

## SPRAYER INSTALLATION ATTACHED TO THE AGRICULTURAL TRACTOR

**Abstract:** A continually development of the global market economy has in foreground a strong increase in consumer goods demand and offer. The agricultural products have a significant share of total transactions performed on the market. Therefore, it is important that on the cultivated field areas to be obtained optimum harvests that ensure a continuous farms development based on higher crop yields. Today there are many solutions to make the agriculture more efficient regarding crops yield obtained. The use of herbicides aims to maintain the farm lands clean of weeds that may have harmful effects on crops. They can be administered mechanized on large areas using herbicides autonomous installations or attached to the tractor. The agricultural tractor is the machine that performs most of the mechanized works in farmlands using attached auxiliary equipment. The agricultural auxiliary equipments have undergone a continuous development over time. This paper performs a functional description for the sprayer installation assembly that can be attached to the agricultural tractor.

**Key words:** agricultural equipments, sprayer installation, tractor, assembly, three-dimensional modelling.

### 1. INTRODUCTION

The continuous development of agricultural machinery made possible the excellent results regarding agricultural production achieved nowadays.

The technical requirements for mechanized agricultural works are now realized within the farm lands with minimum fuel consumption, minimum labor required, using a limited number of agricultural machine units and less time in order to ensure a maximum level of agricultural production.

Besides soil preparation, fertilizers distribution or planting seeds, the agricultural tractor is conducting the applying of plant protection treatments through multiple attached devices.

By applying herbicides and treatments in the farm fields aims to maintain the land clear of weeds and pests which may have harmful effects on cultures. They can be administered mechanized on large areas using herbicides autonomous installations or attached to the tractor.

The sprayer installation that can be attached to the tractor represents an optimal solution for small farmers in the sense that they do not have to purchase an autonomous machine specialized in the treatment of field plants.

There are specialized sprayer installations that can perform treatments for fields weed control, but also preventive against pests and diseases that may occur within agricultural crops.

The auxiliary attached sprayer equipments are positioned usually at the tractor rear side.

The advantages of sprayer operations are represented by reducing the number of necessary works for the destruction of weeds, with a positive effect on soil structure, reduces the mineralization rate of organic substances, enable the development of the plant roots system within the soil layers and reduce expenses for unit area and the need for manpower.

The applied herbicides treatments presents disadvantages because repeated use contribute to the occurrence of chemical pollution, decreases ventilation and water infiltration into the soil with undesirable effects on the microorganisms activity.

The sprayer installations of small and medium capacity (200 - 1500 l) can be attached directly to the tractor chassis while high capacity models (over 1500 l) are towed by tractor.

These systems circulate pressurized fluid from their main tank through attached pipelines on metallic wings having special nozzles on the extremities that pulverizes fluid at the plants level over which the installation is carried out by the tractor. The wings are mobile thus allows folding for the transport position and extension in working position and in this way the installation covers a large area on a single pass of the tractor through cultivated land.

### 2. AUXILIARY SPRAYER EQUIPMENT

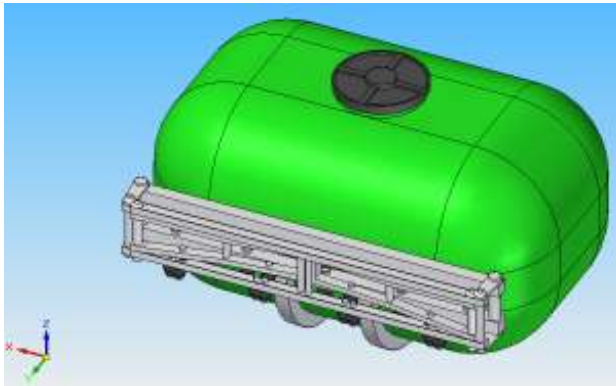
Special systems have been developed for application of various plant treatments on the field that can be attached to the agricultural tractor. They are connected to the tractor power source that drives a hydraulic pump necessary to circulate the working fluid from the tank to the external environment through nozzles mounted on installation mobile wings.

Mounted at the tractor rear side by means of hydraulic suspension mechanism, the sprayer installation is composed of: [2]

- articulated rods that allow the coupling at hydraulic suspension mechanism;
- pump actuation circuit;
- fluid tank with capacity of up to 1500 liters;
- articulated mobile wings;
- flexible pipes;
- spraying nozzles;

- fluid filters.

In Fig. 1 it is realized the representation for the sprayer installation three-dimensional model assembly achieved using Solid Edge V20 software mounted for the transport and for the working positions.



a). sprayer installation mounted for the transport position



b). Sprayer installation mounted for working position

**Fig. 1.** Representation for the sprayer installation three-dimensional model assembly

The working fluid is circulated from the tank through flexible pipes to the nozzles through which is discharged under pressure in the external environment.

The nozzles are positioned on the installation mobile wings at a distance of up to 50 cm between them, spraying being conducted at a pressure of 2 to 4 [bar] and a circulated flow in unit time ranging between 0.2 and 1.4 l / min.

There are nozzles patterns which can provide a jet with an opening angle from 90 to 120 degrees.

The nozzles must realize accurate spraying so that the fluid reaches the plants and there are no jet diversions caused primarily of atmospheric air currents.

The installation also contains filters that helps retain the particles present in the working fluid thus avoiding pipes or nozzles warping during operation.

### 3. AGRICULTURAL TRACTOR WITH SPRAYED INSTALLATION MOUNTED

The tractor as a self-propelled machine may be equipped with different auxiliary equipments which take over a part of engine power in order to achieve various land agricultural work activities.

At the beginning the agricultural tractor was used for towing simple agricultural machines, but with the continuous development of agricultural equipments for the tasks for the tractor have increased. [4]

The attached auxiliary equipment can be to the agricultural tractor by means of a suspension mechanism that achieves equipment fixation on the base machine.

The suspension mechanism is composed of several articulated rods that allow position modifications for the auxiliary equipment relative to ground, so the proposed works can be carried out at ground level but also rising to the transport position.

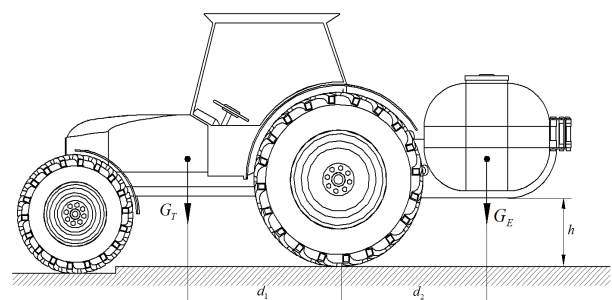
A three-dimensional model assembly representation for the agricultural tractor with mounted auxiliary sprayer installation is shown in Fig. 2.



**Fig. 2.** Assembly of agricultural tractor with sprayer installation attached [9]

Being an auxiliary equipment carried by the agricultural tractor the total weight in transport position is completely taken over by the tractor driving system. [2]

The tractor has to balance the attached installation weight as well as to perform displacement on rough terrain in order to fulfill the proposed working process.



**Fig. 3.** Assembly efforts distribution [9]

In Fig. 3 are presented schematically the efforts as distribution acting directly on the tractor assembly having the sprayer installation mounted.

For various plant sanitary treatments and herbicides apply works, the tractor must be able to defeat displacement resistances and to have the facility to sustain the fully loaded tank weight of auxiliary attached equipment. The resistance force for rolling displacement at ground level can be determined using the following relationship: [9]

$$F_r = R_r G_t \quad (2.1.)$$

where:

$F_r$  - rolling resistance force;

$R_r$  - Rolling resistance coefficient;

$G_t$  - Assembly total weight.

$$G_t = G_1 + G_2 \quad (2.2.)$$

During work operations the tractor overcomes displacement resistance whose resultant force is parallel to the ground surface and opposes the motion. This resistant force value is generally determined by the relationship:

$$F_t = R_w L \quad (2.3.)$$

where:

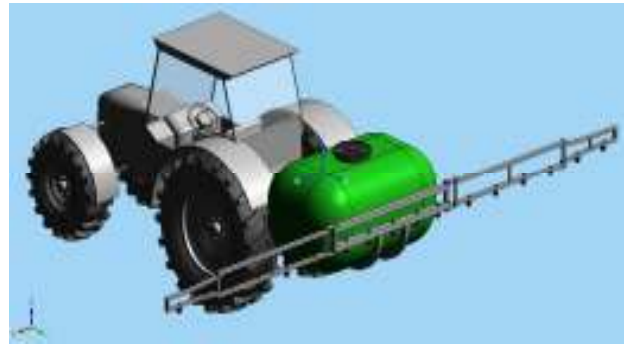
$R_w$  - working resistance;

$L$  - agricultural tractor working width;

A three-dimensional model assembly for an agricultural tractor realized in Solid Edge V20 is presented in Fig. 4. This program allows design and construction of component parts and then final assembly in final position on base machine.



a). Sprayer installation mounted at tractor in the transport position



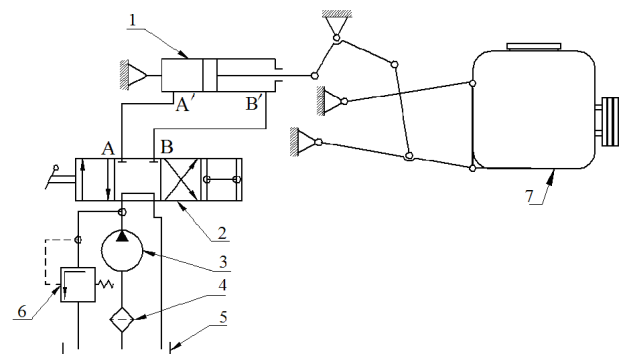
b). Sprayer installation mounted at tractor in the working position

**Fig. 4.** Agricultural tractor with sprayer installation assembly design three-dimensional model [9]

The installation coupling to the agricultural tractor is accomplished by means of the hydraulic suspension mechanism. This mechanism can raise the sprayer assembly up to the maximum height corresponding for transport position, but also it may be lowered to the working position according to the field plant height where the working fluid should be applied, respectively.

The suspension mechanism can be locked in any vertical position and can become reinforced in the horizontal plane in order to ensure proper assembly stability.

The hydraulic system schematically presented in Fig. 5 is composed of power supply pump (3), hydraulic dispenser (2), linear hydraulic motor (1) or cylinder, safety valve (6), filter unit (4), fluid tank (5) and working body (7).



**Fig. 5.** Hydraulic components diagram for coupling between suspension mechanism and sprayer installation [1] [9]

The sprayer installation working parameters adjustment regarding the operating pressure, tractor moving velocity, working height adjustment, fluid flow rate in time and nozzle type used have a great influence on the quality of treatments applied on field plants.

#### 4. CONCLUSION

In the last decades has considerably increased the constructive and functional complexity of agricultural tractors materialized by increasing the number of hydraulic components, electro-hydraulic and electronic systems that have replaced the manual control and allowed the attachment of new equipments to the tractor base machine at the same time with the optimization of workflow processes. Agricultural sprayer installations are designed for applying different plant treatment fluid solutions to field crops, with the aim of weed control on the agricultural surfaces under cultivation. Special nozzles are used for fluid herbicide, fungicides or insecticides solutions administration.

Due to extendable mobile wings which are folded over behind the tank during transport, and then extend in the field, a sprayer device can cover a large area on a single pass of the tractor on the cultivated land.

The tractor through hydraulic suspension mechanism performs the sprayer installation lifting in transport position at maximum height from ground level, but also lowering in any intermediate position and at a predetermined level position where is intended to be applied the proposed fluid treatment.

The tractor attached sprayer installations are made of metal frames, above which the polyethylene tank is mounted in an optimal position in terms of gravity center.

Rounded shapes used for the tanks are meant to be able to make optimal fluids mixture used in the installation in order to have minimal residual amounts but also easy washing.

There are sprayer installations systems which can provide a large area of coverage at a single tractor pass due to folding wings able to be extended up to a total length of 20 m, providing then the folding in transport position of only 2.6 m.

The wind action is a component that can negatively influence the application of treatments and herbicides with sprayer installations. Therefore they are performed only when the weather is favorable without strong winds.

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