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SPISE

Standardized **P**rocedure for the **I**nspection of **S**prayers in **E**urope

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Advice for funcional inspection of soil disinfection equipment

Part 1: gaseous/liquid formulation application equipment

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This document has been compiled by the SPISE Technical Working Group 10

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Content

1 Introduction

In the Article 8 of the EU Directive 128/2009/EC it is foreseen that all Pesticide application equipment should be inspected before the end of 2016. The number of machines in use is not large, but the products that are used with this type of machine are very toxic (chloropicrin, metam-natrium and metam-kalium). This SPISE inspection advice not only focusses on a good functioning machine, but also takes into consideration important health precautions for inspectors and users from this type of machines. On top of that, because of the small number of such machines, an economical approach was made so the inspection of this type of machines doesn't require large investments for the inspection services.

Figure 1: Typical soil-disinfection machine.

Soil disinfection machines (Figure 1) are mainly used in vegetable growing, and mostly in greenhouses. The treatment is performed periodically and the aim is to get a sterile soil after the treatment (free from fungi and nematodes). The treatment gets it's good functioning out of the evaporation from the soil-disinfectant into the soil. In a first stage the soil is loosened and the disinfectant is injected into the soil at the desired depth by means of the soil-disinfection machine and in a second stage the injected area is covered immediately with plastic foil to prevent evaporation from the disinfectant into the air.

Figure 2: Injecting the disinfectant and manual plastic covering.

In greenhouses the plastic covering is performed mostly manually, while outside used machines mostly have the possibility to cover the treated area automatically with plastic foil.

Figure 3: Injecting the disinfectant and automatic plastic covering.

Most machines are equipped with injectors that exist out of a coulter with an injector tube placed behind the coulter, or a ploughshare with a nozzle placed underneath (Figure 4).

Figure 4: Left coulter with injector tube and right ploughshare with nozzle.

Furthermore two systems are used to pressurize the liquid. On the one hand there are the machines using an air pressurized pesticide tank to control the flow, but there are also some machines that use a small pump to pressurize the liquid system. In all cases a low variation of the final pattern is a key success factor.

The following chapters are intended to provide the technical indications to make a correct inspection of those type of machines, and is mainly based on the existing ISO16122 standard.

2. Working principle of soil disinfection machines

In order to clarify the inspection protocol, one first needs to know how this type of machines are working. Therefore a hydraulic scheme is useful and two simple schemes show the working principles.

2a. Air pressurized soil disinfection machines

A simple scheme containing all elementary parts from an air pressurized machine is shown in Figure 5.

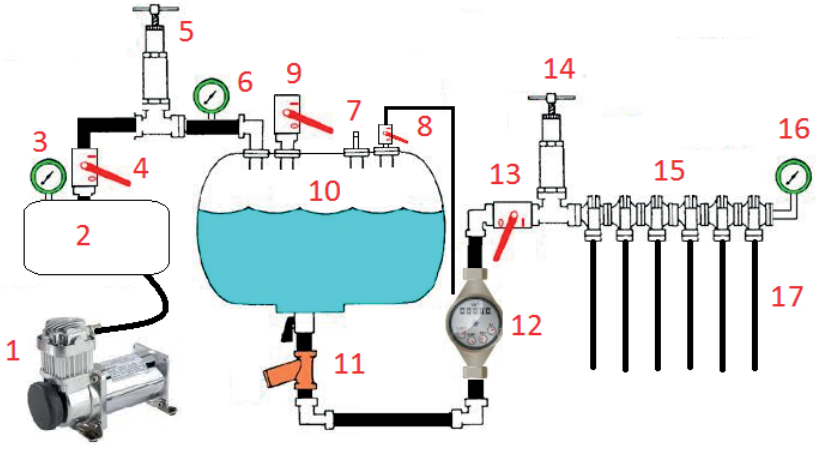

Figure 5: Hydraulic scheme of an air pressurized soil-disinfection machine.

Briefly one could divide the scheme into two main parts. On the one side you have the air pressure part (part 1-8) and at the other side the liquid pressure part (9-17).

As concerns the air pressure part, in most cases, a battery or hydraulically powered compressor (1) is used to pressurise the air-pressure tank (2), but it has to be mentioned that some specialised firms use a scuba tank for pressurising the pesticide tank (10). A pressure gauge (3) on the air pressure tank indicates the available air pressure. A valve (4) between the air pressure tank and the pesticide pressure tank (10) is available to shut off the air pressure between both tanks. Between the air pressure tank and the pesticide pressure tank a pressure valve (5) makes it possible to adjust the air pressure in the pesticide pressure tank (10) based on a pressure gauge (6). There is also a safety pressure valve (7) foreseen, and a pesticide tank depressurizing valve (8) to safely depressurize the pesticide tank.

At the liquid side the metal pesticide pressure tank (10) is sealed hermetically and there is a filling valve (9) to fill the tank with the soil-disinfectant. There is an optional pressure filter (11) and a main shutoff valve (13). A dividing block (15) with restrictor plates, small taps or narrow tubes divides the liquid to the different injectors (17). Optionally an analogue or digital flowmeter (12) and an extra flow regulating valve (14) can be installed to fine-tune the flow. An extra pressure gauge (16) on the dividing block (15) is interesting to read out the pressure at injector height.

2b. Pump pressurized soil disinfection machines

The liquid system from pump pressurized machines is more or less comparable with the one from a normal spraying machine. A simple scheme containing all elementary parts is shown in Figure 6.

Figure 6: Hydraulic scheme of a pump pressurized soil-disinfection machine.

The pesticide tank (2) is sealed hermetically and there is a filling valve (1) to fill the tank with the soil-disinfectant. A tank valve (3) is foreseen to prevent emptying from the tank when the suction filter (4) is loosened. Altough other pump types could be used, the only pumps that were encountered on those type of machines were 12V diaphragm pumps (5). The pump could be controlled by using an electronic control box with a potmeter (6), but there are also machines using a simple rate controller for automatic flow regulation. An optional pressure filter (8) is possible and by powering off the diaphragm pump the liquid flow stops. A dividing block (9) with restrictor plates, small taps, narrow tubes or nozzles divides the liquid to the different injectors. An analogue or digital flowmeter (7) and/or a pressure gauge (10) on the dividing block is installed.

3 Safety

As one knows soil-disinfection machines are used with hazardous products such as chloropicrin, metam-natrium and metam-kalium so at first and above all inspector safety should be considered.

Thus before testing those machines the owner should be asked explicitly to clean the machine thorougly, rinse the tank and to fill it with clear water ! The tank lid should be left open after rinsing. When there is any doubt on the clean state of the machine then inspection shall not be started up !

When the machine is accepted as clean then the inspectors should follow some basic rules before starting up the inspection.

At first the inspection of soil-disinfection machines should always be performed in open air to obtain maximum ventilation. The machine should also be positioned downwind to prevent as much as possible inhalation of hazardous vapours.

Secondly inspectors should always wear a pesticide mask with replacable active carbon filter (Figure 7), gloves cat III and safety shoes. A spray overall is also recommended.

Figure 7: Mask with active carbon filtering.

Following this basic directive should prevent health problems for inspectors and bystanders.

4 Pre inspection : admittance rules

4.1. Cleaning

At first the machine needs to be presented in a clean state and shall be cleaned externally and internally. There shall not be there any pesticide residues into the tank or on the external surface that can be a source of contamination for the inspector or the environment.

Method of verification: visual check.

4.2. Power transmission parts and moving parts of the equipment

All moving parts have to be protected. (PTO, chains, ...). The protective devices shall be in a good and undamaged state, and work properly.

Method of verification: visual check and function test.

Figure 8: Unprotected chain and unprotected PTO.

4.3. Structural parts and framework

Structural parts and framework of the machine shall be without permanent deformation, significant corrosion or considerable defects.

The hitching device shall be in good condition and shall work properly.

Method of verification: visual check.

4.4. Static leaks

The pesticide tank has to be filled with clean water to its nominal capacity. There shall be no No leakages at all, according to ISO16122 leakages while not injecting/spraying. Air pressurized machines shall also be presented in pressurized condition and there shall be no air leakages.

Method of verification: visual check.

4.5. Scuba tanks

The scuba tanks from those machines that are using one to pressurize the pesticide tank shall wear a traceable inspection mark/sticker confirming inspection according to the national legislations.

Method of verification: visual check.

Figure 9: Inspected scuba tank.

5 Inspection

This inspection advice aims an economical inspection and following the sequence of the chapters beneath will result normally in the most efficient inspection approach for this type of machines.

5.1. First inspection stage while injecting/spraying

In a first stage injecting/spraying shall be started at normal work pressure as used by the owner.

5.1.1. Pressure pulsations

The pressure pulsations shall not exceed 10% of the working pressure while spraying injecting at normal working pressure.

Method of verification: measurement by observing the pressure indicator on the machine.

5.1.2. Pump capacity (pump pressurized systems)

The pump capacity shall be suited to the needs of the machine. The pump shall have sufficient flow rate capacity to maintain the required working pressure within a range of +/- 10%.

Method of verification: measurement by observing the pressure indicator on the machine.

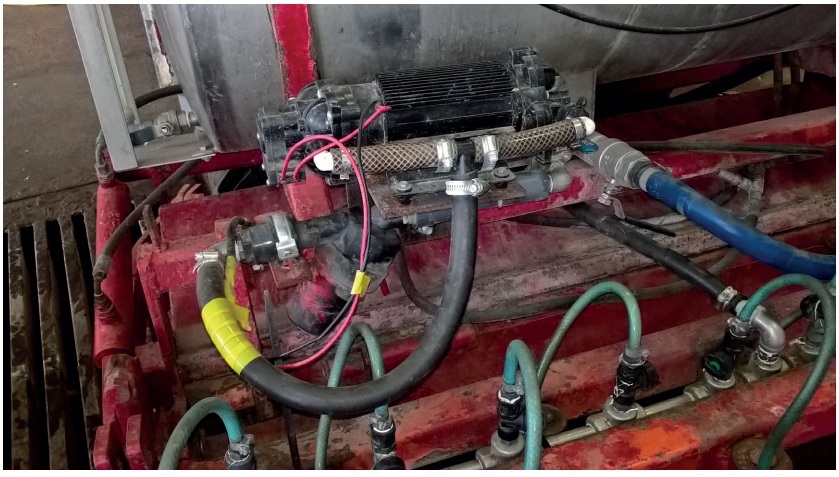

Figure 10 : Machine using a 12V pump to pressurize the liquid system

5.1.3. Air pressurization system (air pressurized systems)

The compressor or scuba tank capacity shall be sufficient to maintain the required working pressure within a range of +/- 10%. The air pressurization system shall also have an overpressure safety valve and the configuration shall correspond to the manufacturer's original design specification.

Method of verification: visual check and measurement by observing the pressure indicator on the machine

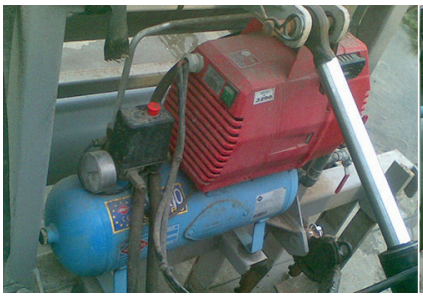
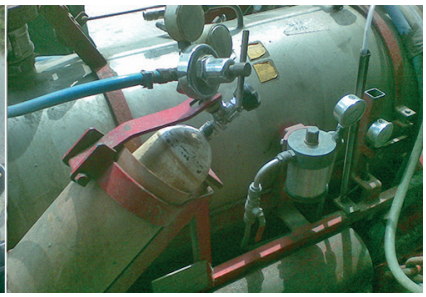

Figure 11 : Battery powered compressor; Figure 12: Scuba tank pressurization

5.1.4. Measuring systems, controls and regulation systems

All devices for measuring, indicating and/or adjusting pressure and/or flow rate shall function.

5.1.4.1. Controls

The valves for switching on and off the liquid flow shall function. Switching of and on all injectors shall be possible simultaneously (main valve or pump shutoff).

The controls to be operated during spraying/injecting shall be operable from the operator`s position and the instrument displays shall be readable from this position.

Method of verification: Compliance shall be checked by inspection and function test.

Figure 13: Section shutoff valves and flowmeter

5.1.4.2. Regulation system

All devices for adjusting the pressure shall function and shall maintain a constant pressure with a tolerance of ± 10 % at constant setting and shall return within 10 s to the original working pressure ± 10 % after the spraying/injecting has been switched off and on again.

Method of verification: compliance shall be checked by adjusting the pressure valve or pump controls and by shutting on and off the main valve or the pump controls.

Note: Pressure varying on air pressureized soil disinfection machines is performed by raising or lowering the air pressure in the pesticide tank. Depending on the air volume in the tank and compressor capacity, pressure changments can take some time.

Figure 14: Air pressure adjustment valve.

Figure 15: Pump potentiometer controls

5.1.4.3. Measuring system

At least one measuring instrument shall be present to make accurate adjustments. This may be a pressure indicator and/or a flow meter in the main conduit. The measuring device should be visible from the operators postion.

Method of verification: visual check

5.1.5. Dynamic leaks

With the machine running at a pressure which is equal to the maximum obtainable pressure for the system, with the section valves closed, there shall be no leakage from any part of the machine.

Method of verification: visual check

5.1.6. Dripping

When closing the main valve or shutting of the pump, the injectors shall not drip or the function to blow the liquid lines empty shall function properly.

Method of verification: visual check

5.2. Transverse distribution

5.2.1. General

For all types of machines the transverse distribution shall be measured by collecting the liquid for each injector on the machine. There are mainly two types of machines and depending on the type of machine the most suitable test method shall be selected.

Machines with tube injectors

For all machines that are using tubes placed behind a coulter or a knife, a set of buckets shall be used in combination with a stopwatch.

Figure 16: Pattern determination using buckets.

Machines with nozzle injectors

For machines that are using nozzles an orchard nozzle test bench shall be used in combination with a stopwatch.

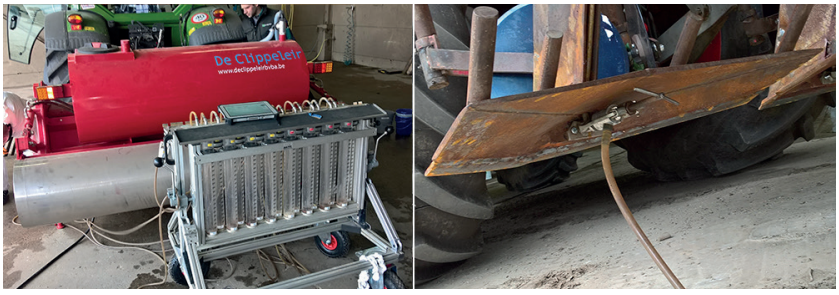

Figure 17: Machine with nozzle injectors

Method of verification:

The pressure and/or flow shall be adjusted to reach the desired value while spraying/injecting without collecting devices. For machines using a rate controller, the speed simulation module in the controller shall be activated and the normal work speed is selected.

After regulation and reaching the desired settings, the main valve is shutted off and an empty collecting device is placed underneath each injector. The start value of the flow meter (if present and when the flow meter is a counter) and the test pressure is written down.

Then the main valve is opened and at the same time a stopwatch is activated. For real time flowmeters the real time flow is registered while spraying/injecting.

After minimum 2 minutes of measuring the main valve is shut off and the stopwatch is deactivated. Note : The inaccuracy following out of different supply pipe lengths is compensated by the long measuring period.

By weighing the volume from the different buckets or reading out the graduated cylinders, combined with the measured time, the actual individual flow/flowrate (pattern) and total flow/flowrate can be determinated, and the dose (l/ha) is calculated.

5.2.2. Transverse distribution

5.2.2.1. ransverse distribution

The transverse distribution shall be uniform. The uniformity of the transverse distribution is evaluated on the basis of the coefficient of variation which shall not exceed 15 %.

Method of verification: 4.2.1 general

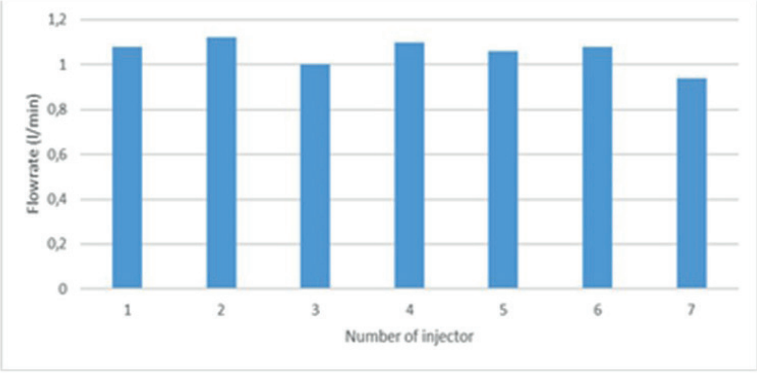

Figure 18: Pattern of soil-disinfection machine nr. A13300003.

5.2.2.2. Nozzle flowrate

If the coëfficient of variation exceeds 15% and the machine uses nozzles at injector height then an additional nozzle flow rate measurement is performed.

Method of verification: measurement according to ISO16122-2 point 5.7.3.

5.2.2.2.1. Nominal nozzle flow rate known

The deviation of the flow rate of each nozzle of the same type and size shall not exceed:

- ±10 % of the nominal flow rate indicated by the nozzle manufacturer with a flow rate more than or equal to 1 l/min for the maximum working pressure given by the nozzle manufacturer, or
- ±15 % of the nominal flow rate indicated by the nozzle manufacturer with a flow rate less than 1 l/min for the maximum working pressure given by the nozzle manufacturer.

5.2.2.2.2. Nominal nozzle flow rate unknown

The flow rate of a single nozzle shall not exceed ± 5 % of the average flow rate of the nozzles of the same type and size mounted on the machine.

5.2.3. Flow meter

Flow meters shall measure with a maximum error of +/- 10% of the actual value. For counter flow meters the counted value shall be compared with the total captured flow. For real time flow meters the calculated total flowrate shall be compared with the actual flowrate.

Method of verification: 4.2.1 general

Figure 19: Counter flowmeters.

Figure 20: Real time flowmeter.

5.2.4. Rate controllers

Rate controllers shall function with a maximum dose error of +/- 10% of the actual value. The captured value shall be compared with the setted dose.

Method of verification: 4.2.1 general

5.3. Inspections on a depressurized machine

5.3.1. General

In a final stage air pressurized machines shall be depressurized and a number of inspections shall be performed on a depressurized machine.

5.3.2. Spray liquid tank

5.3.2.1. Filling valve

The tank shall be provided with a filling valve. It shall be well adapted and in good condition. The filling valve shall be tightly sealed to prevent air or liquid leakages and shall avoid unintended opening.

Method of verification: function test.

5.3.2.2. Depressurization

It shall be possible to depressurize air pressurized liquid tanks in a safe way and unintended opening shall be avoided.
Method of verification: function test.

5.3.2.3. Pressure safety valve

There shall be a pressure safety valve to avoid over-pressure in the tank.
Method of verification: visual inspection.

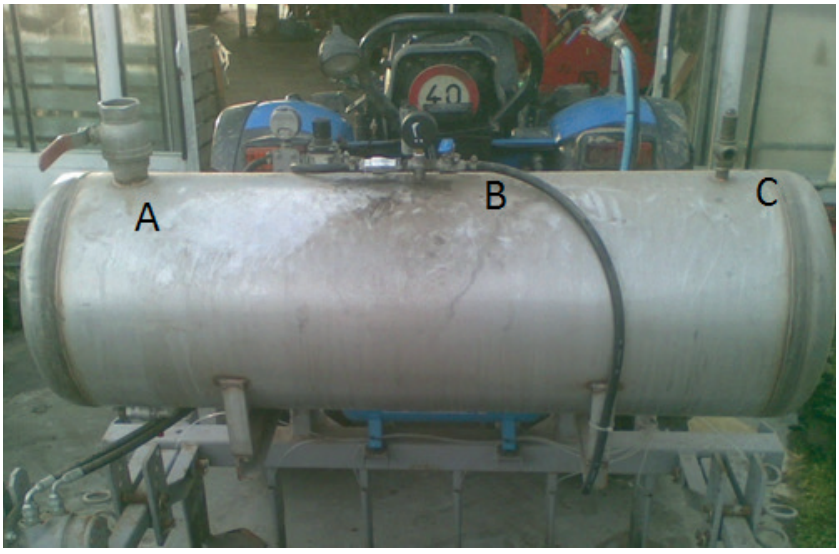

Figure 21: Tank with unsafe filling valve (A), depressurizing valve (B) and safety valve (C).

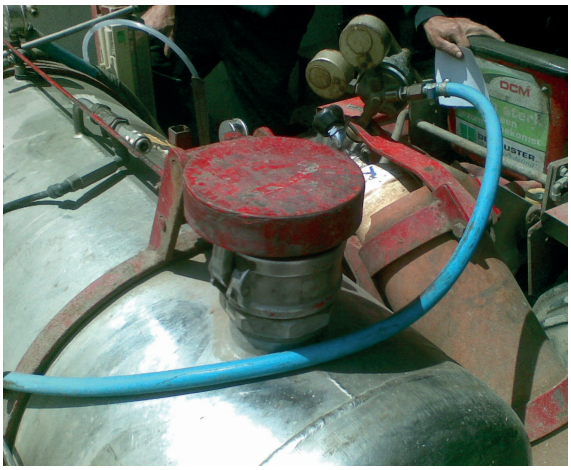

Figure 22: Tank with extra safety lid.

5.3.2.4. Tank content indicator(s)

The volume of liquid in the tank shall be clearly readable from the driver's position and/or from where the tank is filled.

Method of verification: visual inspection.

Figure 23: Tank contents indicator without measuring scale.

5.3.2.5. Tank emptying

It shall be possible to

- empty the tank e.g. using a tap, and
- collect the liquid without contamination of the environment and without potential risk of exposure of the operator.

Method of verification: visual inspection.

5.3.2.6. Cleaning equipment

If provided, tank cleaning devices, devices for external cleaning, devices for cleaning of induction hoppers, and devices for the internal cleaning of the complete sprayer, shall function.

Method of verification: visual inspection and function check.

5.3.3. Pressure indicator

5.3.3.1. Scale and dimension of pressure indicator(s)

At least one digital or analogue pressure indicator shall be fitted at a position where it is clearly readable from the operator's position. Pressure indicators shall be suitable for the working pressure range used.

Method of verification: visual inspection.

5.3.3.2. Scale of analogue pressure indicator

5.3.3.3. Accuracy of pressure indicator

The scale of analogue pressure indicators shall provide graduations:

- at least every 0,2 bar1) for working pressures less than 5 bar;
- at least every 1,0 bar for working pressures between 5 bar and 20 bar;
- at least every 2,0 bar for working pressures more than 20 bar.

Method of verification: visual inspection.

5.3.3.4. Accuracy of pressure indicator

The accuracy of the pressure indicator shall be

- ± 0,2 bar for working pressures at 2 bar and below,
- ± 10 % of the real value for pressures at 2 bar and above.

This requirement shall be achieved within the working pressure range suitable for the machine under test.

Method of verification: measurement according to ISO16122-2 point 5.3.

Figure 24: Pressure gauge test stand.

5.3.3.5. Diameter of analogue pressure indicator

For analogue pressure indicators the minimum diameter shall be 63 mm.
Method of verification: measurement.

5.3.3.6. Forward speed sensors

Forward speed sensors used for controlling the volume/hectare rate, shall measure within a maximum error of ± 10 % of the value read on the reference instrument within the range of the measuring device.

Method of verification: measurement according to ISO16122-2 point 5.5

5.3.4. Lines(pipes and hoses)

Lines shall not show excessive bending, corrosion and abrasion through contact with surrounding surfaces. Lines shall be free from defects such as excessive surface wear, cuts or cracks.

Method of verification: visual inspection.

5.3.5. Filters

5.3.5.1. Filter presence

There shall be at least one filter on the liquid side of the machine, and in the case of positive displacement pumps, one filter on the suction side.

NOTE Nozzle filters are not considered as discharge side filters.
The filter(s) shall be in good condition and the mesh size shall correspond to the nozzles fitted according to the instructions of the nozzle manufacturer.
Method of verification: examination of specification and visual inspection.

5.3.5.2. Isolating device

It shall be possible, with the tank filled to its nominal volume, to clean filters without any spray liquid leaking out except for that which may be present in the filter casing and the suction lines.
Method of verification: visual inspection and function test.

5.3.5.3. Filter insert changeability

Filter inserts shall be changeable in accordance with the sprayer manufacturers' instructions.
Method of verification: visual inspection and function test.

5.3.6. Injectors

5.3.6.1. Alignment and spacing

The injector frame shall be in a good state. (no excessive wear, bad welding, deformations,…) and the injector spacing and their orientation shall be uniform along the frame. The configuration shall correspond to the manufacturer's original design specification.

Method of verification: measurement and function check.

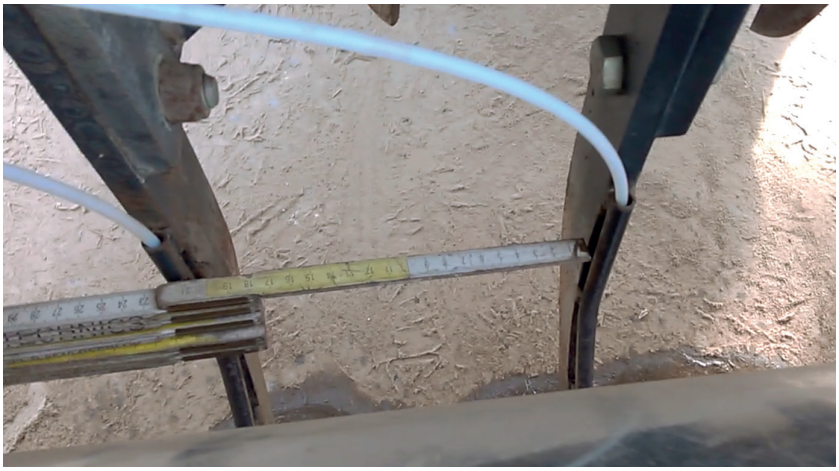

Figure 25: Measuring distance between the different injectors.

5.3.6.2. Injector protection

The injector (nozzle or tube) shall be in a good state and shall be adequately protected to prevent blockages and damaging.

Method of verification: visual inspection.

Figure 26: Detail of an injector knife with pipe.

5.3.6.3. Injector knives, coulters

The injector coulters or knives shall be in a good condition and shall have uniform specifications.
Method of verification: visual inspection and measurement.

6. References

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EXAMPLE SPREADSHEET FOR THE PATTERN MEASUREMENT OF A SOIL DISINFECTION MACHINE

Inspection service :

Machine owner:

Soil disinfection machines: Pattern measurement and flowmeter check.

	Set 1		Set 2	
Flowmeter 1 : Type counter	*Read out*	*Difference*	*Read out*	*Difference*
Start-value (liter)				
Stop-value (liter)				
Injected volume counter (liter)	0,00		0,00	
Real injected volume measured (liter)	7,96		0,00	
Flowmeter 2: Type real time				
Real time flow read out (l/min)				
Real time flow read out (l/min)				
Real injected volume (captured)				
Total real flowrate (total l/min)	3,29		0,00	
Mean flowrate per injector (l/min)	0,55			

Short descrition of pattern measurement

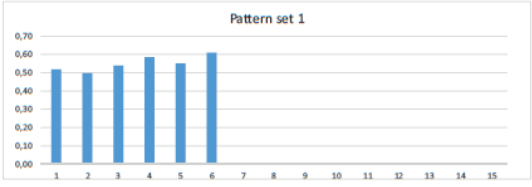
1) Inject and regulate the pressure to the normal work pressure
2) Wait till pressure stays stable and close main valve
3) Place a bucket underneath each injector
4) Write down in this sheet workpressure and flow start-value from counter flowmeter
5) Open main valve and start stopwatch
6) While injecting write down in this sheet real time flowrate from flowmeter (if real-time)
7) Inject minimum 2 minutes or until buckets are 3/4 filled
8) close main value and fill in the captured flows and flowvalues in the yellow fields

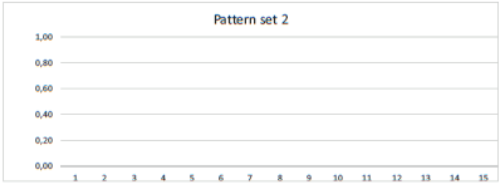
=calculated field
= fill in fields
= NOK
=OK

Injector test set 1

Stopwatch time (sec): 145,00 Pressure (bar): 1,50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Captured flow (liter)	1,25	1,20	1,30	1,41	1,33	1,47									
Flow per injector (l/min)	0,52	0,50	0,54	0,58	0,55	0,61	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Individual difference	-5,78%	-9,55%	-2,01%	6,28%	0,25%	10,80%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
OK/NOK	OK	OK	OK	OK	OK	NOK	OK	OK	OK	OK	OK	OK	OK	OK	OK





Injector test set 1

Stopwatch time (sec): Pressure (bar):

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Captured flow (liter)															
Flow per injector (l/min)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Individual difference	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
OK/NOK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

SPISE – Standardized Procedure for the Inspection of Sprayers in Europe

Established in 2004 by founding members from Belgium, France, Germany, Italy and the Netherlands, the SPISE Working Group aims to further the harmonisation and mutual acceptance of equipment inspections. In regular meetings, several Technical Working Groups (TWG) prepare advice about the items taken into account by the

EU Directive 128/2009/EC but still not considered in the actual ISO/CEN Standards. The present document is intended to provide technical instructions and describes

a procedure which is not mandatory but can be voluntary adopted in the course of inspection or calibration.

Further information can be found at **https://spise.julius-kuehn.de**

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