Wireless flow-sensor to inspect spray rate controllers

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Summary

In Belgium, the mandatory inspection of sprayers was already started up in 1996 and the 8th inspection cycle (2017-2018-2019) is currently running. The inspection of sprayers is performed by official and mobile teams ruled by two inspection authorities and the management is done by the Federal Ministry for Consumer Protection, Public Health and the Environment (FAVV). In the Flemish region the inspection is delegated to the Institute for Agricultural and Fisheries Research (ILVO).

In the past decade the number of field crop sprayers equipped with a spray rate controller increased significantly. In the first inspection cycle (1996-1998), only 4.58% of the field crop sprayers were equipped with a spray rate controller in Flanders. In the 7th inspection cycle (2014-2016), this percentage increased significantly to 26.92%.

As the original inspection method for spray rate controllers showed some lacks and was time consuming, ILVO developed a simple and reliable method to test rate controllers on field crop and orchard sprayers.

Key words: sprayers, inspection, rate controller, flow

Introduction

Since 1995 sprayer inspection is mandatory in Belgium which makes it one of the forerunners in Europe. The items that need to be inspected and the requirements are completely described in the Belgian legislation. This legislation also describes the inspection protocol for a limited number of items, but for most items there is no detailed description of the inspection methodology.

Consequently, inspection authorities need to develop procedures describing in detail how to perform the inspection. This is also one of the reasons why Belgian inspection authorities need to have an ISO17020 accreditation so that inspection methods are traceable and transparent.

One of the items to be inspected are spray rate controllers on sprayers. Due to the increasing number of sprayers fitted with a rate controller, ILVO felt the need to develop a time saving and accurate inspection method for spray rate controllers.

Belgian law: spray rate controllers inspection limits

The inspection of spray rate controllers is described as follows in the Belgian legislation: "Mechanical and electronic regulation systems with a flow equal with the driving speed and also the electronic indication from the sprayed volume per hectare are inspected (respectively D.P.A.m and D.P.A.e systems). The driving speed and the sprayed amount during a certain period are determined. The amount that is sprayed in reality is calculated and compared with the set values on the rate controller. When the difference between the actual amount sprayed and the set value on the rate controller is more than 10%, the sprayer is rejected."

Hence, there is no description on how to inspect this item and as a consequence, inspection authorities need to set up an inspection protocol themselves.

Original inspection method for spray rate controllers (until 2009)

To check application rate and sprayer speed, the following method was used till 2009: Two marking points were placed with a distance of 100 m in between with at least 10 to 20 m of free "run in" track before the start of the 100 m track. Farmers/fruit-growers were asked to program their usual application rate and to start a first short run (e.g. about 20 m) at a constant speed. During this run, the rate controller could adjust the control valve to obtain the desired application rate. After this run, the farmer was asked to stop spraying by shutting of the main valve and the inspector placed 3 spray test sacs underneath three nozzles (Figure 2).

Figure 2: Spraytest bags

In a second run, the driver was asked to start driving again at constant speed and to open the main valve from the sprayer just after passing the first marking point and at the same moment the inspector started the stopwatch. When finishing the 100 m track, spraying and stopwatch were stopped. The spraytest bags were removed and the contents of the bags were poured into a measuring cup with accurate scaling. The mean value was calculated and al the measured values were putted into the inspection software to calculate the actual spray rate and compare it with the value set in the spray rate controller.

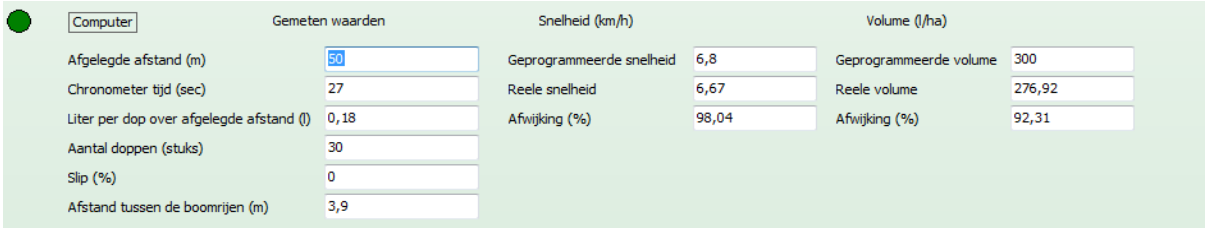

Figure 3: Screen shot from the spray rate calculation program as part of the inspection software

As one can see this method has a lot of disadvantages and also involces some inaccuracies. Firstly, when restarting and re-opening the main valve at the first marking point the rate controller has

(re)regulate some meters to obtain the desired rate. In addition, the driver needs to start and stop spraying exactly at the moment of passing the marking points and, at the same moment, he has to pay full attention on maintaining the desired speed. Finally, there is also the inaccuracy of the inspector to start-stop the stopwatch, and read out the measuring cup. To compensate those inaccuracies, a long test track is used (100m+20m). With a consequence that it is difficult to find suitable locations to perform this test.

New inspection method for spray rate controllers in Flanders: version 1 (from 2010-2017)

To overcome the problems involved with the original inspection method using the spraytest bags and the stopwatch, a new testing device was developed at ILVO. The main goal was to reduce the length of the test track and to decrease test time while improving measuring accuracy. Furthermore the test device needed to be easy to use even for a "non professional".

To obtain these objectives, ILVO developed an accurate, reliable and online measuring method. In this way, the main inaccuracy caused by reopening the main valve at the first marking point and rate (re)regulation during the first meters of the test strip is eliminated.

As already mentioned, in Belgium nozzle flow is measured separately on a nozzle test bench during the inspection so the average nozzle flow of a nozzle set is known. Out of the measured nozzle set, a pre-measured nozzle with a flow rate close to the average flow rate is selected. So measuring the flow through this nozzle when mounted on the spray boom in combination with a stopwatch measurement when driving a fixed test track, makes it possible to determine the spray volume rate in an accurate way.

The first version of the measuring device consists of a flowmeter attached between a nozzle holder on the sprayer and the pre-measured nozzle (Figure 4). The flowmeter is wired by a 10 m long cable to a spray rate/volume read out unit by a double pole toggle switch which can interrupt the pulses from the flowmeter and also commands the stopwatch. So when passing the start marking on the test track the toggle switch is activated and flow and stopwatch start counting. At the last marking on the test track the toggle switch is deactivated and total flow and timing can be read to determine actual speed and flow rate.

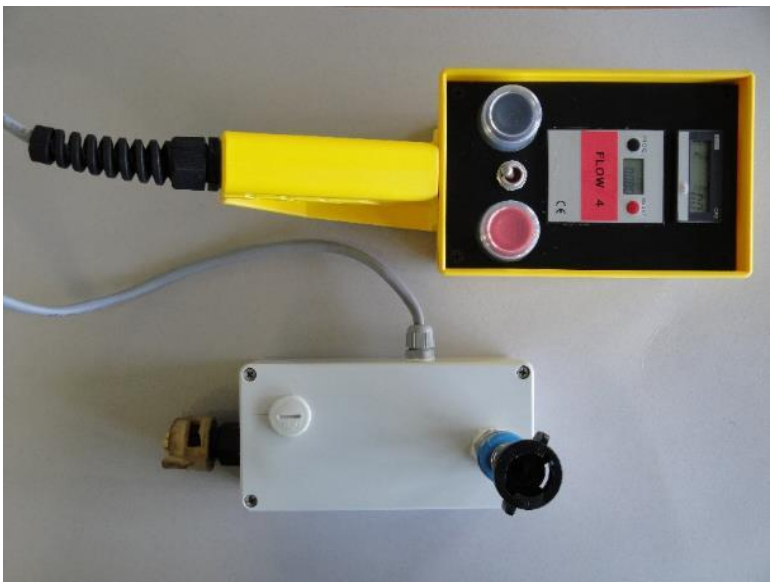

Figure 4: Spray rate controller inspection equipment (version 1)

New inspection method for spray rate controllers in Flanders version 2 (from 2018).

Despite the fact that the first version provided good work, there are some weak points. At first there is the long connection cable that has to be wired each test. In addition, some calculations are needed to

calculate the actual speed and spray volume. Those are the main reasons why ILVO searched for a wireless solution in combination with an app installed on a tablet or laptop.

After some research, a flowmeter readout module with integrated bluetooth was developed in house. The module reads out the pulses from the flowmeter and sends the values over bluetooth to a tablet. The values that are received are displayed and recalculated on the tablet with a dedicated app. The app has a start/stop button that replaces the toggle switch from the first version. During the test, the app shows the current sprayed volume and at the end of the test the sprayed volume and the actual speed are calculated. So after finishing the test, the inspector can evaluate the test immediately.

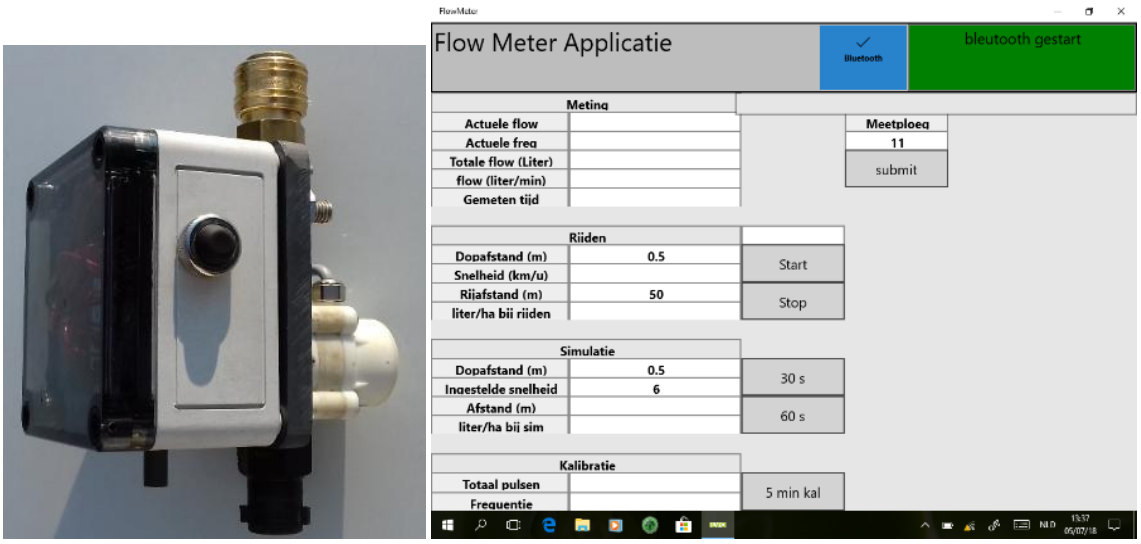

Figure 5: Spray rate controller (version 2) - Flowsensor and app screenshot

The flowsensor is calibrated in the accredited ILVO Spray Tech Lab (ISO17025) at a flowrate range from 0.75 to 2.5 l/min with a calibration accuracy of +/- 1% (ISO 16122 asks +/- 2%). So it is possible to test sprayers equipped with ISO02 up to ISO06 nozzles, used by 99% of the Flemish farmers.

The test procedure consists of different steps:

At first two marking points are placed but instead of 100 m used in the original method, 50 m is sufficient and even distances of 30 m give satisfying results on condition that the "run in" of the test track is long enough to obtain a stable rate and speed.

The farmer/fruit-grower is asked to program a spray application rate that lies in the range of 0.75 l/min to 2.5l/min per nozzle.

The inspector mounts the flowsensor with the pre-measured nozzle on the spray boom and takes place in the tractor/sprayer cab with the tablet. The farmer/fruit grower is asked to start spraying at a constant speed.

When passing the first marking point the measurement is started up "on the go" by pushing the start button in the app. During spraying the real time flow, the actual flow and the stopwatch time are displayed simultaneously.

When passing the second marking point the stop button in the app is pushed and the farmer/fruit grower is asked to stop spraying.

Beside showing the total nozzle flow and the stopwatch time, the app also directly calculates the actual sprayrate in liters per ha and the exact driving speed. So the inspector can immediately evaluate the performed test.

Conclusions

As one can see the new equipment makes the spray controller test procedure less time consuming and easier with a higher accuracy.

The driver can completely concentrate on driving and maintaining a constant speed. There is also no need to stop and restart after positioning the spraytest bags. This results in a more accurate measurement and time savings even with shorter test tracks. Also important to mention is that while performing the test the real time flow rate can be read. So while driving, the inspector can already determine if the spray rate controller works correct. Furthermore after testing, the actual sprayed volume and drive speed can be read out directly with a known accuracy. Moreover, the device can also be used to measure the real time nozzle flow rate of all nozzles on the sprayer, although originally it was not designed for this purpose.

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