The inspection of soil-disinfection equipment in Belgium.

J. Declercq[1], G. Defays[2], D. Nuyttens[1], B. Huyghebaert[2]

[1] Institute for Agricultural and Fisheries Research (ILVO), Technology & Food Science Unit - Agricultural Engineering – Burg. Van Gansberghelaan 115 – 9820 Merelbeke - BELGIUM
[2] Agricultural Research Centre (CRA-W) – Agricultural Engineering Department Chée de Namur 146 – 5030 Gembloux – BELGIUM
Contact: johan.declercq@ilvo.vlaanderen.be
DOI 10.5073/jka.2015.449.0010

Summary.

In Belgium, the mandatory inspection of field and orchard sprayers was already started up in 1995. At that time, there were only inspection protocols available for those two types of sprayers. From 2008 on, two new inspection protocols were developed: one for greenhouse sprayers and one for soil-disinfection machines. Those inspection protocols were added to the Belgian legislation and implemented since 2011. The inspection protocol for greenhouse sprayers was mainly based on the two existing protocols (field and orchard sprayers) as the working principle of those machines was similar.

Soil disinfection machines used on Belgian territory needed another approach because of the differences in pressurising and application technique compared to classical spraying machines. Soil disinfection machines use a closed tank containing the vaporous disinfectant. The tank is pressurised by a compressor or a diving cylinder. As concerns the injector side of those machines there are different possibilities. Some are using a manifold with restrictor plates or a small tap per injector, others use narrow tubes towards the injectors, and sometimes nozzles are used.

As one can see, there are no standard inspection methods available for those types of machines. Neither a standard spray pattern measurement, nor a separate pressure and nozzle testing is possible on most of those machines. On top there are some important safety aspects that need special attention due to the hazardous products used.

The Belgian inspection protocol was almost completely developed in-house and makes it possible to inspect soil-disinfection machines in an accurate, safe and economical way.

Key words: sprayers, soil-disinfection, inspection, results, defects

1. Introduction.

Since 1995 sprayer inspection became mandatory in Belgium which makes it one of the forerunners in this field in Europe. At that time, the bad technical condition of the sprayers, the excessive supplementary costs for the farmer arising from an inefficient pesticide use, the negative impact on the environment and the necessary restructuring of the European Agriculture to keep it competitive after the CAP reform and GATT negotiations, were the main reasons for the implementation of the sprayer inspection. Now, the Framework Directive for a sustainable use of pesticides introduces the inspection for all pesticide application equipment in professional use in Europe.

In many ways, the mandatory inspection of sprayers in Belgium differs from inspections in other European countries. The FAVV/AFSCA (Federal Agency for Food Security) is responsible for the inspection but it delegates the inspection to two regional bodies: ILVO (Flemish region) and CRA-W (Walloon region). Those two official bodies are also BELAC ac-

credited according to ISO 17020 which guarantees a maximum quality of the performed inspections. The inspection teams (3 in the Flemish region and 2 in the Walloon part) are equipped with a test van that contains all necessary equipment to perform the inspections according to the Belgian federal legislation (Fig. 1). The inspections are carried out at a neutral location where farmers/contractors are invited at an exact date and time, to present their sprayer for testing at this place. All over the country test locations are hired in a way that farmers/contractors don't need to travel distances > 15 km with their sprayers. On demand inspection teams also perform inspections at the farmyard, but therefore an extra fee is charged. The inspection procedure is based on the analytical principle which means that all parts of the machine are tested separately. After the inspection the farmer/contractor receives a certificate confirming the approval of the sprayer for the next three years or specifying all the items that need to be repaired in case of a rejection. No repairs are made to the sprayer during the inspection, so the farmer/contractor needs to repair the defects himself or leave the repairs up to a workshop. Consequently, the repaired sprayer has to be represented for a second passage.

Fig. 1. Inspection van with test equipment.

As concerns soil-disinfection equipment, a new theoretical protocol was developed and legally approved and inspections based on this protocol were started up in 2014. Before and during start-up of inspections a number of problems needed to be solved and cleared out.

2. Working principle of a common soil-disinfection machine.

In order to clarify the inspection protocol, one first needs to know how this type of machines work (Fig. 2). Therefore a hydraulic scheme is useful and a a simple scheme is shown in Fig. 3 containing all elementary parts of a common used soil-disinfection machine.

Fig. 2. Typical soil-disinfection machine.

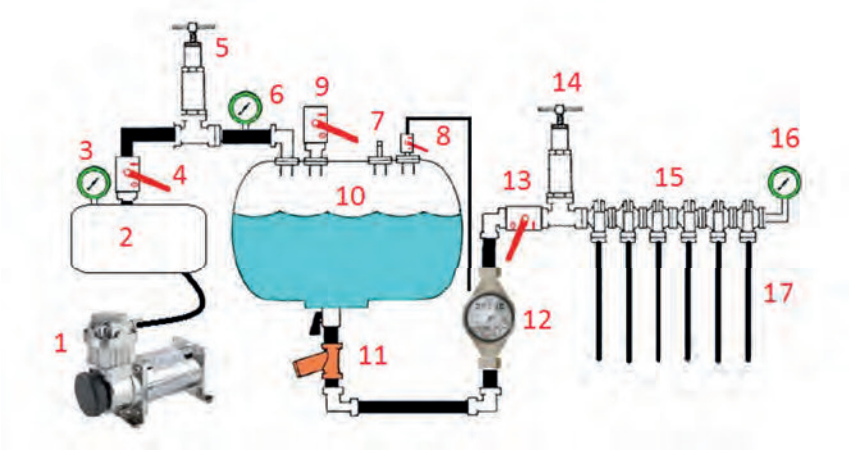

Fig. 3. Hydraulic scheme of a soil-disinfection machine.

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 flow meter (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.

3. Problems to deal with.

At first some practical problems needed to be solved. As one knows soil-disinfection machines are used with hazardous products such as chloropicrin, metam-natrium and 1,3-dichrloropropene. Thus for testing those machines the owners were explicitly asked to clean the machines, rinse the tank and to fill it with clear water. However during first inspections, there were problems encountered with contaminated machines. Although the inspected machines looked quite proper, after half a day of testing, inspectors encountered breathing and dizziness problems. Probably the inside of some machines was not rinsed enough and there was still some contamination at the outflow of the injectors. As the owners of the inspected soil-disinfection machines were not wearing any protective equipment during testing, inspectors assumed that there was no health danger and only wore gloves and no pesticide mask. So conclusion was that one could never be sure that the machine was proper rinsed by starting up inspections.

So in order to protect the health of the inspectors, a procedure was developed for inspecting those types of machines. At first 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 inhalation of hazardous vapours. Inspectors are obligated to wear a pesticide mask, gloves and safety shoes. Following this basic directive should prevent further health problems.

Furthermore there are only a small number (17) of such machines in Belgium that need to be inspected, what made it necessary to search for an economical approach. As a consequence, we tried to use, as much as possible, the existing testing equipment or cheap testing equipment.

Another problem was an underestimation of the time needed for inspecting those types of machines, mainly due to a wrong inspection sequence. At first owners were asked to present their machines unpressurised, in order to firstly check the pressure gauges on a test stand and to evaluate afterwards if there are no problems with pressurizing the pesticide pressure tank. For some machines pressurisation from the tank took quite a while because of the presence of only a small compressor in combination with a partly filled pesticide tank, a large air volume was needed. So it was better to ask owners to present their machine in pressurised state in order to be able to start up the inspection almost immediately.

Last but not least it was a question how to inspect the injected pesticide volumes. As one can see it is not possible to use a normal patternator or combined pressure/nozzle measurements to define the injector pattern.

To solve all problems above a simple, safe and economical inspection method had to be developed.

4. Inspection method.

Primary before starting up the inspection, all admittance rules are overlooked. So the machine needs to be presented in a clean state and all moving parts have to be protected. The pesticide tank has to be filled for ¾ with clean water and there may not be any big leakages. Furthermore the owner is asked to present his machine in a pressurised condition (normal work pressure) to make it possible to start the inspection almost immediately.

In a first stage spraying is started at normal work pressure used by the owner. The good working of the pressure adjustment valve is checked by varying the pressure and checking if pressure remains constant (less than 10% of variation) while shutting off and on the main valve. It is also checked if the capacity of the compressor (or scuba tank) to maintain the pressure in the pesticide tank is sufficient, which means that the pressure has to be stable while spraying at normal working pressure. At the same time the machine is visually inspected for leakages and also all shutoff valves should work properly (main valve, individual valves, etc.). At least one measuring instrument needs to be present to make accurate adjustments. This may be a pressure gauge and/or a flow meter.

After checking all items above, the testing of the injector/spray pattern is started up. As already mentioned, it is impossible to use standard methods to test the injector/spray pattern, such as a patternator or the combination of a pressure and a nozzle flow rate measurement. Because of the small number of such machines, a reliable, safe but economical method to measure the injector pattern was needed.

At first, pattern testing was performed with graduated measuring cups and a stopwatch as sometimes performed on normal field crop sprayers. Disadvantage of this method is that some of the injectors are very difficult to reach and with two inspectors only 3 injectors at a time can be measured. Furthermore while inspecting, the inspectors are close to the outflow of the injectors, and in some cases need to position arms underneath the machine what makes this an unhealthy and unsafe situation.

Fig. 4. Soil-disinfection machine injectors, pattern measurement.

Finally a number of identical buckets and a digital balance were bought. Before testing the pressure and/or flow is regulated to the desired values while spraying. Then the main valve is shut off and underneath each injector an empty bucket is placed. The start value of the flow meter (if present and when the flow meter is a counter) and also the test pressure is written down. Then the main valve is opened and at the same time a stopwatch is activated. While measuring, the test pressure is written down, and for real time flow meters the real time flow is registered. After minimum 2 minutes of measuring the main valve is shut off and the stopwatch is deactivated. By weighing the buckets combined with the measured time, the individual flow/flow rate (pattern) and total flow/flow rate can be de-

termined. The flow meter value can be compared with the captured flow. A maximum difference of 10% is accepted. The inaccuracy following out of different supply pipe lengths is compensated by the long measuring period. The mean value of the flows is calculated and the difference with this mean value per individual injector may not be above 10%. As injected soil-disinfectant gets its good working from evaporating into the soil, this 10% is a satisfying limit for this type of applications.

A13300003	1	2	3	4	5	6	7
Opgevangen (liter)	1,08	1,12	1	1,1	1,06	1,08	0,94
Gemiddeld debiet (l/min)	1,05						
Individuele afwijking	2,44%	6,23%	-5,15%	4,34%	0,54%	2,44%	-10,84%

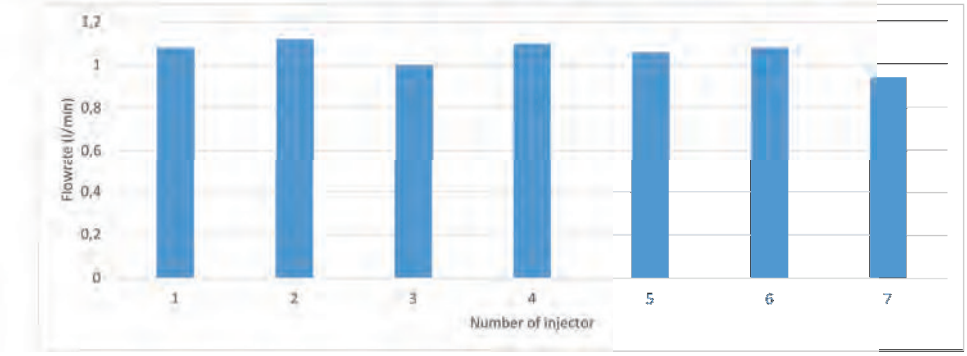

Fig. 5. Pattern of soil-disinfection machine nr. A13300003.

When the injectors use nozzles, the testing method is similar as above, except that an orchard test bench is used instead of buckets. When the pattern is bad then the machine is always rejected, but additionally the nozzles are demounted from the machine and tested on a nozzle flow rate test bench. When the nozzles are worn they must be replaced. When the nozzles are still OK the owner knows for sure he has to look at his machine to repair the problem. However during inspection, no further measurements are performed on the machine to locate the problem, because in most cases extra pressure measurements are difficult to perform, and time consuming.

In a final stage the pesticide tank is depressurised and it is checked if this can be done in a safe way, and if there is no danger for unintended opening of the tank filling valve. There also has to be a pressure safety valve. The machine in Fig. 6 has a possibility to depressurise it in a safe way with valve B and a tube that leads the air-flow downwards. However the filling valve from this machine can be opened easily when pressurised and all the air with hazardous vapours could be blown directly into one's face, so this is an unsafe situation. Here we recommend to remove the lever from the valve when the tank is filled.

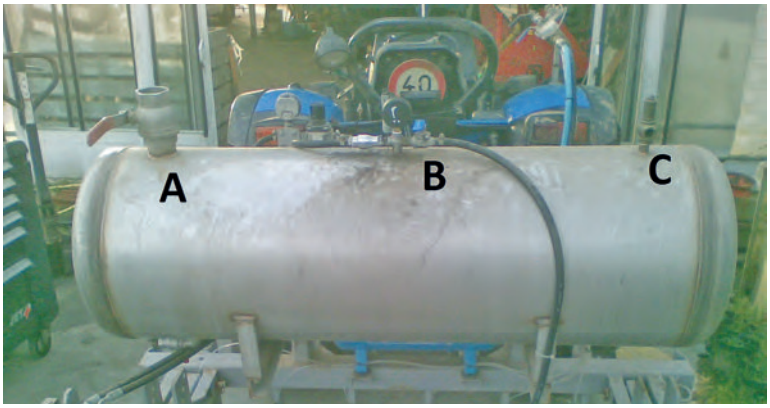

Fig. 6. Pesticide tank with unsafe filling valve (A), safe depressurising valve (B) and safety valve (C).

After depressurization, it is checked if the visibility of all measuring instruments from the operators position is sufficient. In a next step the tank contents indicator is inspected on its presence and readability. Furthermore there is also looked if moving parts are adequately protected and if the general maintenance condition of the machine is OK. Then filters are checked for their presence and when pressure problems were detected the filters are inspected for dirt or other problems.

The state of the injector knives is also inspected. They have to be in good condition and they also have to be equal. There is also looked if the injector pipes are adequately protected.

In a final stage all pressure gauges are demounted from the machine and tested separately on a manometer test stand. The pressure value may not differ more than 10% from the one read on the reference pressure gauge.

5. Conclusions

Because of their specific construction there was the need to develop a complete new inspection protocol for soil-disinfection machines. Furthermore a number of additional problems needed to be solved. At last a complete new and well balanced inspection protocol was developed.

The owners of the soil-disinfection machines are also as much as possible involved in the actual inspection and they are given advice during the inspection. All test results are registered in an official test report.

References

Braekman P., Huyghebaert B., Sonck B. (2004).
The Belgian way of organizing a compulsory inspection of sprayers. *Julius-Kühn-Archiv*. 1st European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE I, 27-29 April 2004, Braunschweig, Germany **397**.

Huyghebaert B., Mostade O., Braekman P., (2004).
Overview of the sprayer inspection in Belgium. 1st European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE I, 27-29 April 2004, Braunschweig, Germany **397**.

Huyghebaert B., Mostade O, Braekman P., Declercq J, (2007).
Options for very old sprayers-Options for brand new sprayers. *Julius-Kühn-Archiv*. 2nd European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE II, 10-12 April 2007, Straelen, Germany **412**: 74-77.

Declercq J, Huyghebaert B., Nuyttens D. (2009).
An overview of the compulsory inspection of sprayers in Belgium. *Julius-Kühn-Archiv*. 3th European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE 3, 22-24 Sept 2009, Brno, Czech. **426**: 122.

Declercq J, Huyghebaert B., Nuyttens D. (2009).
An overview of the defects on tested field sprayers in Belgium. *Julius-Kühn-Archiv*. 3th European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE 3, 22-24 Sept 2009, Brno, Czech. **426**: 157-163.

Declercq J, Nuyttens D. (2012).
Inspection method for spray rate controllers in Flanders (Belgium). *Julius-Kühn-Archiv*. 4th European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE 4, 27-29 March 2012, Lana, Italy. **439**: 117-121. doi 10.5073/jka.2012.439.016

Declercq J, Nuyttens D, Huyghebaert B. (2012).
An overview of the defects on tested orchard sprayers in Belgium. *Julius-Kühn-Archiv*. 4th European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE 4, 27-29 March 2012, Lana, Italy. **439**: 180-185. doi 10.5073/jka.2012.439.036