An overview of the defects on tested field sprayers in Belgium

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Summary

In Belgium, the inspection of sprayers is performed by official and mobile teams ruled by two regional inspection authorities. The management of the inspection is done by the federal Ministry for Consumer Protection, Public Health and the Environment. Regional authorities need to have an ISO 17020 certification, so as a consequence the Belgian inspection is completely independent and objective. In this way inspection results are centralized and can be easily consulted. The inspection results are a very useful tool to have an overview of the general condition of the Belgian sprayers. Those results can be helpful when advising on changes in legislation. They can also be used as an instrument to advise farmers on how to improve their spraying machines, or what points they have to pay attention to when buying a new or second-hand machine. Therefore, a detailed overview is made of the inspection results of the year 2008.

Fig. 1 Measuring pressure in different boom sections

Introduction

Since 1995 sprayer inspection is mandatory in Belgium which makes it one of the forerunners in this field in Europe. At that time, the bad technical state of the sprayers, the excessive supplementary costs for the farmer consequent upon the waste of pesticides, 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 (Huyghebaert et al). Now, the Framework Directive for a sustainable use of pesticides introduces the inspection for all pesticide application equipment in Europe.

In many ways, the mandatory inspection of sprayers in Belgium differs from inspections in other European countries (Braekman et al.). The inspection is carried out by two official governmental bodies: ILVO (Flemish region) and CRA-W (Walloon region). Those two official bodies are also accredited according to ISO 17020 (BELAC) 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 testing according to Belgian legislation. The inspections are carried out at a neutral location and farmers/contractors are invited by letter 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 great distances with their sprayers (maximum 15 km). At this moment about 21.200 machines are tested every 3 years, mainly boom and orchard sprayers. The inspection procedure is based on the analytical principle which means that all parts of the machine are tested separately. On average, one inspection team carries out about 12 inspections a day. After the inspection the farmer/contractor receives a clear certificate that confirms the approval of the sprayer for the next three years or that specifies 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. It is also worthwhile to mention that the inspections can be performed at a very competitive price!

Fig. 2 Inspection van with equipment

The diagnosis principle and rejection procedure

The protocol of inspection developed in Belgium fits EN 13790 for 95 % in terms of inspected criteria. However, the inspection methodology is based on the analytical principle which consists in measuring separately and independently the performances of the different parts of the sprayer so the defect(s) can be determined and a precise diagnosis can be made.

To illustrate the analytical principle, the check of the pressure stability can be mentioned. The pressure stability is described for a boom sprayer in EN 13790-1, paragraph 4.2.2. it specifies that "There shall be no visible pulsations caused by the pump". If one follows a simple inspection protocol, the inspection can be stopped after observing pressure pulsations on the working manometer for example.

Now, if one applies the analytical principle, further measurements, observations and analysis are carried out so as to determine the exact cause of the pressure pulsations. Indeed, pressure stability depends on several factors such as the pressure in the air-bell, the state of the diaphragm of the air-bell, the state of the induction and exhaust valves and the membranes of the pump, the air-tightness at the induction side of the pump, etc. With the analytical principle all these factors are measured or observed to determine the precise cause of the pressure pulsations and to advise the user properly on the repair(s) that need to be made.

Up to 58 criteria are verified on the sprayer, some are checked visually, some are subject to measurements (pressure, nozzle flow rate, nozzle spacing, volume/hectare, etc.). All checks and measurements are encoded and stored in a computer with tailor-written software. The analysis is done automatically and the report is printed on site.

The dysfunctions are listed in this report and classified according to their seriousness to disturb sprayer performances, together with advice on repairs. The combined analysis of the nature of the dysfunction and its cause allow determining the weight of this dysfunction in the inspection results. The dysfunction leads to a rejection of the sprayer if it significantly disturbs spraying or safety and if its origin is imputable to the user (lack of maintenance). Moreover, for objectivity reasons, the dysfunction leading to a rejection of the sprayer has to be determined in an indisputable and objective way (measurements). Thus, not all checked criteria lead to a rejection of the sprayer. Depending on the weighted analysis, the defect criterion will lead to a rejection. Moreover, the same defect criterion could lead to different consequences (rejection or not). From the 58 checked criteria, only 13 lead potentially to a rejection of the sprayer.

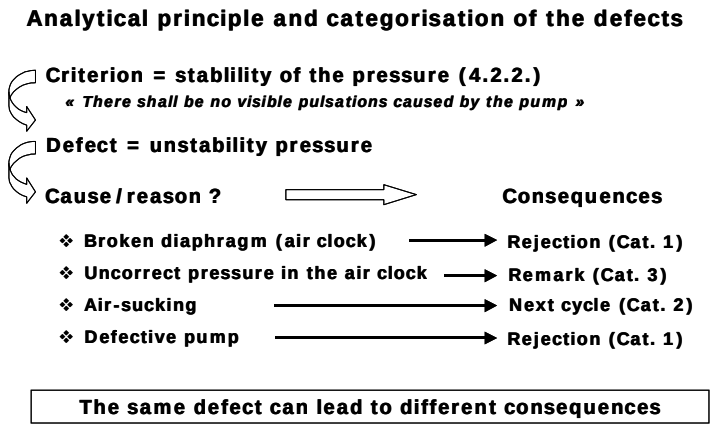

Fig. 3 Analytical principle and categorisation of the defects

The defects observed during the diagnosis are divided into three different categories:

Category I defects are defects that automatically entail a rejection. Faults within this category must be repaired within four months and the sprayer must be submitted for retesting.

Category II defects do not result in rejection, but should be repaired by the next inspection during the inspection interval. This means that the user has three years time (= one inspection cycle) to repair these defects.

Defects of **category III** are only added for information reasons and are aimed at improving the general operation of the sprayer. The user is completely free to follow these comments.

Overview of the defects of field crop sprayers

This overview is based on the inspection results obtained in 2008. Approximately 4900 sprayers were inspected, 580 (11,8 %) of which were rejected during the first passage. A sprayer can display several defects from different categories, or from one category (e.g. 2 defects cat. I). Also sprayers that received a pass can display defects from category II or category III.

Defects of category I

Defects of category I lead to rejection of the sprayer requiring repair and resubmission within 4 months after the first inspection. Between the first and the second inspection it is allowed to use the sprayer.

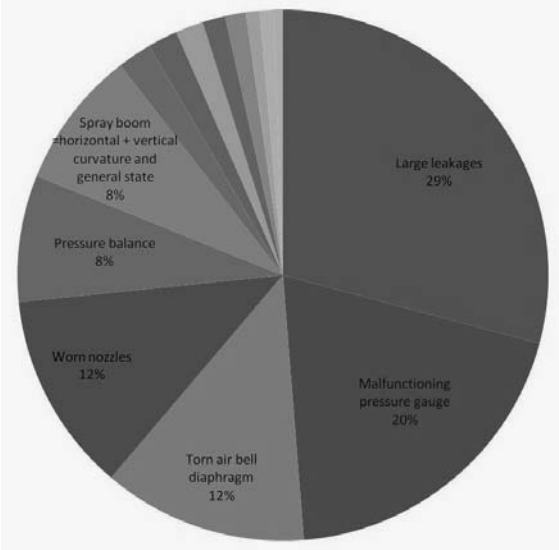

Fig. 4 An overview of Cat. I defects during 2008

Within category I defects, the largest number of rejections was caused by leakages (29 %). Although the user is asked to pay attention to leakages, this criterion often poses problems. Possible leakages are observed for spraying pressures from 2 to 5 bar and are measured by using a measuring cylinder and a chronometer when there is doubt about the size of the leaks. Leakages in excess of 30ml/min are considered as major leakages (Cat. I), leaks below 30ml/min are classified as minor (Cat. II). Major leakages (pump, tank, pipes, etc.) are considered as critical and automatically lead to a rejection of the sprayer.

Malfunctioning pressure gauges cause the second highest number of rejections (20 %). The sprayer pressure gauge is checked by comparison with a reference manometer. The whole measuring range is explored, generally from 2 to 5 bar. The pressure gauge on the sprayer is tested and the pressure is compared with that measured with a reference manometer placed on the sprayer boom. When the deviation exceeds 10 % the pressure gauge is dismantled from the sprayer and tested on a pressure test bench. When the deviation is also higher than 10 % on the test bench, the pressure gauge and the sprayer are rejected.

Fig. 5 Testing the work manometer

A torn air bell diaphragm is responsible for 12 % of the rejections. A torn diaphragm is one of the main causes of pressure instability. The pressure pulsations are detected on the working manometer as a rapid oscillation of the needle. Additionally, the inflating pressure of the air-bell is checked (1/3 to 1/2 of the spraying pressure). A broken diaphragm is detected when water squirts from the inflating valve. Another cause can be a defective pump. But this defect occurs much less frequently (1,5 %).

On the fourth place we find worn nozzles responsible for about 12 % of the rejections. The nozzles are removed from the boom and placed on a specific test bench where their flow rates are measured individually. The variation in flow rate compared with that of a new nozzle (the reference) is checked. When the deviation between the average flow rate of the inspected nozzles and the nominal flow rate exceeds the threshold, the complete nozzle set and sprayer are rejected.

The pressure balance between the different spray boom sections is certainly a major parameter that ensures equal feeding of all nozzles. The pressure deviation between the working manometer and the boom, but also between the different boom sections should be as small as possible. A manometer is placed on each boom section to check the pressures. The mean pressure is calculated from the results of all section manometers, and if the pressure deviation of one or more sections exceeds 10 % the sprayer is rejected. There can be different reasons for pressure heterogeneity: sections and/or feeding pipes of different length, clogged filters in the boom sections, blocked or strangled feeding pipes, and defective distribution block. According to the weighted analysis, only the last two defects lead to a rejection of the sprayer. About 8 % of the sprayers are rejected as a result of an unequal pressure between the different sections.

Fig. 6 Testing the spray computer

Also the state of the boom poses a lot of problems (8 %). About 3 % of the rejected sprayers display a major problem of horizontal curvature of the boom and 2 % have a problem with the vertical curvature. Spray boom slanting causes an uneven distribution and has to be avoided. Finally 3 % of the spray booms are also in a very bad general condition (torn weldings, completely rusted, asymmetric, etc.)

A number of Cat I problems also appear less frequently. Heterogeneity of the nozzle sets (type, size, angle) with an occurrence of 2 % of the rejected sprayers is nowadays lesser encountered. User awareness on the importance of this parameter is higher than in the past. Also defects involving sprayer regulation system are less frequent. Only a few of the rejected sprayers are affected by a defective pressure valve (1,8 %), a defective distribution block (1,7 %), malfunctioning sensors, flow meter or computer (0,8 %), and a maladjusted mechanical regulated pump (0,6 %). Finally defective pumps are responsible for about 1,6% of the rejections.

Defects of category II

Category II defects do not lead to a rejection of the sprayer. The user is encouraged to repair as soon as possible the determined defects of this category. Anyway, these defects have to be repaired by the next inspection (3 years later). If not repaired, these defects will result in a rejection.

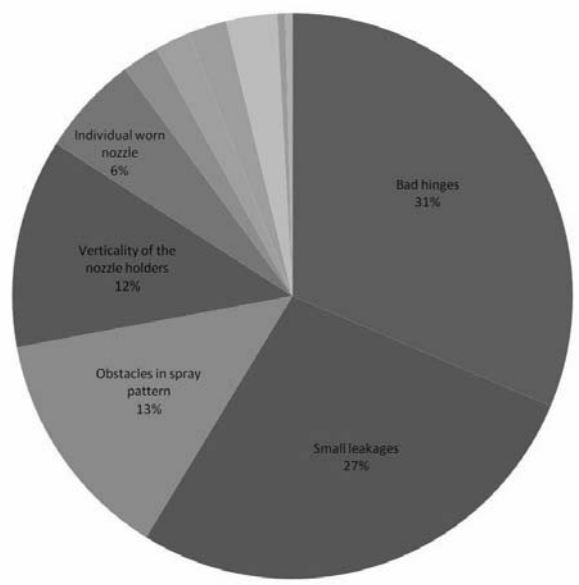

Fig. 7 An overview of CAT II defects

Category II defects refer mainly to spray boom problems (60 %).

Major problems involve bad hinges and loose connections (31 %). This causes irregular movements of the spray boom especially at the start and finish of spraying. Another frequently encountered problem are obstacles in the spray pattern (13 %), mostly tubes that are not sealed properly. There are also still many nozzle holders that are not positioned vertically (12 %) . Furthermore there are problems with the suspension system and balance of the boom (3 %), and the distance between the nozzle holders (1 %).

Also small leakages (<30ml/min) are quite frequent with an occurrence of 27 %.

In 6 % of the cases, only some nozzles of the set are worn and need to be replaced. Filtering causes fewer problems (2 %).

A rejected sprayer can also display defects from this second category.

Defects of category III

Defects of category III never lead to a rejection. The user is simply encouraged to repair the determined defects of this category. Those defects are of less importance, but their repair will improve spraying quality or user comfort.

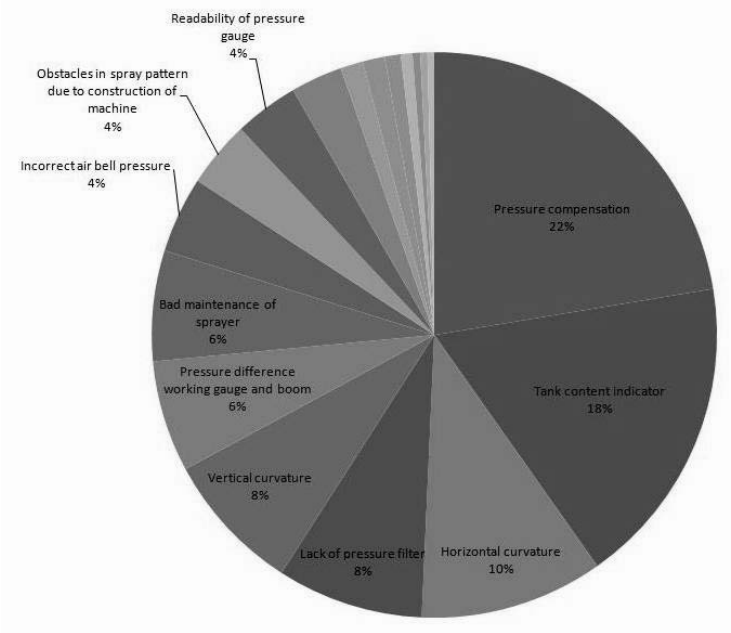

Fig. 8 An overview of CAT III defects

Many old sprayers don't have the pressure compensation (22 %). The user has to adjust the working pressure when he closes a boom section. Also a large number of problems concern the readability of the tank content indicator (unreadable or defect 18 %). Minor horizontal (10%) and vertical (8 %) curvatures are classified as category III defects. Some (older) sprayers lack a central pressure filter (8 %) and many sprayers also show a pressure drop between the working pressure gauge and the spray boom (6 %). Furthermore an incorrect air bell pressure (4 %), obstacles in the spray pattern as a result of bad machine construction (4 %) and poor readability of the pressure gauge (4 %) are also noted. There are also a large number of smaller faults that do not occur that often.

Conclusions

The farmers are as much as possible involved in the actual inspection and advice is given to the farmers about possible effects. All test results are registered in an official test report. Since the start of the inspection in Belgium, farmers became far more aware of the negative effects of a badly maintained sprayer resulting in a significant decrease in the number of rejections. Continuous information and training of farmers is still necessary to maintain or even improve the current maintenance level of the sprayers.

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