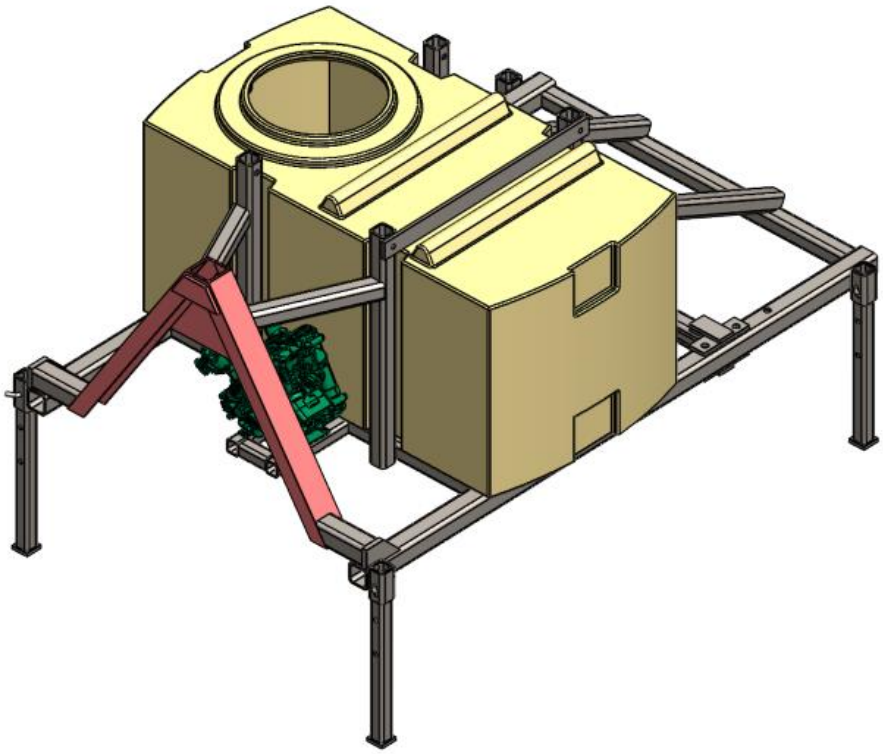
THE PIPUCULTEUR: SANITIZED URINE APPLICATION TOOL BY INJECTION

Instructions for manufacture, use and maintenance

This document was translated quickly. It might contain errors.



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Enville
Engrais humain des villes

OCAPI

AGENCE eau SEINE NORMANDIE

leesu
laboratoire eau environnement systèmes urbains

ÉCOLE NATIONALE DES PONTS ET CHAUSSÉES
IP PARIS

Soutenu par
RÉPUBLIQUE FRANÇAISE
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ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

Table of Contents

FIRST PART

Assembly instructions

1. Project context and overall tool overview

1.1. Presentation of the project

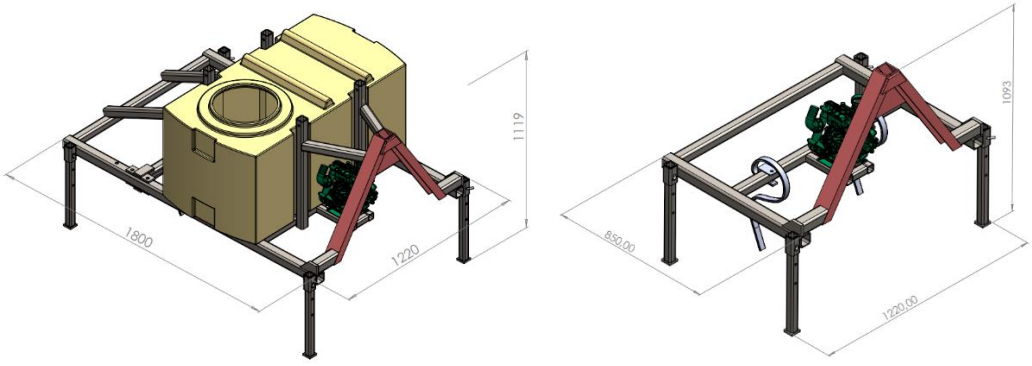
The Pipiculteur is a machine for injecting sanitized urine into the soil. Sanitized urine is an agricultural fertilizer made from human urine that is sanitized by storage(1-3). This document is a technical datasheet. The drawings and the complete design report of this machine are available here: https://www.leesu.fr/ocapi/les-projets/enville/outils-agricoles/.

The use of human urine to produce fertilizers ensure a circular and sober agriculture resource. It is independent of fertilizers derived from fossil resources, and reduces the nitrogen pollution to be treated in waste water treatment plants. This project is supported by the action research program OCAPI, within the LEESU (Water, Environment and Urban Systems Laboratory) at the Ecole Nationale des Ponts et Chaussées. This research program is investigating the possibility of circular management of our urine and feces (more information: https://www.leesu.fr/ocapi/). The Pipiculteur was designed as part of the development of "citizen networks" for the valorization of urine, and in particular the ENVILLE project which developed a demonstration network between urban dwellers who collect urine at home and make it available to a partner farm that uses it as a fertilizer. Details of the development of this demonstration are presented in the ENVILLE project's full report and in summary sheets (https://www.leesu.fr/ocapi/les-projets/enville/). If you are looking to develop such a similar project, whether you are a farmer or a resident, we hope that these documents will be useful to you! For more advice, you can also get closer to our team: enville@enpc.fr.

As mentioned above, the principles of design of the tool and the choices relating to the technical route of the Pipiculteur are specified in a dedicated report. The use of fertilizers produced from human urine requires several precautions which are detailed in these documents. **In this manual we will only cover the technical aspects of the manufacture and use of the machine**, but it is essential to take note of the conditions and recommendations for safe use of the urine based fertilizers.

We are talking about the Pipiculteur, but in reality, there are several distinct tools. We therefore refer to machines as follows:

- **Pipiculteur**: the complete machine that includes a tank, pump and teeth.
- **Free tank Pipiculteur:** the free tank version of the Pipiculteur.



1.2. Use of human urine in agriculture

This leaflet is not intended to detail all the recommendations for using urine in agriculture. For more information, you can consult the Enville Project report, the Pipiculteur's design report, the Agrocapi Fact Sheets (Using Human Urine in Agriculture) or the Rich Earth Institute report. However, here are some things we think are essential if you want to use human urine as a fertilizer (based on recommendations from the World Health Organisation and the Stockholm Environment Institute) (1.2).. Using the Pipiculteur will allow you to comply with a number of these precautions from the outset.

HYGIENISATION OF URINE BY STORAGE

- 6 months at 20 °C if applied to crops capable of being eaten raw
- 1 month on other crops
- Treatment of urine by storage produces 'sanitized urine' (Lisain in french)

PRECAUTIONS FOR APPLICATION OF REDDISH

- Do not apply to the aerial parts of crops.
- Apply on or in the floor, cover immediately after application if possible.
- Not spraying.
- Allow 1 month between application and harvest for raw consumed crops.
- If dilution or drip use: rinse with water after application to avoid clogging.
- If you dilute the slurry directly into the tank, add the water only after performing the storage treatment.
- In order to further increase the safety of the practice, it may be proposed not to fertilise with slurry crops that are grown on open land and can be eaten raw. This simplifies storage time management as one month of storage is sufficient.

MEASUREMENTS FOR FERTILISATION WITH LISAIN (DE LOOZE, 2018)

- 'NPK' typical of 0,6/0,05/0,1. The sanitized urine typically contains 6 g of nitrogen per litre.
- "Basic" dose = 2L/m²; to be refined according to the crops and other fertilising materials used (see table below).

Category	Plant	No. of litres of urine to be applied per m²
Heavy Use	Cabbage and chard	4
Sustained use	Celery	3
	Card	
	Cucumber	
	Aubergine	
	Leek	
	Pepper	
Medium Usage	Artichoke	2
	Asparagus	
	Beetroot	
	Broccoli	
	Garlic	
	Onion	
	Spinach	

Category	Plant	No. of litres of urine to be applied per m²
Medium Usage	Courge	2
	Potato	
	Tomatoes	
	Courgettes	
Moderate Usage	Carrots	1
	Parsley	
	Radish	
	Salad	
	Echalote	
	Cutter	
	Shuttle	
Less useful	Pea	0.5
	Beans	
	Pea	

1.3. General presentation of the Pipiculteur

Below is a representation of the main components of the Pipiculteur (piping elements are not shown). There is also a free tank version.

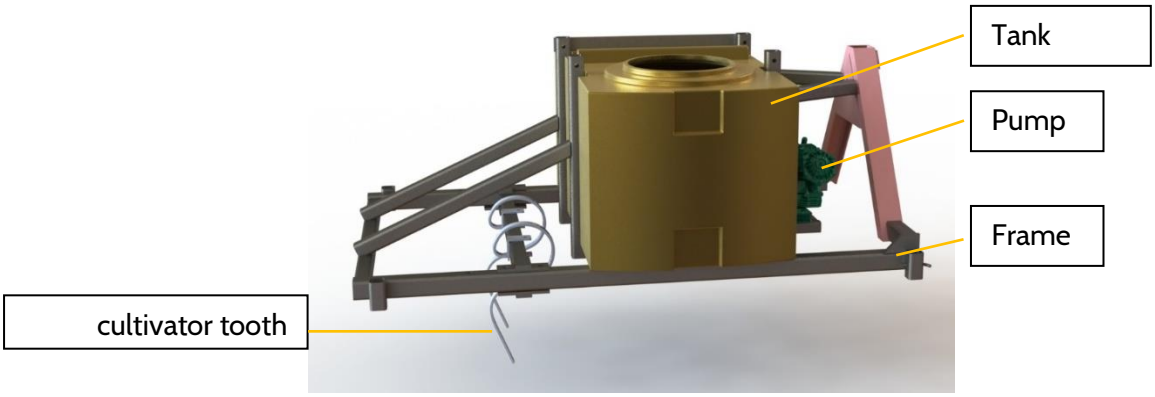


Figure 1 :: 3D representation of the Pipiculteur (without the pipes and valves part)

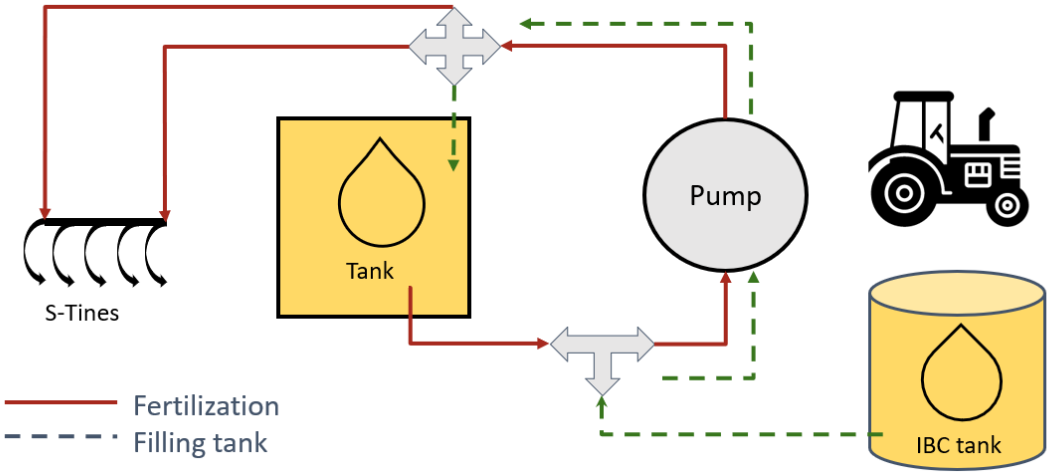


Figure 2: Urine diagram

1.4. General safety rules

Personal protective equipment

With regard to the use of machinery, the same personal protective equipment as for the use of a tractor must be respected: safety shoes, earplug or muffs, gloves.

With regard to urine use, although there is no high risk associated with the application of treated urine, it is recommended that agricultural workers wear appropriate protective clothing, in particular to protect themselves against the risks associated with direct contact (gloves, goggles, dedicated clothing and changed clothes after handling the sanitized urine).

For people who regularly work with sanitized urine and especially in a closed environment, we recommend the use of anti-ammonia masks. Within the LEESU, for example, we use cartridge masks equipped with 6059 cartridges.

Conditions of use of the machine

- Do not work on wet soil after a heavy rain
- Check that the power of the tractor and the admissible load are adequate
- Away from the driver of the tractor, any person shall be within at least 3 meters of the Pipiculteur in operation
- Do not climb on machine
- Apply the hand brake properly and disengage the power take-off before disengaging the tractor
- Cut off the motor power when manipulating the drive shaft
- Avoid as much as possible between the tractor and the tool and, if necessary, take all precautions to avoid danger

1.5. Conditions of use

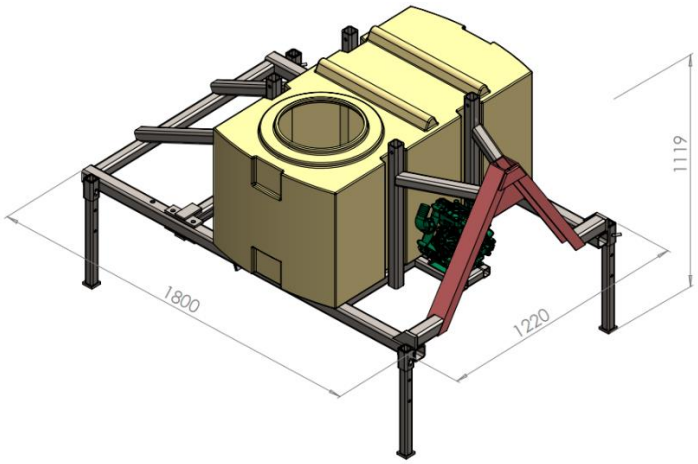
Due to the restrictions of the pump manufacturer, the Pipiculteur can only be used when the outside temperature is between 0 °C (32 °F) and 45 °C (113 °F). The temperature of the liquid to be pumped must be between 5 °C (41 °F) and 38 °C (100 °F).

1.6. Technical data

1.6.1. Pipiculteur

Dimensions (in mm)

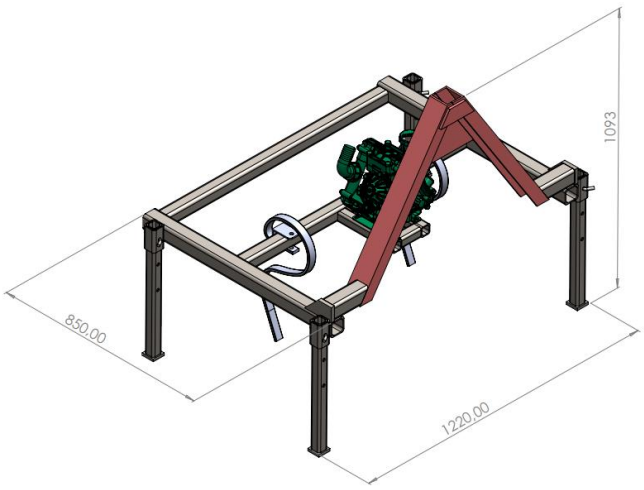
Weight 210kg



1.6.2. Free tank Pipiculteur

Dimensions (in mm)

Weight 80kg



1.7. Frame

The Pipiculteur chassis was developed by the OCAPI programm within LEESU. The drawings are licensed under CC BY NC SA and are available on the OCAPI (LIENPIPICULTEUR) website. The frame is inspired by the vibroplanche of Atelier Paysan.

Several versions are possible:

- With removable bar
- With fixed bar
- Without tank

During the prototype manufacturing, we chose to put the soil working tools on a removable bar, in order to be able to change this bar and validate different tools. Since the tests went well, we recommend to manufacture the version with a fixed bar that is simpler and less time-consuming to manufacture.

It is appropriate for the users to choose the version to be manufactured according to the needs and the equipment available on the farm.

1.8. Pump

The pump used is a UDOR ZETA 100 pump whose characteristics are described below.

Be careful, the pump is supplied with an inlet connection of ⌀38 mm, but to facilitate the connections with the other components, the connection has to be changed to ⌀40 mm.

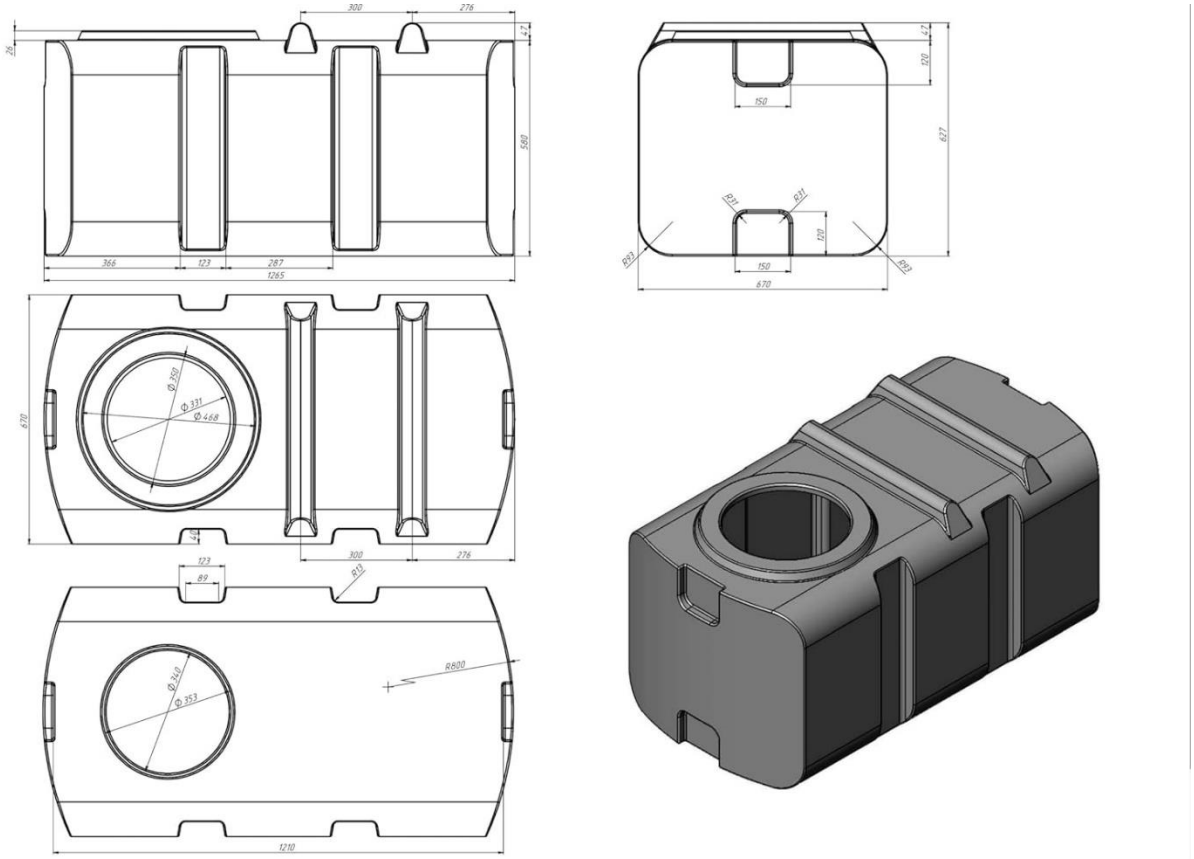
Model	ZETA 100 1C
Flow rate	91.3 l/min • 24.1 GPM
Pressure MAX	20 bar • 290 PSI
RPM	550
Power MAX	4.8 HP • 3.5 kW
Weight	13.3 Kg

Figure 3:: Characteristics of the UDOR ZETA 100 pump Available Udor website

We have added the UDOR DL 3/40 control kit This kit makes it possible to distribute urine flows uniformly across the different pipes. It is essential for the version with the tank and recommended for the others.	
To actuate the pump on the power take-off of the tractor, a drive shaft shall be used. The length is to be chosen according to the tractor used.	

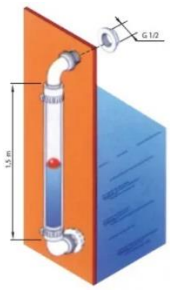
1.9. Tank and piping

The dimensions of the tank are as follows (in mm) :



Below are all the piping elements present in the Pipiculteur:

We let the French names on the section bellow, so it is easier for people to find the elements on internet if they want to buy them.

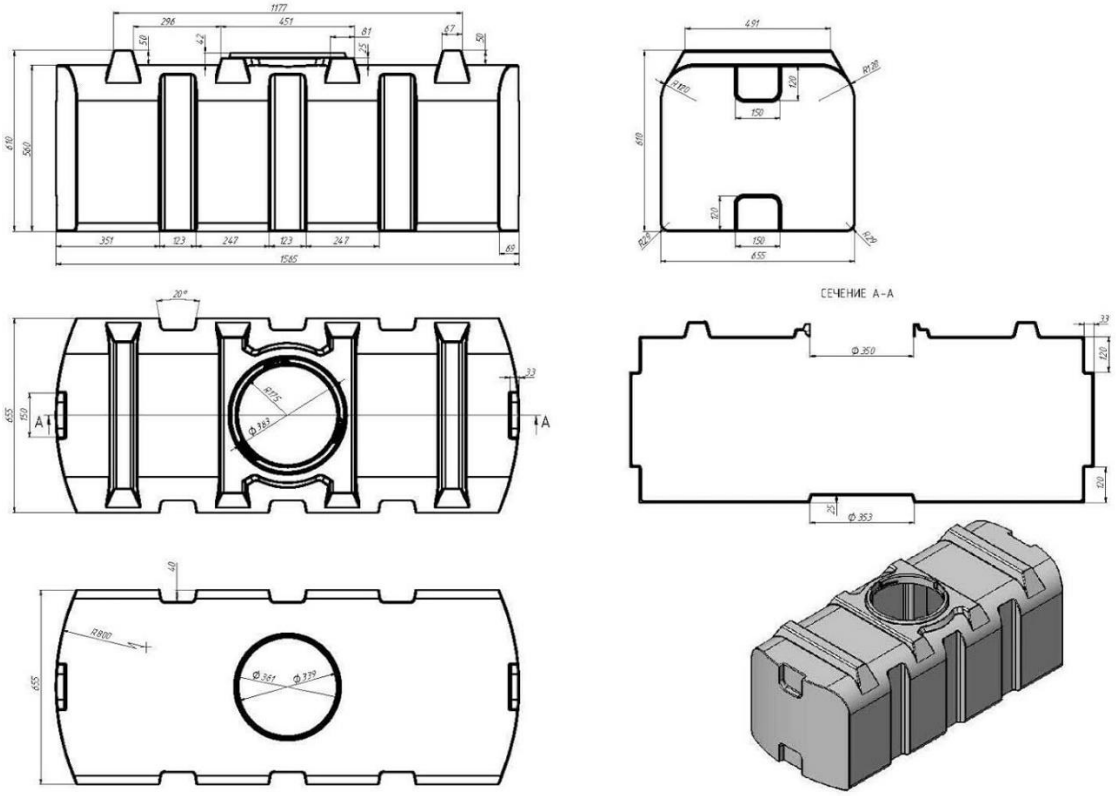
Référence	Quantité	Photo
Douille Cannelée D 40x40/42 à coller	5	
Emb Cann Ecrou Tarraudé Fem 3/4" x 19	1	
Embout Cannelé Coudé 90° M 3/4" x ø 10	1	
Kit niveau de cuve Arag	1	
Manchon D 20/25x3/4 po. PN16 mixte taraudé	2	
Manchon D 3/4 po. PN16 à visser taraudé	1	
Raccord 90° ø40 mm Ecrou tournant 1"1/2	1	
Raccord à Cames F 53 x Can. ø40 AGZ000153809	2	

Raccord à Cames M 53 x Can. ø40	3	
Raccord à Cames Bouchon M 53	2	
Raccord à Cames Bouchon F 53	2	
Raccord en "Y" Tubulure ø10 mm (Optionnel dans le cas où l'on souhaite utiliser 4 dents)	2	
Raccord S60X6 cuve eau - Embout droit Diamètre 40 mm	1	
Trop-plein cuve - Mâle 3/4" Pas gaz (20x27 mm) - Version longue	2	
Trop-plein cuve eau 1000L - Embout coudé Diamètre 40 mm	1	
Tube tulipe IRL diam.20 mm gris	2	

Tuyau d'aspiration ALIFLEX Ø 40 mm - Longueur 10 mètres	1	
Tuyau de pression/ aspiration Ø20 mm	1	
Tuyau PVC tressé bleu pour pulvérisation - 50 m	1	
Tuyau souple D 19x26 PS 10 PVC tressé alimentaire	1	
Vanne 3 voies en T D 40 PN10 EPDM à coller	1	
Vanne à boisseau à coller - Diamètre 40 mm	1	
Crépine inox 1"1/4 pour clapet anti-retour	1	
Douille Cannelée D 40x1.1/4 po. mixte fileté	1	
Coupleur à cames type C D 3/4 po.x19	1	

Adaptateur à cames type E D 3/4 po.x19 à douille cannelée	1	

It is also possible to fit a 500 L tank, for example the model shown below with its dimensions. Be careful, the drawings that we propose for the frame do not correspond to this model, but it would be easy to change the position of the reinforcements to adapt it.



1.10. Teeth

We used cultivator teeth with 50mm bar flange. During the tests we used 2 teeth but the "Y" connections on the spreading pipes (ø10 mm) allow 4 teeth to be used.	
The version with a square bar 80x80 mm should use cultivator teeth. This allows urine to be buried deeper. During our tests, we did not consider it necessary to use this type of teeth.	

Close the furrows:

Several options can be considered to close the furrows after the tool has passed: disks, deflector, or teeth. We have not developed this part but we recommend using a system that closes the furrows if the tool is used with a soil containing large clods.

1.11. Other

The following elements are not shown on the drawings but are essential for the correct operation of the machine.

Clamp

The following quantities are required:

Pipe Diameter	Quantity of clamps for Pipiculteur	Quantity of clamps for free tank Pipiculteur
40 mm	14	10
19 - 20 mm	4	2
10mm	4 (if 2 teeth) 10 (if 4 teeth)	2 (if 2 teeth) 8 (if 4 teeth)

Screw

The following quantities are required:

Designation	Quantity for Pipiculteur	Quantity for free tank Pipiculteur
M10x60 Screws	6	6
Self-braking M10 nut	6	6
M10 Washer	12	12
M12x100 Screws	1 per tooth	1 per tooth
Self-braking M12 nut	1 per tooth	1 per tooth
M8x25 Screws	2	2
Self-braking M8 nut	2	2
M16x100 Screws	4	
Self-braking M16 nut	4	
Washers M16	8	

Consumables

Pack PVC GLUE, PVC sanding paper, PVC cleaner and Teflon tape before starting assembly.

2. Assembly

2.1. Frame

Build the chassis according to the drawings. Attention to the following points:

- After tack welding the reinforcements for the tank, verify that the tank fits the reinforcements before removing it and weld joint
- We recommend the use of a commercial hitch triangle, but you can manufacture one if you wish. [1]

2.2. Pump

Secure the pump with the M10 screws, washers and nut.

Secure the splitter with M8 screws, washers and nut.

It is possible to adjust the pump output pressure. In our case, we do not want urine to leave the pump at high pressure to reduce the risk of volatilization. Below is an extract from the pump manual we used:

[1] drawings available here: https://www.latelierpaysan.org/Le-triangle-d-attelage-38

7.3 PULSATION DAMPENER (ACCUMULATOR)

Before starting the Pump, verify the air pressure in the accumulator, if present.
This operation may be carried out, with the Pump off, connecting an air source to the inflation valve.
The air pressure should be checked periodically.

⚠ Using the Pump without air in the accumulator may cause system malfunctioning, damage the accumulator diaphragm or the whole Pump.

The accumulator's air pressure varies according to the Pump's operating pressure:

Pump Working Pressure	bar *PSI*	2 *29*	5 *72*	10 *145*	20 *290*	30 *435*	40 *580*	50 *725*
		⇩	⇩	⇩	⇩	⇩	⇩	⇩
Accumulator Pressure	bar *PSI*	1 *15*	2 *29*	4 *58*	5 *72*	6 *87*	7 *102*	8 *116*

UDOR normally inflates the Pumps pulsation dampener at a pressure of 5 bar (72 PSI) approx.

Figure 4 extract from the instructions for the Udor Zeta 100 pump

We therefore recommend that the pump be used with a pressure of between 1 and 2 bar on the accumulator.

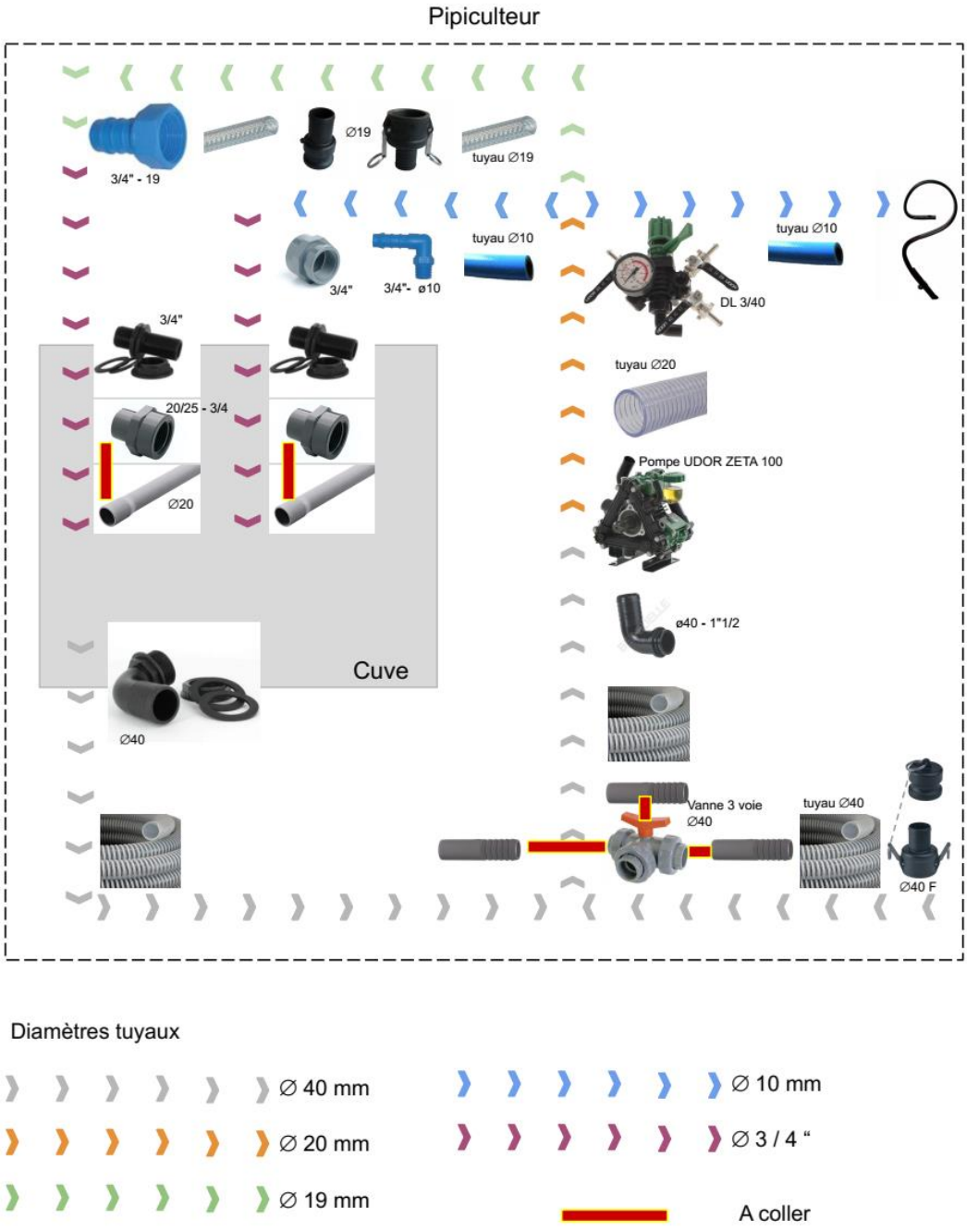
Figure 5 Zeta 100 pump accumulator and inflation valve (in red)

2.3. Covering and piping

We advise to put Teflon on all screwed parts without sealing.

Below is a diagram of all the parts necessary for the manufacture of the Pipiculteur *(Tuyau = Pipe, cuve = Tank, a coller = to glue):*

2.3.1. Pipiculteur



piping shown in grey (ø 40 mm)

The zones for drilling the tank are not defined exactly. It is necessary to choose flat zones (not too close to the edges).

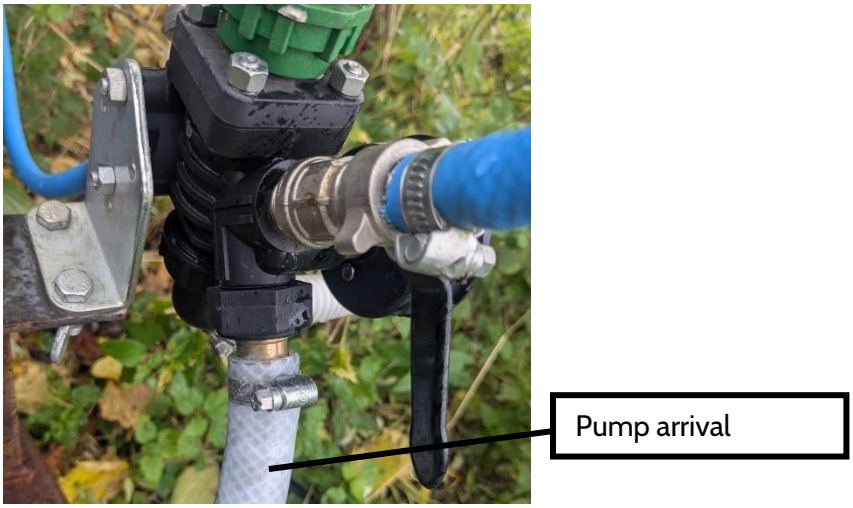
To pierce in the bottom of the tank the simplest is:

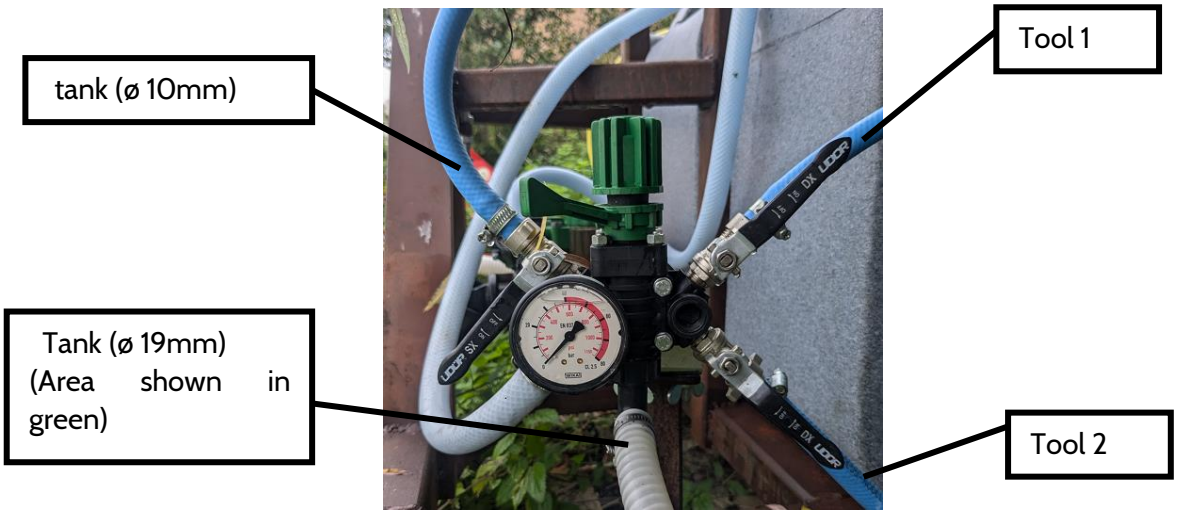
- Place the tank in place
- Marker the metal bars
- Remove the tank
- Drill in a space-free area close to the lid (to easily fit the wall pass). Drill with a hole saw according to the recommendation of the supplier (*for the prototype we made: 50 mm*). Beware, small "low price" hole saws sometimes makes bigger holes than announced... The best thing is to do a test on a similar material.

- Assemble the various elements by adjusting the length of the pipes as much as possible and secure the pipes with clamps.
- If necessary, secure the pipe ø 40mm with self-locking Cable Tie .

piping shown in Orange (ø 20 mm)

- Connect the pump to the distributor by adjusting the length of the pipe. Attach pipes with clamps.





For ø10mm (shown in blue) and ø 19mm(shown in green) piping, use the picture above to connect the pipes.

piping shown in Blue (ø 10 mm)

Attention on the diagram above we have shown only one pipe that goes to the teeth. **In reality, there are two**. It is also possible to split them with the "Y"-connection Tubulure ø10 mm" if you want to use 4 teeth.

Pipes should be held in place with "gaffer" tape at the tip of the teeth.

Figure 6:: Pipiculteur's teeth and spray pipes hanging from the "gaffer"

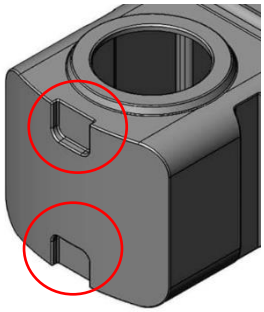
Piping shown in purple (ø 3/4")

- Drill the tank using a hole saw according to the recommendation of the supplier (*for the prototype we made: 28 mm*)
- Cut the pipe down to the lowest level without touching the tank
- Paste the pipe to the sleeve
- Make a small hole at the top of the pipe (at the sleeve) to avoid syphon effects
- Place the wall-pass with the long side facing outwards
- Screwing the remaining elements

Piping shown in green (ø 19 mm)

- Connect the pump to the tank by adjusting the length of the pipe. Attach pipes with clamps.

Bonus



It is possible to add a level indicator to the tank. It level with the flat areas on the side.

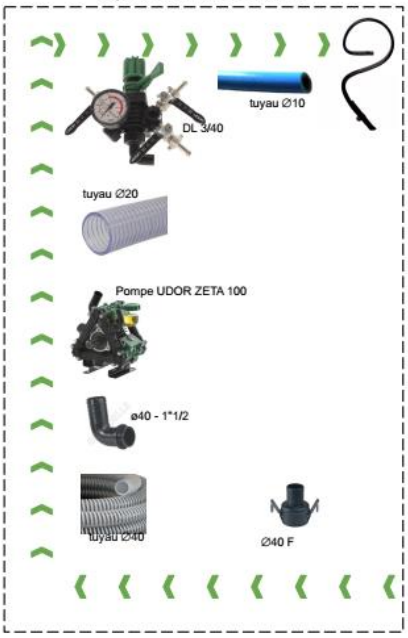
Attention, on the tank we used there is already a brass thread present. Do not use it because the diameter is not the same as the level we purchased (to date, we have not installed the level on the prototype).

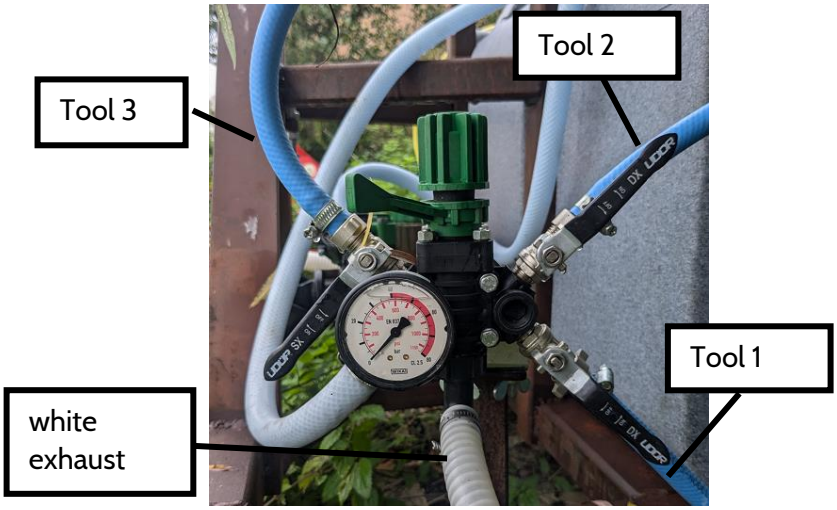
2.3.2. Free tank Pipiculteur

A free tank version is available. This reduces manufacturing time and costs. The use of this version without tank, requires having a tractor equipped with pallet forks in order to carry an IBC tank during fertilization.

Below are the assembly diagrams of the free tank Pipiculteur. After the distributor, it is possible to make 1, 2 or 3 pipes leave towards the teeth.

Free tank Pipiculteur





: Urine Flow

In this case, the outlet, called the “white exhaust” pipe, will be used to use the pump as a lifting pump to transfer urine from one tank to another.

2.3.3. “IBC Pipes”

This pipe connects an IBC tank to the Pipiculteur, it is used in both versions of the machine.

The ideal starting point is this pipe and the Pipiculteur. The remaining drop of the coil will be used to make the "hose barrel" (next paragraph).

- Stick the "D 40x40/42 Grooved Socket" to the plug valve
- Assemble the whole
- Wear clamps (not shown)

The length of the pipe is to be defined depending on the tractors used.

When using the IBC, it is necessary to attach the pipe to fixed parts of the tractor so that it does not idle. We have not yet developed an optimal solution for this. The use of gaffer can be considered but we invite users to make flanges to attach to their tractor (and to send us photos of these flanges 😉).

2.3.4.'Hose barrel'

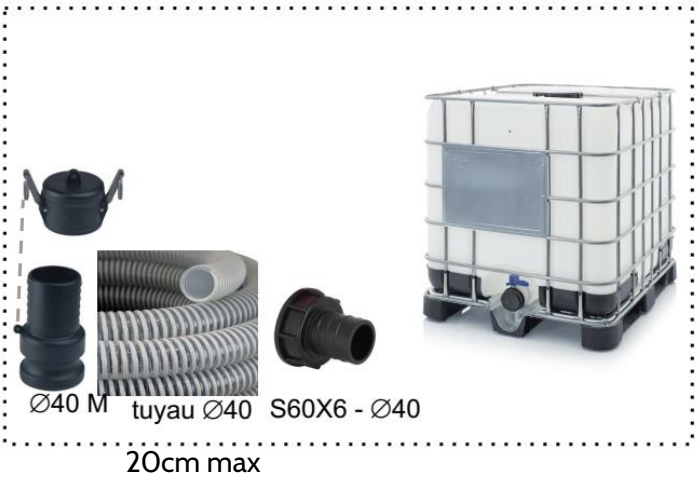
This hose allows to connect the Pipiculteur pump to a barrel in order to fill the onboard tank, it is used in the tank version only.

- Cut 1m50 of pipe (or use the end of the coil).
- Assemble the whole
- Tight with clamps (not shown)

2.3.5.IBC tank

An adapter must be placed at the outlet of the IBC tank in order to be able to connect it to the Pipiculteur.

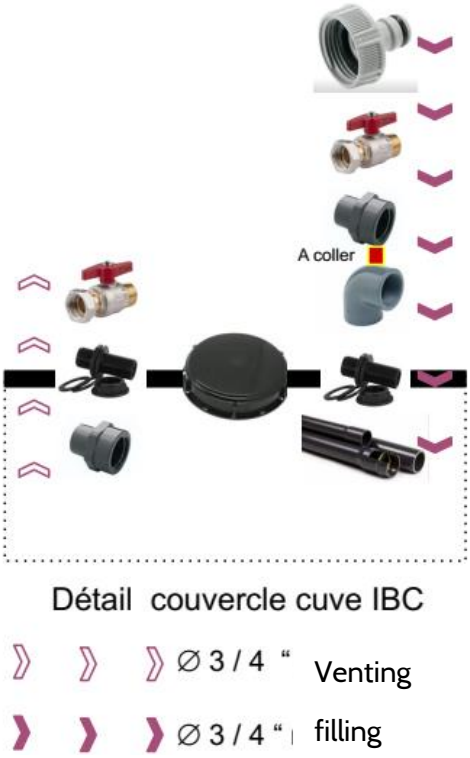
- Assemble the whole
- Tight with clamps (not shown)
- Connect the camlock connector to a camlock plug using a chain



IBC tank plug adapter

We created a special plug for the IBC tank to fill it without putting pipe inside. This avoids as much as possible contact with urine and residual drops. We recommend using the same system to drain the Pipiculteur tank into the IBC tank if necessary.

Below is a photo of the prototype as well as the assembly diagram. The lid should be pierced to the diameter recommended by the wall pass manufacturer.



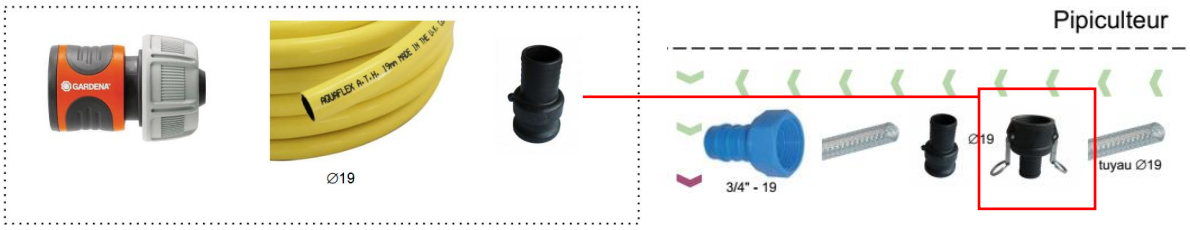
Here are the parts needed to make this lid:

We let the French names on the section bellow, so it is easier for people to find the elements on internet if they want to buy them.

Référence	Quantité	Photo
Tube D 25 PN25 PVC Pression Length must be adapt to arrive 5cm above the the bottom of the tank	1	
Manchon D 20/25x3/4 po. PN16 mixte taraudé	2	
Trop-plein cuve - Mâle 3/4" Pas gaz (20x27 mm) - Version longue	2	
Couvercle plein de cuve eau 1000 L - Diamètre 150 mm – Sotralentz (To adapt according the IBC tank)	1	

éCoude 90° D 25x3/4 po. FF mixte PN16	1	
Vanne papillon à écrou libre MF 20x27 (3/4")	2	
Manchon D 20/25x3/4 po. PN16 mixte taraudé	1	
Nez de robinet GARDENA 26.5 mm (G 3/4) - Anti-éclaboussure	2	

The pipe that connects the Pipiculteur and the IBC tank is as follows (we have not yet tested this in this manual). It connects to the 19mm female cam connector on the Pipiculteur. The clamping collars are not shown.



2.4. Teeth and deflectors

Place the teeth at the required distance. In the photo below we used 2 cultivator teeth. It is also possible to fit them on the 50mm square tube at the rear.

It is possible to add deflectors on the rear bar to close the grooves mechanically, but these tools have not yet been developed.

3. EC certification

The use of this machine in European union requires a self-certification by the manufacturer. We have created an example of a machine self-certification file that can potentially be used by people who want to make one. This document is available on the OCAPI website: https://www.leesu.fr/ocapi/les-projets/enville/outils-agricoles/.

We do not know the regulations concerning the use of this machine outside European union.

PART TWO

Use of the Pipiculteur

4. Prerequisites for use of the Pipiculteur

4.1. Tractor

This machine has been designed for use with a 40hp tractor equipped with a power take-off. Once the tank is full, the machine can weigh up to 620 kg. It is appropriate for each user to check that his tractor is powerful enough to use this machine.

The conventional version does not require a pallet fork on the front of the tractor, but they are recommended for moving IBC tanks (if it is this format used to store urine before spreading).

4.2. Preparation of soil

In order for the soil to close itself after the tool has passed, it is necessary not to have large clods, so we recommend to have small clods before using the machine. Otherwise, it is possible to add deflectors on the rear bar to close the furrow mechanically.

4.3. Setting up crops

In order to limit the losses due to volatilization and flushing, it seems that it might be advantageous to fertilize at most one week before planting. It should also be possible, if possible, to avoid tillage (soil preparation) after injecting the sanitized urine into the soil. These two points need to be specifically examined.

In the case of manual planting after fertilization, it is preferable to wait a few days between fertilization and planting to reduce the odours that can appear when moving the soil.

Given the product injected (sanitized urine), we recommend using this machine during plant growth periods, between mid-February and October.

4.4. Urine storage on the farm

The urine used in this machine is sanitized by storage in a closed tank. The storage time is 6 months if used on crops that are susceptible to raw consumption, 1 month for other crops. It is necessary to count the storage time from the last filling of the tank.

Figure 7 IBC TANK

It is also possible to use flexible tanks which have the advantage of increasing their volume by filling them. This prevents ammonia being released into the atmosphere. However, these tanks are more fragile and do not move when they are full. If the tank is too large, it is either necessary to wait a long time for the sanitization to be carried out or to fill it quickly (or to stop even if it is not full).

Care must be taken not to install this flexible tank in a flood-prone area.

Figure 8:: Example of a flexible tank. The volumes can range from 5 to 500 m3.

4.5. Determination of sanitized urine for spreading

Sanitized urine can be applied on most crops, and in particular those with a high demand for nitrogen (spinach, cabbage, chard, corn, wheat, etc.). The basic figure that is recommended in several books is **2L/m²**, but can be refined according to cultures. Below is a table giving the silt content per m². [2]

Category	Plant	No. of litres of urine to be applied per m²	Category	Plant	No. of litres of urine to be applied per m²
Heavy Use	Cabbage and chard	4	**Medium Usage**	Courge	2
Sustained use	Celery	3		Potato	
	Card			Tomatoes	
	Cucumber			Courgettes	
	Aubergine		**Moderate Usage**	Carrots	1
	Leek			Parsley	
	Pepper			Radish	
Medium Usage	Artichoke	2		Salad	
	Asparagus			Echalote	
	Beetroot			Cutter	
	Broccoli			Shuttle	
	Garlic		**Less useful**	Pea	0.5
	Onion			Beans	
	Spinach			Pea	

Figure 9 :: Total amount of sanitized urine (before dilution if any) to be applied, depending on the crops.

5. Operation of the pump

The pipes that connect the pressure control unit and the tank reduce the flow to the teeth (by feeding some of the pumped urine back into the on-board tank rather than to the teeth). In the

[2] According to Martin TMP, Esculier F, Levavasseur F, Houot S. Human urine-based fertilisers and Looze R. L'Urine, liquid gold in the garden

paragraph below we note a flow rate of 100% if 100% of the urine leaving the pump reaches the teeth and 67% if only 67% of the urine leaving the pump reaches the teeth.

The flow rate of the pump can be adjusted in two ways:

- By PTO speed in revolutions per minute (RPM)
- By opening and closing the distributor valves (in % pump flow in the table below)

% / RPM	**100%**	67%	50%	44%	38%	21%	33%
550	**98** (L/min)	65	49	43	37	21	32
500	**90**	60	45	40	34	19	30
450	**82**	54	41	36	31	17	27
400	**73**	49	36	32	28	15	24

Table 1 :: Injected sanitized urine flow rate (L/min)

The table above shows the possible output flow rates (in L/min) as a function of the pump's rotation speed in Rotation Per Minutes (RPM) and the percentage flow rate sent to the teeth.

We recommend that priority be given to 100% of the throughput. Indeed, it is preferable not to "stir" the urine to avoid volatilization. If the desired throughput is not available with the 100% configuration, it is nevertheless possible to get into the 67% configuration. The red configurations use only one dispatcher output and the grey configurations use 2. At this time, we do not believe it is necessary to use the other configurations.

To choose the percentage of throughput to be sent to the tools, here are the different configurations:

	Main valve		Secondary valves			
%	0 bar	Pressure	Tank blank	Tank blue	Tool 1	Tool 2
100%		**X**			**X**	**X**
67%		X		X	X	X
50%		X		X	X	
44%	X		X		X	X
38%	X		X	X	X	X
33%	X		X		X	
21%	X		X	X	X	

For the "blank tank" pipe, there is no secondary valve, it is supplied if the main valve is in "0 bar" or when the distributor is under overpressure.

Careful, to send 33% and 21% of the flow rate, only one tool output is needed. The best way is not to use these configurations.

For example, if a flow rate of 90 l/min is required, a rotation speed of 500 rpm must be chosen with a flow rate of 100%. It is therefore necessary to go into a pressure configuration and open the two tool valves.

Free tank machine

When using the machine without a tank, all the sanitized urine coming out of the pump reaches the teeth, it can only be at 100% of the flow rate distributed over one, two or three pipes.

6. Coupling the machine

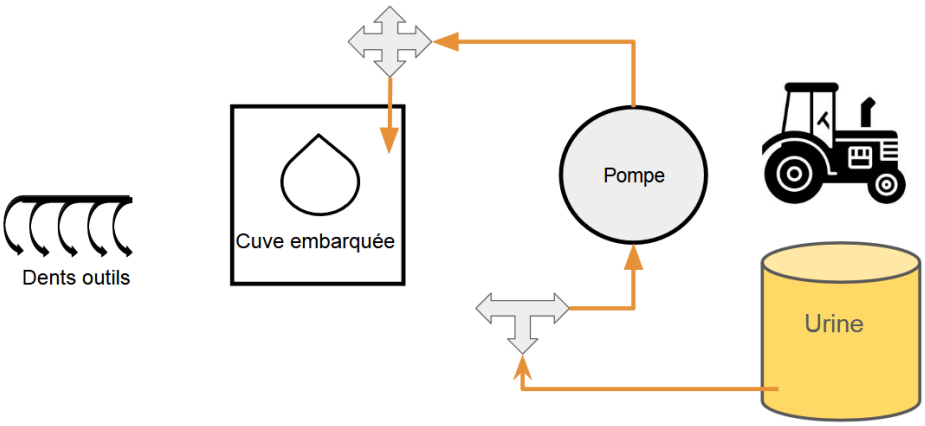
The machine we offer is equipped with a hitch triangle. It is therefore also necessary to equip your tractor with a “tractor-side hitch triangle” (male triangle).

1. Hitch Machine
2. Connect the pump to the PTO with the drive shaft
3. Lift the machine with the tractor
4. Remove the props (crutch)

7. Fertilization

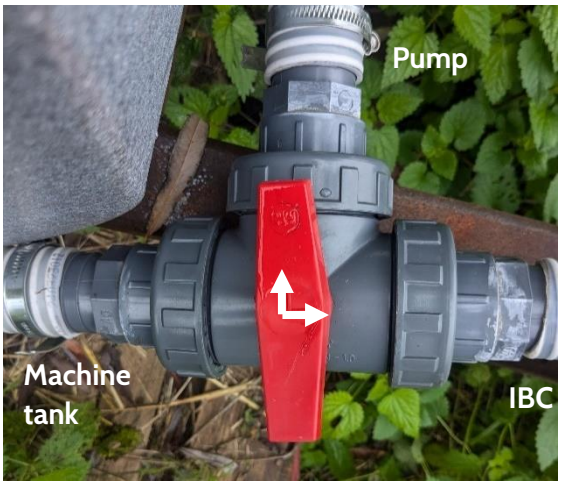
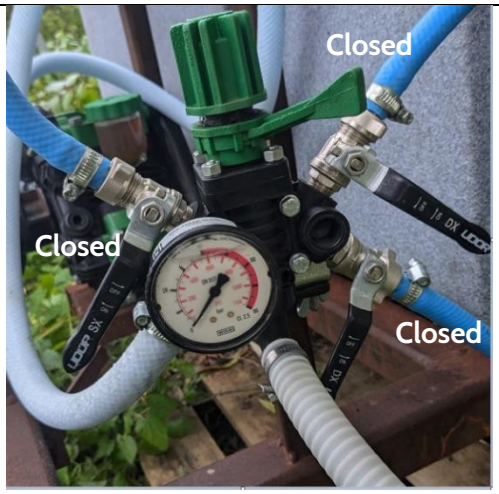
7.1. Filling the tank for fertilization

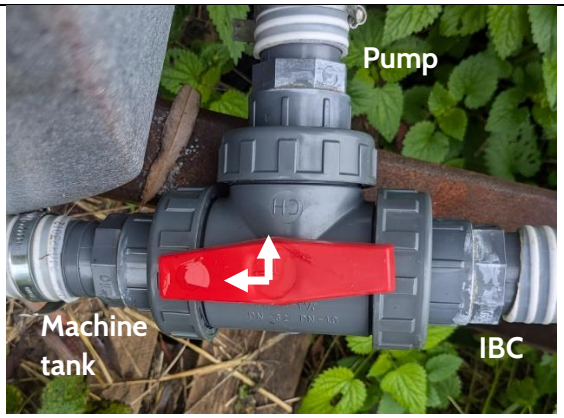
This operation is required for the vat version. Below is a diagram of the urine flow.



Pompe = Pump *Cuve embarquée = Tank* *Dents outils = Teeth*

7.1.1. If the sanitized urine is stored in an IBC tank (or other tank)

Stage	Deposit	Photo
1	Connect the IBC tank to the 3-way valve with the dedicated pipe	 
2	Open IBC Pipe Valve	
3	Move the 3-way valve to the IBC-Pump position	
4	Close all 3 tool valves on the distributor	

5	Get on "0 bar"	
6	Activate the pump with the tractor	
7	Pay attention to the filling level of the tank and stop the pump	
8	Close IBC Pipe Valve	
9	Place the 3-way valve in the machine tank-Pump position	
10	Disconnect the pipe from the 3-way valve and plug in the stoppers.	
(11)	Repeat step 1 when the tank is empty	

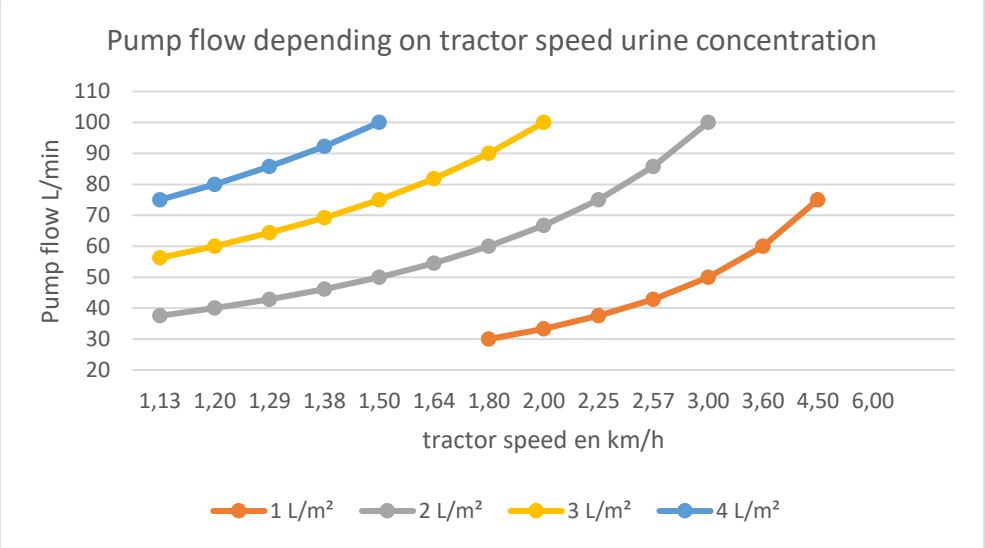
7.1.2. If urine is stored in barrels

Stage	Deposit	Photo
1	Connect the 3-way valve to the barrel pipe and place the pipe in a barrel	
2	Go to step 3 of the chapter 'If the sanitized urine is stored in an IBC tank'	

7.2. Calculation of flow rate and tractor speed for silt dosing

Repeat the table with the possible flow rates and configurations in the chapter “Operation of the pump”

% / RPM	100%	67%	50%	44%	38%	21%	33%
550	**98** (L/min)	65	49	43	37	21	32
500	**90**	60	45	40	34	19	30
450	**82**	54	41	36	31	17	27
400	**73**	49	36	32	28	15	24



1) Choose the amount of sanitized urine to put into the soil
   For example: 2L/m² (a dosage conventionally used for a large number of crops)

2) Make a **no-load** pass on the board starting at 550 rpm (**without activating the power take-off**), time to cover the board.
   For example: 60sec

3) Measure (or know in advance) the length and width of the board and apply the following calculations:

$$Pump\ flow\ (\frac{L}{min}) = \frac{Concentration\ \left(\frac{L}{m^2}\right) * length\ board(m) * width\ board(m)}{time\ (s)/60}$$

Or

$$Temps(s) = \frac{Concentration(\frac{L}{m^2}) * Length\ board(m) * Width(m)}{pump\ flow(s)\ /60}$$

For example: a 50 x 1.2m board

$$Exemple\ pump\ flow = \frac{2 * 50 * 1{,}2}{60\ /60}$$

$$Exemple\ pump\ flow = \ 120\ L/min$$

4) If one of the flow rates is possible in the flow table (±5 l/min), choose this configuration. If not, change the tractor speed and/or PTO speed and start over in step 2.

In our example, a flow rate of 120 L/min would be required, which is not possible with this pump because the max flow rate is 98 L/min. So we choose to lower the tractor speed and start again the no load charge with time measurement.

We obtain a new time of 75s (1min 15s) to cover the board.

$$Pump\ flow(\frac{L}{min}) = \frac{Concentration\ \left(\frac{L}{m^2}\right) * board\ length\ (m) * board\ width(m)}{time\ (s)/60}$$

$$pump\ flow\ exemple = \frac{2 * 50 * 1{,}2}{75\ /60}$$

$$pump\ flow\ exemple = 96\ L/min$$

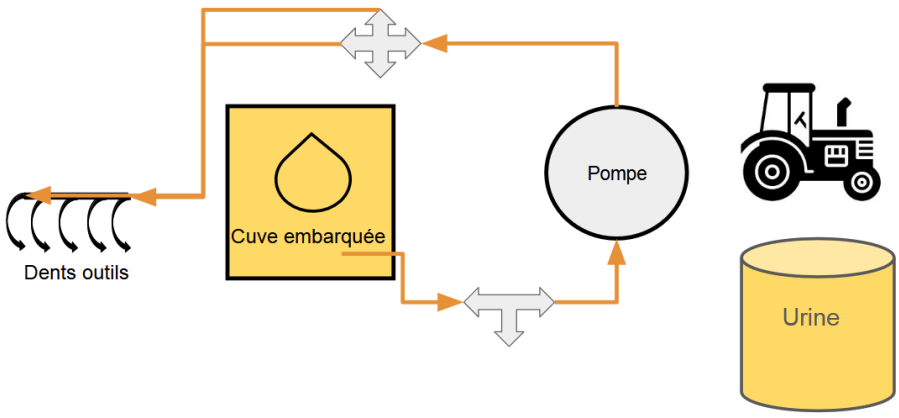
The target flow rate is very close to one of the possible flow rates according to the table, so this configuration can be used for fertilization.

You can use an online spreadsheet to do field calculations on your phone. We offer you two possible links. We put these spreadsheets online in May 2025 but we do not guarantee their sustainability over time.

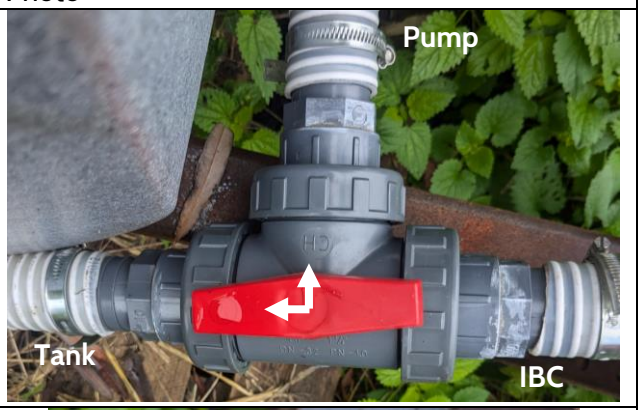
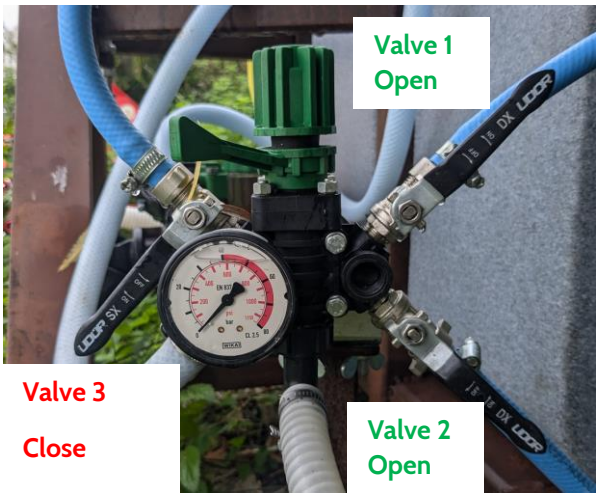
7.3. Injection of urine into the soil

7.3.1. Pipiculteur

Below is a diagram of the urine flow (in the case where 100% of the urine flow goes to the teeth).



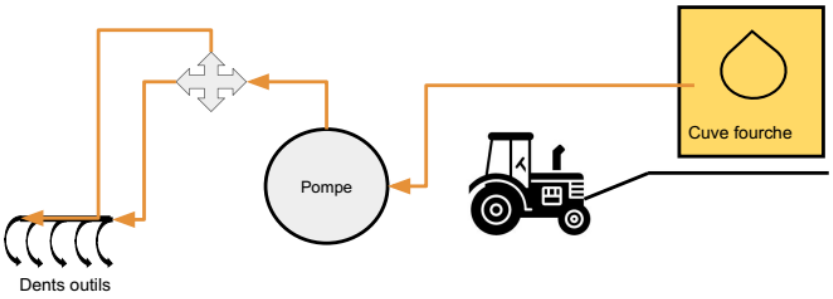
Pompe = Pump Cuve embarquée = Tank Dents outils = Teeth

Stage	Deposit	Photo
1	Check that the 3-way valve is in the tank-Pump position	
2	Putting the distributor in the correct configuration (according to the flow calculation in the previous chapter) *To continue the example in this document: 98 L/min* ⇨ *100% throughput* *It is therefore necessary to go into "pressure" mode with the tool 1 and tool 2 valves open* ⇨ *Power take-off speed 550 rpm*	 
3	Use the Pipiculteur as a conventional cultivator.	
4	**<u>Activate the pump when the teeth enter the floor</u>**	
5	Stop the pump when the teeth come out of the ground	
6	When the tank is empty, fill it again (see previous chapter)	

7	When fertilisation is complete, clean the machine (Next Chapter)	

7.3.2. Tank-less Pipiculteur

Below is a diagram of the urine flow.



Pompe = Pump *Dents outils = Teeth* *Cuve Fourche = pallet fork Tank*

Stage	Deposit	Photo
1	Check that the IBC tank on the forks is properly connected to the pump connection. Be careful that the hose is secured to the tractor and does not drag on the ground.	
2	Putting the distributor in the correct configuration (according to the flow calculation in the previous chapter) *To continue the example in this document: 98 L/min* *It is therefore necessary to enter a "pressure" mode with the tool valves open* *Power take-off speed 550 rpm*	
3	Use the Pipiculteur as a conventional vibrator.	

8. Cleaning and storage machine

Do not store urine in the pump and pipes. This can cause damage to the pump and valves, as well as an increase in malodour during operation or maintenance of the Pipiculteur.

8.1. Empty the machine tank

If the machine tank is full, disconnect the 19mm white-tank pipe and connect it to the IBC tank using the IBC fill pipe.

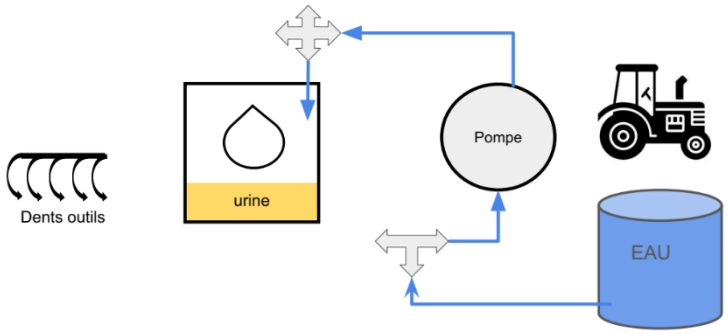
Empty the tank with the tool pump.

8.2. Clean Up Circuit

The aim of this operation is to partly clean the different circuits and to make sure that there is no stagnant urine in the pump. To do this, perform the following steps:

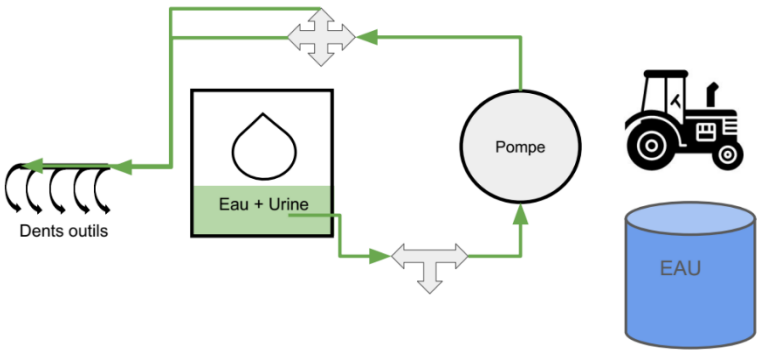
8.2.1. Pipiculteur

1) Setting up a tank filling
2) Pump the equivalent of a 20L barrel of water with the barrel and/or IBC pipe

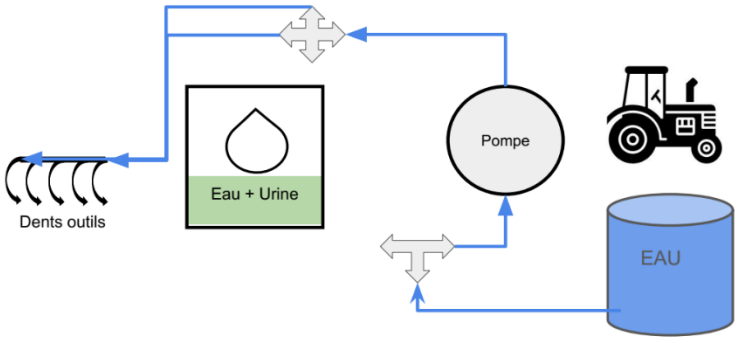


Eau = water

3) Set up for fertilisation, i.e.:
    - 3-way valve on the Pump Tank
    - Pressure mode distributor and tool valves 1 and 2 open.
4) Empty the on-board tank with the water/urine mixture. This operation can be carried out on the board that has just been fertilised. The water-sanitized urine mixture can be recovered and used to fertilise a tree or hedge close to the fertilised area.



5) Set up the lift pump, i.e.:
    - 3-way valve on IBC-Pump
    - Dispatcher in 0bar mode
6) Pump the equivalent of a 10L water drum with the barrel and/or IBC pipe



8.2.2.Tank-less pipiculteur

1) Close the outlet valve of the IBC tank
2) Disconnect the pipe from the IBC tank
3) Pump the equivalent of a 20L barrel with the IBC pipe barrel

8.3. Global Cleanup

During the installation of the machine or during cleaning, drops of sanitized urine may be found on the machine. In this case, wipe with a water jet.

8.4. Storage

- Hand over the crutches
- Do not forget to remove the shaft from the PTO before uncoupling
- If possible, store away from rain and sun.

9. Maintenance

9.1. General

Clean the water system after each use.

9.2. Pump and transmission shaft

Carry out the maintenance of the pump according to the instructions in the instructions.

Perform the lubrication and maintenance of the transmission shaft according to the instructions.

9.3. Leakage test

At each use, check the tightness (visual) of all the elements.

9.4. Check tightening screw

Before each use verify that the screws are properly tightened and that the pump is properly attached to the machine.

9.5. General Visuals

Before each use, check the general condition of the welds.

9.6. Storage

If possible, store away from rain and sun.

9.7. Transport

During transport in the field (coupled to the tractor), the tank may be full.

When transporting in a lorry, the tank must be emptied first. The machine must be strangled to the lorry during transport.

9.8. Failure

In case of pump failure, refer to the pump instructions.

If the tank is full, it is necessary to:

- Drain the tank with another pump
  Or

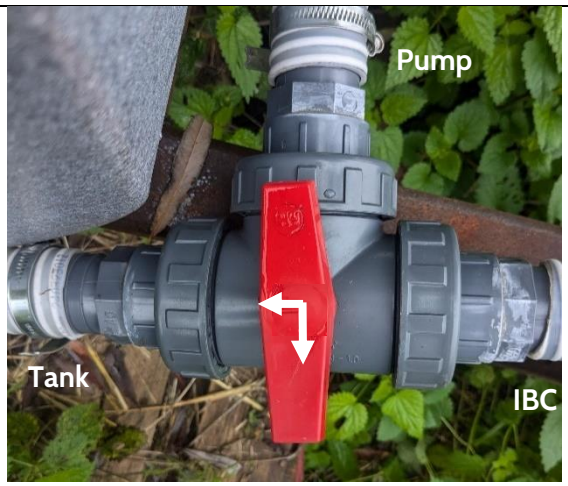
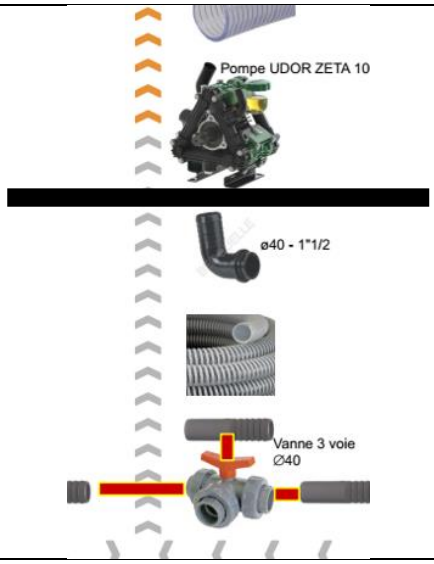
Place the 3-way valve in the closed position	
Disconnect the pump inlet connection	
Empty the tank in suitable containers by placing the 3-way valve in the Tank-Pump position	

Photo credit

Photos of the elements used to make the Pipiculteur are taken from the following sites: bedouelledistribution.com, connexion-pression.com, agrieuro.fr, agrizone.net, manomano.fr, multicuves.com.

The credit of the other photos and diagrams is Ocapi.

Notes

We strongly invite all interested parties to download the drawings of this machine, to build it, to modify it or to create others. If you have any questions or suggestions for improvements, you can contact us at: enville@enpc.fr.