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GENERAL WORKING PRINCIPLES FOR AGRICULTURAL TRACTOR WITH PLOUGHING EQUIPMENT

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ABSTRACT

Agricultural machines are considered part of special mechanical equipments category intended to perform mechanized works in farmlands, in order to obtain optimal harvests. The continuous development of these equipments was mainly aimed at evolutions of specific technological processes, constant increasing of speed in operation mode and also increasing of engine power. In order to well perform the proposed technological process, they should have high resources of reliability, durability and stability in execution in spite of the external conditions in which their operation is carried out. This paper performs a constructive and functional description for agricultural tractors equipped with plowing working equipment. Also it is described the hydraulic suspension system by means of which the plowing device can be raised for transport or lowered to the working position. For instance, it was chosen the three-point articulated model for the suspension system used because it is the most widely used on the most constructive pattern of agricultural tractors.

KEYWORDS*:* agricultural machine, tractor, ploughing equipment, hydraulic drive

1. INTRODUCTION

Of all time man has tried to find ways to work farmlands in better conditions with an increasingly higher speed and with maximum efficiency. Thereby agricultural machines have appeared through which work on the fields has become an easier task for humans, thus contributing to the development of human communities based on the increasing harvests obtained. Today's agricultural machines belong to the special mechanical equipments category intended to perform mechanized works in farmlands, in order to obtain the optimal harvests. The continuous evolution of these equipments was mainly aimed at the development of specific technological processes, constant increasing of speed in operation mode and also increasing of engine power. In order to well perform the proposed technological process, they should have high resources of reliability, durability and stability in execution in spite of external conditions in which their operation is carried out.

Mechanization technologies of agricultural works shall be determined so as to achieve minimum energy consumption, low production costs, with minimum labor required, using a limited number of agricultural machine units, while ensuring the maximum level of agricultural production.

Most representative agricultural machines are the agricultural tractors and combine harvesters. There are multiple auxiliary

agricultural equipments that can be attached to both tractor and combine by means of which the soil heavy works are being carried out, including soil preparation, sowing seeds, and then harvesting of agricultural production. Because the tractor is running on unprocessed ground, the attached agricultural work devices are usually positioned on the rear side. For harvesting combines the harvest device equipment is usually positioned in front of the machine.

2. OPERATIONAL MODEL FOR AGRICULTURAL TRACTOR WITH PLOWING EQUIPMENT

The tractor represents one of the most important agricultural machinery by means of which the majority of agricultural land mechanized works are carried out. A tractor is a self-propelled machine, equipped with an internal combustion engine of considerable power. Power reserve provided by engine is intended for defeating significant resistances to machine displacement when are attached various pieces of auxiliary equipment for carrying out different agricultural works. One of the most significant displacement resistances occurs when the plowing work is made with the plowing equipment attached to the tractor.

A schematic representation of the tractor with plowing equipment mounted is shown in Figure 2.1.

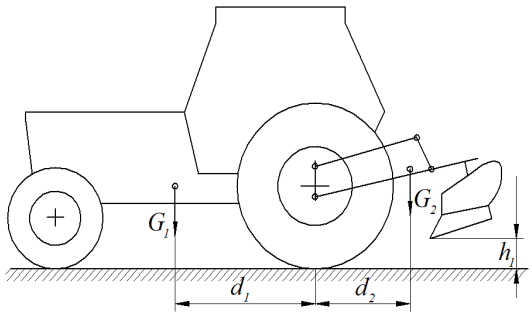

Figure 2.1 Schematic representation for tractor with ploughing equipment mounted [7]

The resistance force for rolling displacement of agricultural machine at ground level can be determined using the following relationship: [7]

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

where:

F_r - rolling resistance force;

R_r - Rolling resistance coefficient;

G_t - Assembly total weight.

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

During plowing works, the tractor should be able to overcome displacement resistances whose resultant force is parallel to the ground surface and opposes the motion. This resistant force value is generally determined by the relationship: [7]

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

where:

R_w - working resistance;

L - agricultural machine working width;

The movement resistance during plowing workflows can be described using the relationship:[7]

$$F_t = R_w^* h l n \qquad (2.4.)$$

where:

R_w^* - ploughing resistance;

h - working depth;

l - working width;

n - number of plow working bodies.

If the value of R_w^* is high, we can appreciate that the plowing work is more difficult to be performed and this requires an increased fuel consumption.

In general, soil mechanical and physical characteristics but also humidity conditions have direct influences on movement resistance values during the workflow of agricultural machinery.

The tensile strength can be calculated if are considered as known the values for resistance forces for different imposed actions: [7]

$$P_t = F_t v_d \qquad (2.5.)$$

where:

v_d - Displacement velocity.

3. HYDRAULIC SUSPENSION MECHANISM

The most important self-propelled machinery used in agriculture are the farm tractors and combines. The tractors are used in soil processing, seeding, transport and combines for harvests gathering. The suspension mechanism is composed of articulated rods that allow the coupling of different devices to the tractor. Because most agricultural equipments can be attached to the tractor on the back side, currently tractors are equipped from the factory with hydraulic suspension mechanism that allows the coupling

of different agricultural devices. In Figure 3.1 is presented the suspension mechanism for the plowing equipment. This mechanism with three joint points must provide rising and lowering of the agricultural equipment in working or transport position and also should not stiffen drive with the tractor in order to ensure optimal execution of farm works. The suspension mechanism can lock in any vertical position and can become reinforced in the horizontal plane in order to create a corresponding aggregate stability.

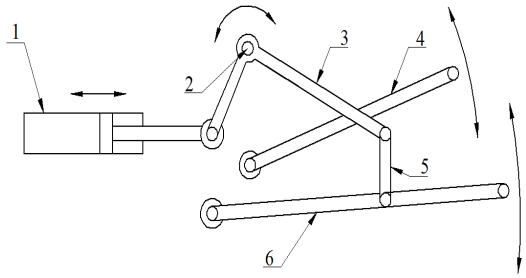

Figure 3.1. Schematic representation of the suspension mechanism[11]

Based on hydraulic linear motor action (1) the rod displacement obtained is acting on the main lever mechanism (2), so that the inferior (6) and central (4) tie rods describe a rotation movement around the articulation point causing in this way lifting or lowering of suspension mechanism. The three point linkage suspension system of basic geometrical dimensions can be determined function of inferior tie rod (6) characterized of its rotation around linkage articulated points which form an angle with the horizontal direction.

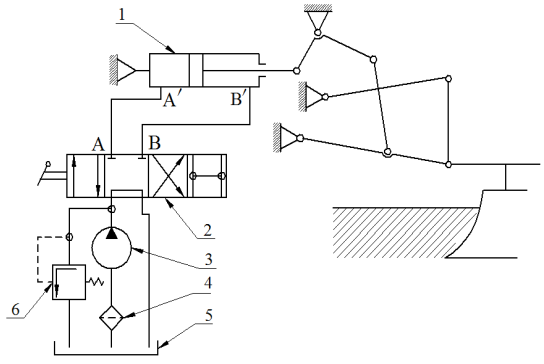

Figure 3.2. Hydraulic components diagram for suspension mechanism [11]

For the operation of suspension system hydraulic actuation is used. The actuation system schematically presented in Figure 3.2 is composed of power supply pump (3), hydraulic dispenser (2), linear hydraulic motor (1) or cylinder, safety valve (6) and filter unit (4).

The suspension system must be able to keep the plow equipment in transport position at maximum height from ground level, in any intermediate position and at a predetermined level position at which the proposed agricultural work is meant to be performed.

In addition to raising and lowering of plowing equipment and maintenance in any intermediate position, the hydraulic suspension system must ensure the maintenance of initial working parameters regarding depth, but also equipment position in relation to the tractor during work.

When plowing equipment is equipped with tracking wheels, the hydraulic system should provide the possibility for changing the position of working tool during operation where ground uneven surface must be followed in order to achieve the same plowing depth over the entire crossed areas.

The three point suspension mechanisms used for agricultural tractors are internationally standardized, according to ISO 730 2009. [16]

Also suspension systems placed in front of the tractor are being used with about the same working principle based on the structural and functional parameters as the rear placed suspension system.

4. CONCLUDING REMARKS

A tractor represents a hard-working machinery that meets the requirements of today's modern agricultural implements and must be utilised to the full potential within a wide range of agricultural applications.

The power range that manufacturers offer tractors on the world market currently ranges between 25 and 220 kW, but there are models that arrive at the value of 450 kW, running on tracked driving version.

The rear linkage suspension system has been optimised specifically to complement to each size of tractors. It must prove a special lifting capacity, meaning that heavy-mounted agricultural equipments can be lifted easily.

Today these systems have electronic linkage control and are equipped with adjustable lift rods and external stabilisers with quick attach hook ends for quick and safe equipment mounting.

The emission standards for agricultural tractors continually change in order to reduce pollutants released into the atmosphere, while agricultural productivity requirements also increase. All agricultural machinery producers must consider these conditions in order to

provide competitive products on the global market.

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