (the plant stand)
- A stainless-steel and glass Florentine flask
- A stainless-steel adapter with a 25 cm PTFE tube you can screw to the hydrolat outlet valve of the Florentine flask
- Two bottom-less glass bottles (replacement part for the Florentine flask)
- 3 Glass pipets of 10 mL with a three ways rubber pipet filler
- 10 Pasteur pipets with a Pasteur pipet bulb
- A glass funnel and a glass tube with a coiled stainless-steel wire (light oil distillation)
- 4 replacement tubes
- A glass flask with a stainless-steel wire (for heavy oil distillation)
- A stainless wire with a piece of microfiber fabric to clean the condenser and the nozzle
- 2 Additional thumb nuts with screws and hex nuts (replacement parts)
- 3 Stainless-steel screws with conical head
- A replacement O-ring for the Florentine flask
- A thermometer

You will also have to connect a 1/2'' ID water hose (not included) with the length and fitting you need to the barbed fittings at the inlet and the outlet of the condenser and fasten them with the hose clamps (see picture 1 & 2). To get a good sealing, you can heat the tips of the hose in very hot water to soften them and screw them quickly on the barbed fittings.

For light oils distillation, insert the tube with the coiled wire into the Florentine flask and insert the glass funnel into the Florentine flask so that the tip enters about 1-2 cm into the tube (this is called a ''casse-essence'' in French and it is designed to redirect the light essential oils at the surface of the hydrolat during the distillation – see picture 3).

For heavy oil, replace the tube with the coiled wire by the glass flask (cut bottle) with the W-shape stainless-steel wire. Heavy oil will sink and stay at the bottom of this flask during the distillation (see picture 4).

If you plan to collect some hydrolat, you can Install the stainless adapter and the PTFE hose on the Florentine flask, this allows to collect the hydrolat more easily.

You can finally install the Florentine flask on the cohobation tube as shown on the overview.

How to use your still

In all cases, before starting any distillation or extraction, find a stable, levelled, and open or very well-ventilated place. Stay protected from the wind and far from any flammable or hazardous products/material and far from ignition source for extraction with flammable solvents.

Steam distillation using a propane burner

Steam distillation is the main technique used nowadays for essential oil distillation as it generally gives better yields and quality than water distillation. In steam distillation, the plant material is not immersed in water. It is loaded as is in the still and stands on a grid above the bottom of the still. No water is added when the steam comes from an external boiler. When the steam is generated inside the still, the grid is higher, and some water is brought to a boil at the bottom of the still. This latter technique is sometimes called "water and steam distillation". In any cases, the steam that rises through the plant volatilizes and drives its volatile compounds out of the tank to the condenser and Florentine flask.

We recommend using this technique (steam or water and steam distillation) as soon as you can as it generally gives good results (yields and quality), it is faster and requires less energy than water distillation. However, resins, wood/bark sawdust, some crushed seeds or roots and some very fragile flowers cannot easily be distilled by steam distillation because steam cannot go through the plant material homogeneously (they melt or swell, and clog then steam escapes by some channels and the plant material is poorly distilled). In these cases, consider the water distillation (described below).

- Before starting a steam distillation, make sure that the drain valve is closed, put between 10 and 15 litres of clean water into the still. The level of the water must be at least 2-3 cm higher than the drain valve at the bottom of the tank. Important note: if during distillation you see some steam escaping from the cohobation tube, it means that the water level is too low, and you must add some more water until the steam escape stops.

- When the right amount of water is in the still, place the stainless-steel grid with the screws down so that the grid stands well above the water level.

- Pack the plant as homogeneously as possible into the still (very important point) and compact it by hand (again, as homogeneously as possible).

The compaction is one of most the important parameters the distiller must play with. The most important point is to get a homogeneous compaction so that the steam rises homogeneously through the plant. If the compaction is no homogeneous, the steam will escape through the easiest way and some of the plant material may be poorly distilled resulting in a low yield or a longer distillation. The optimal compaction depends on the plant material, but a good strength can generally be applied on plants with a good "structure" (conifer needles for instance) if they are not turned into powder. On the other side, plants with much less structure (soft leaves or flowers) or finely crushed plant material should not be compacted with too much strength as they could clog more easily.

- If not installed, put the O-ring on the flange between the tank edge and the lid screws (picture 5). If the O-ring is hard to place, stretch it a bit. Be sure you have nothing (no plant fragment) below or above the O-ring, put the lid on the top of the still (screws in holes) and screw each thumb nuts manually (do no overtighten them, this is not necessary nor recommended).

- Install the Florentine flask on the cohobation tube as shown in the overview picture and put the glass tube or flask with the glass funnel into the Florentine flask as shown on picture 3 and 4. Make sure that the hydrolat valve is closed and fill the Florentine flask with fresh and clean water until water level stabilizes. Adjust and tighten the three tri-clamp fittings so that the nozzle (the distillate outlet) arrives just above the funnel in the Florentine flask.

⚠ - Connect the hose to the water, open a bit the water regulation valve and start the propane burner (be careful to not burn the water hose with the burner). If the propane burner is well sized and set, the distillation should start within 30-40 minutes. When it starts, be sure your condensing water flow is correct during the firsts 30 minutes and that all the distillate drops into the funnel.

⚠ - If you do not want to collect the hydrolat, let the hydrolat valve closed. The hydrolat will return into the still, maintaining the water/hydrolat level in the still for the whole distillation. Again: if during the distillation you see some steam escaping from the cohobation tube, it means that the water level is too low (the plant may absorb some water), and that you must add some more water in the still until the steam escape stops.

This hydrolat recirculation is called "cohobation" and is useful for long distillations or for the distillation of essential oil with difficult separation.

- If you want to collect the hydrolat, make sure to add 1 L of water into the still (using the safety / filling / cohobation tube) for each 1 L of hydrolat you take. To collect the hydrolat, you can use the stainless-steel adapter with the semi-clear PTFE tube.

- Regarding distillation speed/flow, this unit should work between 3 and 6 L/hour. You can calculate it by measuring the mass or volume of water you get from the hydrolat valve in one minute and multiply the result by 60 (just let fall the hydrolat for 2 seconds when you open the hydrolat valve before you collect it to get accurate results).

As for the compaction, the optimal steam flow depends on the plant you distill, if it is crushed or not, the amount and nature of volatile compounds it contains, where they are in the plant, (etc…) and whether you primarily distill for essential oil or hydrolat. The best is to try, compare 2 or 3 different steam flows for a plant (the other parameters remaining unchanged) and see if a given steam flow gives better results. It should however be noted that using twice a given steam flow will require twice the amount of energy (and even more) per unit of time, but you will not distill the same amount of EO two times faster. Very high flow (with no cohobation) may also slightly reduce the EO yield as separation will be more difficult and you'll produce more hydrolat containing some volatile compounds you distill. On the other hand, with a too low steam flow, you will have to distill much longer to get the same amount of oil and the plant will stay longer at 100°C which may result in more chemical degradation. So, the optimal steam flow is a question of compromise both depending on the plant and your purpose.

- The flow of the water running through the condenser can be regulated by the needle valve at the bottom of the condenser and allows to adjust the temperature of the distillate. A low flow gives a relatively high temperature for the distillate and a high flow gives a relatively low temperature for the distillate. In all cases, always use enough water in the condenser to condense all the steam (no steam should escape from the nozzle during a distillation) and do not use a too high flow to not waste water. It may be hard to finely adjust the temperature if the water pressure is not perfectly stable. If it is the case, open the water regulation valve a bit more than necessary to avoid the distillate temperature to rise too much when the pressure (thus flow) of the condenser water decrease.

For some EO that hardly separate from the hydrolat (myrrh and vetiver for instance), the temperature of the distillate is a very important parameter. When temperature rises, the density of EO generally changes faster than those of water and the difference in density increases, the water viscosity decreases and the coalescence of EO droplets is facilitated. Thus, it is generally recommended to distill the EO that hardly separate at higher temperature (as a reminder, here we talk about the distillate temperature, not the temperature inside the tank which depends on the pressure). On the other hand, when temperature rises, both evaporation and solubility of organic compounds in water rise too so as always, this is a question of compromise and the better way to know the ideal distillate temperature for a given EO distillation is to test and compare.

⚠ - If you want to distill at much higher temperature than your condensing water, a simple option is to reduce the exchange area in the condenser, thus its overall efficiency. You can do this by blocking up to 3 tubes of the condensers with conical head screws (just insert them at the top of the condenser as in the picture 6). This reduces the efficiency of the condenser from 15 to 45 %. Do not block more than 3 tubes in the condenser, the steam should always be able to escape easily from the apparatus. Another option (which also has the advantage to save water) is to recirculate the condensing water from and into a 100 to 200 L drum of water. This can be done with two or even just one drum if it is big enough and if the distillation is not too long.

- When the distillation is finished (the distillation time greatly depends on the plant you distill and what you're looking for), you can collect the oil using the drain valve at the bottom of the Florentine flask or with the 10 mL pipet and the red rubber pipet filler (contact us if you do not know how to use it). You always get some water with the oil, but you can remove it with a decantation funnel (not included) or with a pipette from your storage bottle.

Water distillation

Water distillation consists in placing the plant material into the water and boil the mixture. This technique is not recommended for all plants (see why in the previous sections), but it is the only one that can be used for resins, wood/bark sawdust, some crushed seeds or roots and some very fragile flowers.

- In water distillation, you do not need to use the grid in the still as in steam distillation but in some circumstances, it can be good to put it up-side-down before adding the plants and water to avoid the contact between the plant material and the bottom of the still.

- Put the water and the plant (the ratio water/plant depends on the plant, but the plant should always be able to move relatively freely during the distillation) in the still and boil the mixture with the same setup as described previously.

- Do not put more than 80 kg of plant + water into the still, otherwise the water may overflow by the cohobation tube or bump into the column.
- In water distillation, the warm-up phase is longer than in steam distillation (more water to boil) but when it starts, it can be run similarly to a water and steam distillation (steam distillation with a propane burner) and as in water and steam distillation, you can distill with cohobation or not.

- If you take the hydrolat, add 1 L of fresh water each time you take 1 L of hydrolat.

Reflux extraction

Beside distillation, the *Pilot* can be used for reflux extraction with water or various organic solvents. This application requires and optional cold finger condenser, please contact for additional information.

Options

Several options are available or in development:

- A propane burner with baffle
- A tank extension (+ 80 L)
- A column extension (2 tubes of ~ 75 cm, copper or stainless-steel)
- An in-line thermometer you can place where you want between the lid and the nozzle
- A special lid allowing to use an over-head stirrer for agitated hydrodistillation
- An insulation kit
- A copper column
- Copper spirals for the condenser and copper rings for the column
- A cold finger with sight glass for reflux extraction (in development)
- A vacuum kit to perform vacuum distillation and evaporation (in development)
- A stainless-steel stand with IR heating element (in development)

We do not recommend using the special lid (with agitation) for reflux extraction with organic solvent unless both the agitator and the hotplate are explosion proof as we cannot guarantee a perfect tightness of the propeller joint.

Pictures

1: Hose fastening on the inlet barbed fitting

2: Hose fastening on the outlet barbed fitting

3: Florentine flask for light oils
(with glass funnel and coiled tube)

4: Florentine flask for heavy oils
(with glass funnel and glass flask inside)

5: O-ring installation

6: Condenser restriction with conical-head screws (no more than 3 tubes)

7: Safety outlet

8: Pilot overview

Material certificates (304 stainless-steel and PTFE gaskets)

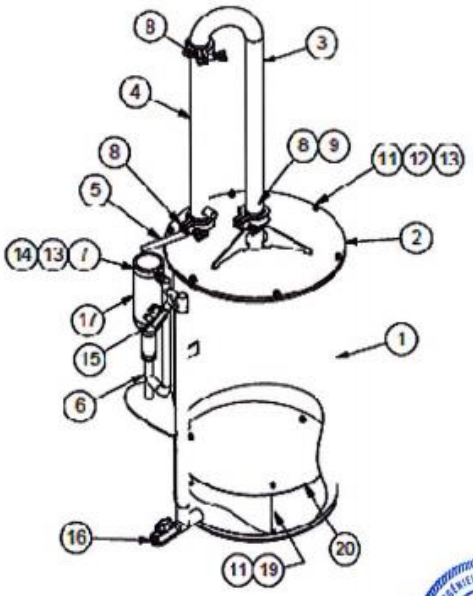
Distributeur-Manufacturier d'équipement en acier inoxydable

ÉQUIPEMENT BENOIT RIVARD INC.

CERTIFICAT DE CONFORMITÉ / CERTIFICATE OF COMPLIANCE

« Équipement Benoit Rivard Inc. » certifie que le matériel utilisé dans la fabrication des alambics de 40 litres pour le compte de « Alchemia Solutions Inc. » est de l'acier inoxydable grade 304/304L. Un alambic typique fabriqué par EBR est illustré au croquis suivant.

" Équipement Benoit Rivard Inc." certifies that the material used to manufacture the 40 liter stills on behalf of "Alchemia Solutions Inc." is 304 / 304L grade stainless steel. A typical still manufactured by EBR is illustrated in the following sketch.



Certifié par / Certified by : Mathieu Myrand 2018/06/07

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CERTIFICATE OF COMPLIANCE

U.S.P. CLASS VI

Rubber Fab, a Garlock Hygienic Technologies company certifies that the material from which we manufacture the below mentioned parts has passed U.S.P. Class VI Cytotoxicity testing and meets 3A and USDA standards and are BSE/TSE compliant. Elastomer parts are FDA CFR 21, 177.2600 compliant, and PTFE, FEP, PFA and Tuf-Steel parts are FDA CFR 21, 177.1550 compliant. Rubber Fab certifies the material for the below mentioned part is Phthalate Free. Note: Electropolished products are 15RA or better

Customer Name: Equipment Benoit Rivard, Ind.
Customer PO No.: 64170
Part No.: 40MPG-150
Part Description: 1.5in PTFE Tri-Clamp Gasket

Material: PTFE
Lot Number: 5944020
Cure Date: 10/17

CERTIFIED

Certified By:

Sean Mayer

Sean Mayer, *Quality Assurance*

Date: April 05, 2018

CERTIFIED

The material used to manufacture our EPDM, FKM Fluoroelastomer, Silicone, PTFE, and Tuf-Steel® parts is Animal-Derived Ingredient-Free.

Gaskets * Hose * Hose Assemblies * Tubing * Fittings * Pump and Replacement Parts

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Durometer: 60A
Batch NO: 6020171115
Shelf Life: 20 Years
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Quantity: 10
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Color: White
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