CONSIDERATIONS REGARDING THE GENERAL RULES OF PROPER EXPLOITATION OF TYRES FROM THE AGRICULTURAL EQUIPMENT

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ABSTRACT

With the development of mechanized agriculture involving the use of self-propelled machinery with powers and large capacities, the soils are subjected to intense compaction processes, especially when these have high humidity. In this context the rational use of tires represent one of the measures of reducing the compaction and also the fuel consumption and implicitly the environmental pollution, this paper presenting a set of general rules intended to support the operators so that the characteristics of the machine to be used at full capacity, with optimal consumptions of resources.

INTRODUCTION

The rational use of the tires at the technical equipment from agriculture has emerged as a need to identify the specific working conditions of these equipment, of the current trends regarding the manufacture and operation, all seen in the context of streamlining, reducing energy consumption and costs and of the environmental protection, primary attributes of promoting of a sustainable development in general and of the agriculture particularly.

Generally the operators of the self-propelled tractors and agricultural machinery do not take into account the importance of respecting a minimum set of rules and recommendations from the equipment manufacturers, correlated with the specifications of the tires fitted to these self-propelled systems, so that their duration of life is significantly reduced, concomitantly with the negative influencing of the characteristics of the machine concerned: reducing the adherence and traction force, increasing the skid, increasing the fuel consumption, etc.

MATERIAL AND METHOD

From tire manufacturers' recommendations and from the practical experience, follows that for prolonging the length of use up to their normal life cycle, must respect a number of main rules of correct operation and economical of the tires used for agricultural machinery.

Compliance with these rules as well as other measures such as avoid running on the rim, avoiding the friction of the metal parts of machinery (ie avoiding the friction of the tie rods of the suspension mechanism of the tractor), avoiding of crossing over objects and pieces with sharp protruding parts etc., lead to their efficient exploitation, ensuring the normal lifetime achievement and even exceed it. Knowledge and application of these rules is mandatory for all those who exploit the tires.

RESULTS AND DISCUSSIONS

- **Correlation of the inflation pressure with the load**

Adapt the inflation pressure of the tires to the operating conditions in general and correlation of pressure with the load in particular, is main problem in their proper operation. Also, the correlation of the inflation pressure with the load is the general rule of proper

operation of all types of tires, of traction, directional and carriers, of their use at a proper operating pressure depends directly the tires life.

Generally, the heavy operating conditions of the tires in agriculture leading to their strong stress, require that the operating pressure to be correlated with the load and operating mode whenever it passes from one category of works to another.

Correlating the pressure with the load under operating conditions is the most easy to achieve at the tires used for tractors, these generally having a given mass, which varies relatively little depending on the equipment used. That is why, the correlation of the pressure with the operating conditions is recommended for tractors only when passing from the operating mode in field at the one of transport and vice versa.

At the agricultural equipment which also have a relatively constant weight, is indicated a single working pressure, that correlated with the normal weight and which corresponds to the working conditions in field.

At the means for the transportation of agricultural products, the problem of the correlation of working pressure of tyre with the load is more difficult. The operating pressure indicated by the manufacturer corresponds to the maximum charging load. As not always these are fully loaded (for example when carrying bales, hay, silage), the exploitation of tires to the maximum pressure is not indicated.

Too high pressure hastens the tires removal from service, especially through the accentuated wear of center of the tread. For the lower loading capacity should be lowere accordingly also the tire pressures.

Of course it is not possible to change the tire pressure at each laden but it is possible and desirable the pressure correlation with the load when working on a season, for example to transport of straws, hay or other technological transports, which not charging the trailer at full load. The optimal working pressure in tires is the one at which the tire deforms slightly and steps on the ground with the entire width of the tread. In general, for the tractors, machines and trailers used in agriculture the correct tire inflation pressure is given by each manufacturer in the technical books.

The heavy exploitation conditions of he tires in agriculture on tractors, agricultural machinery and trailers require that their state of inflation to be daily controlled, and the operating pressure to be check periodically within the technical maintenances.

Checking the tire inflation pressure should be done in the morning, before starting work, when the tires are cold and do not change throughout the day when, because of the work get warm and pressure increases. Measurement of pressure and inflating is done with the valve in the lower position.

Too low pressure causes the strong deformation of the tire and more pronounced warming during the running, phenomena which cause the plies separation of the cord and threads breakage, resulting in the final the uneven wear and housing tear, more pronounced on the flanks.

Pressure too high causes housing overstress increasing the tension in the threads of cord and when "expands" the housing occur cracks in the channels of the tread pattern, the too high pressure reducing the tire capacity to absorb the shocks and favors the uneven wear of the tire, more pronounced on ridge.

Hence, exploiting at a pressure too high or too low leads to shorten the tire life and its premature removal from service.

A particular problem concerning exploiting at a pressure too low raises the tires used at tractors or combines wheels. At these tires the minimum working pressure, generally between 1.0 - 1.2 bar and indicated for working in the field it is arranged so as to ensure good adherence on soil at the heavy works. A pressure of 1.0 to 1.2 bar, is however at the limit at which it ensures a good fixing of the tire on the rim. Under this limit the pressure of the tire bead on the edges of the rim is no longer enough, fixing is no

longer assured and may result in turning the tire on the rim. Rotating the tire on the rim causes the valve rupture, the loss of the air and, if the tractor is not stopped in time, may produces the inner tube and the tire damage.

That is why, at the driven wheel tires a particular care should be taken that the pressure does not fall below the minimum limit. But there are situations when the rotation of the tire on the rim occurs also at normal working pressure. In this case the rotation occurs due to insufficient initial tightening between tire and rim (the tightening have to be assured by the smallest diameter of the tire bead to that of the rim). To avoid rotation of the tire on the rim in this case, the inflation pressure must be increased with 0.2-0.3 bar over the indicated operating pressure.

From the practice of tires exploitation it is known that there are not excluded the cases when the rotation of the tire on the rim occurs also at the steering wheels of the tractors or at the other farm equipment wheels. The cause is still the operating pressure too low or the inadequate initial tightening of the tire on the rim. Also in these cases avoiding the rotation of the tire on the rim with its undesirable effects must be done by increasing the operating pressure within the indicated working pressure for that tire.

Concerning the correct exploitation of the tires, an issue that requires a special attention is the correlation of the pressure with the load and with the operating conditions at the four-wheel drive tractors. At the tractors with fixed gear ratio between the engine front axle and the rear one, is necessary that the effective rolling radius of the tires ftom the front and rear to correspond to some peripheral rolling speed equals. Thus the ratio between the running radius of the the driving wheels ftom front and rear have to be equal to the gear ratio between the two drive axles. As the running radii of the tires depend on the inflation pressure, it is necessary that always, the inflation pressure to be correct and to correspond to the working pressure recommended by the manufacturer in the technical book.

Otherwise occurs a gap between the wheel peripheral speeds, the tires with lower adherence (usually those from the front, at the tractors with unequal four-wheel drive) skating or slip onto the ground and wear out faster. At the same time the tractor tensile force decreases and increases the fuel consumption. The phenomenon is more pronounced when traveling on a road of concrete or asphalt. This explains why when running with the front axle coupled on asphalt road, it causes an increased wear of the tire tread of the front driving tires.

Also, this explains why it is not recommended the coupling of the front axle and the use of the traction on four-driving-wheels when traveling on roads of concrete, asphalt and even on beaten dirt roads. When working in the field where it is permissible a slippage of 15% on stubble and of 20% on field, the lack of correlation of the front and rear driving wheels rays has a less importance and the coupling of the front axle can be made without reservations.

The lack of correlation of the rolling radii of the front and rear driving wheels may be caused, in addition to the incorrect inflation pressure, and of their different wear, of the load variation (when is suspended on tractor a heavy machine), of the road tilting etc. Also in this case the lack of correlation of the rolling radii between the driving front and rear wheels leads to the increased tire wear and to lowering of the traction force, accompanied by the increase of fuel consumption. We therefore recommend that at tractors with four-wheel drive to ensure as far as possible the fitting with tires with the same degree of wear, not to alter the normal distribution of weight on wheels by the suspension of heavy machinery, to maintain the normal equipment of additional wheel weights etc.

All these measures will avoid the negative effects of the mismatch of the tires rolling radii of the front and rear wheels. All tire manufacturers strongly emphasizes their

operating instructions, the need to respect the operating pressure and the indicated load as well as the correlation between them, for the correct exploitation of tires.

From experience, if the inflating pressure decreases to 80-85%, the rolling duration of the tires also falls to about 80%, thus reducing by 20% (fig.1). The same harmful effects it has also the tires exploitation at a load higher than that indicated.

All these arguments pleads for the strict compliance in exploitation with load and operating pressure recommended for each type of tire.

- **Tires exploitation up to the limit of the allowed slip**

At the heavy works of traction, especially in tillage, the driving wheels of the tractor slipping intensely. As a result, it produces a hard wear of the tires. Therefore, in order to maintain the wear of the tires at an acceptable pace, the slippage must be limited. Slipping allowed is 15% on stubble and 20% on field. Exceeding these limits leads to increased tire wear and their premature removal from service. Practically it appears that slippage falls within the permissible limits when over the the trace left by the wheel on the ground appears visible the footprint of the tread band of the tire and the soil is easily pulverized. A strong pulverization of the soil after wheel indicates an increased slip, which must be avoided by reducing the tractive force requested from tractor, respectively by reducing the width, the depth or of the operation speed.

- **Disposing of tires that have reached the wear limit allowed**

In normal operating conditions, the tires are scrapped when the tread band is worn out. The limit of the wear is the one at which the tread band has worn about 85% of the original height or the tread profile height reached up to less than 2 mm (directional and carrying tires).

Exploitation of tires beyond these limits is not recommended, because it no longer ensures good adherence on the ground and operational safety. There are relatively frequent cases when the tires are scrapped because of some malfunctions producedin particular to the housing, defects such as: breaking of the anchor (Radial cracks on the sidewall or at the profiles bottom), bead erosion, detachment of the cord threads etc. In all these cases the tires are removed from service prematurely, before the tread band wear, because it no longer presents operational safety.

- **Avoiding the uneven tire wear**

The uneven tire wear is determined by the incorrect working pressure. Thus, at the working pressure too low (under pressure), the tire rests on the ground with the tread band flanks which are more rigid and become worn more accentuated on these sidewalls.

At the correct pressure (normal) the tire sits on the ground with entire tread width and runs, and the wear is uniform over the entire surface of the tread.

If the pressure is too high (over pressure), the tire rests and runs on the ridge along the ground, emphasizing the wear in this area.

The occurrence of uneven wear is more evident at the tractors and trailers tires which are used more asphalt or concrete roads. That is why, when it is established that the tire wear is uneven, the inflation pressure is adjusted, thus: pressure is reduced if the wear is more pronounced on ridge (the most common) or increases slightly the pressure, if the wear is more pronounced on the sidewalls.

Obviously that both mitigation and increasing of pressure must be within the operating pressure indicated for the tire in question.

- **Avoiding as far as possible the occurrence of accidental breakage at the tire**

Statistics show that at the machinery for agriculture and in particular for tractors, approx. 70-90% of tires are scrapped in normal conditions, at the limit of wear and approx.10-30% from other causes, especially because of the accidental breakage.

The consumption of tires thus is increased abnormally, by their decommissioning,, because of the accidental failures.

Therefore must avoid causing any malfunctions of this kind, among the most common accidental failures, caused by a correct operation that lead to removal from service of tires before the wear limit being:

- tearing the housing;
- detachment of cord;
- erosion of the bead;
- bead breaking or mechanical cuts.

Tearing the housing is caused by the operation of the tire at a pressure too low or at a too high loadind. These produce its excessive deformation, strong friction, heating and breaking of the cord. Tearing may occur most commonly at the bottom of prophiles, between the sidewall and the edge, in the bead area. Breaking the housing is visible as long straight cracks (when are on the yarns cord direction) or slightly wavy. Sometimes the breaking of the housing appears as a cross, visible especially from the inner side. In this case the failure is caused by strong deformation by hitting the housing of a body prominent, tough (a rock, for example). Preventing such damage is possible by respecting the pressure and work load.

Cleavage of the cord occurs in the inside of the housing in the sidewalls area and is due to the tire exploitation at a pressure too low.

Erosion is caused by the deformation of the rim in the bead area, deformation caused by hitting it during the work or at the tire deformation and therefore must be avoided the use of such rims. Sometimes the erosion of the bead can be produced by the rotation of the tire on the rim, especially in heavy traction work, plowing and disking. The occurrence of such a failure must and can be avoided by increasing the inflation pressure with 0.2-0.3 bar.

Breaking the bead can lead to the forced deformation and removing of the tire from the rim or due to too much tightening of the bead on the rim. The failure can be prevented by careful removal and installation of the tire, using appropriate tools and devices without hard hits the bead.

Mechanical cuts are caused by hard objects, sharp, standing on the ground or buried in it.

In operation occur, however, and a number of accidental failures due to manufacturing deficiencies, defects such as deformation of the sidewalls, peeling of the prophiles peaks, tread separation at the retreaded tires etc..

These defects can not be prevented, but can be avoided by proper exploitation without a strong tensile request.

- **Respecting the direction of rotation of the tire**

Respecting the direction of rotation is a rule which imposes at the traction tires with profile in V, used at the driving wheels of the tractors or combines. In general, the tires of this type have imprinted on them with an arrow, the correct direction of rotation. It is appropriate its observance to ensure a good adherence on the ground and a satisfactory self-cleaning.

Always when fitting tires on rims and then on the tractor and when reversing the wheels for adjusting the wheel track etc., must take into account the direction of rotation of the tire. The normal rotational direction is that one with the Vee angle to the direction of travel. Failure to observe the rotational direction leads to charging the tread prophile with soil, especially on lands with increased humidity, the effects being the adherence lowering, slip increase and the increased tire wear.

- **Tyre permutation**

After a long period of operation, the tires of the left and right wheels of the tractors may wear uneven. This stands out especially at the rear driving wheels of the tractors, which are used at ploughing. When approaching to the limit of wear, the more pronounced

wear results in lowering the adherence of the tractor, the increase of fuel consumption and the increased differential request.

To avoid these undesirable effects, it is appropriate that when there is a visible difference between wear left and right wheels to make their reversal (permutation). The operation is made simple, moving the wheel from left to right and vice versa, but maintaining the correct direction of rotation. The same operation has to be done also at the front wheels of the tractor, at which the uneven wear may be due to the disturbance of the wheels convergence angle.

At the farming machinery the uneven tire wear is less common. It notes, however, sometimes an uneven tire wear on the front and rear wheels of the trailers. Also in this case the permutation of the wheels (which must be done by moving the front wheels in the back and reversing left to right) removes the unwanted effects of the uneven wear.

- **Using the appropriate wheel**

When choosing and using the tire rims two elements must be considered: type and size of the rim and its technical condition.

Regarding choosing the type and size of the rim, the problem is relatively simple, whereas by construction, the tractors, machines and agricultural trailers are provided with rims proper to the tire size that it are equipped.

Also in tires catalogs and in standards are indicated the type and size recommended or tolerated. But can arise situations when to a ran out machine must be replaced provisionally a rim. In this case it is desirable replacement of damaged rim with a rim of the same type and size (or entirely changing the wheel). If, however, on the moment, can not find a similar rim, will be chosen a wheel with the same diameter to bead (otherwise can not mount the tire) and having a rim edge width preferably less than that of the original rim. More frequently raise the need to replace a damaged tire. In this case, if can not be find a similar tire, will choose, preferably for a given rim, a tire with a size at balloon immediately above to the original tire; for example a tire 7.50 - 16'' instead of 6.00 – 16" and not vice versa. Generally, the admissible deviation to the balloon tire size may be up to 1/2'' for the small tires with the diameter to rim of up to 20'' and of 1'' at large tires, with a diameter of 28-38''.

Regarding the technical condition of the rim, must take into account that it is not allowed to use rims with the bead edge deformed (hammered when installing or removing the tire), of the rims with roughen or burrs left after retreading, of the rims with cracks and crevices, especially in the bead area. Such rims must be decommissioned and repaired, because their use leads to tire damage (bead erosion) and premature removal from service. Also, such rims are unsafe in operation and may cause accidents.

- **Using the appropriate size for inner tubes**

Each tire is fitted with an air tube with appropriate size to the tire size. To not confuse, on the sidewall of the inner tube is marked as shown, the same symbol as of the tire for which is designed. Also, the tires are supplied in complete sets, consisting of tires plus the inner tubes of the same size. But there are situations when on some old inner tubes the marking can not be read (was removed by the friction with the tire, was vulcanized in this area etc). In this case, to identify its size and to determine whether it corresponds to use in a given tire and rim, proceed to measure it, so: the inner tube is inflated slightly until it get the normal form of torus and is measured first the inner diameter, which should approximate to the rim bed diameter, and then the balloon (or the section width), which must correspond to the tire balloon, with a difference negative of 20 ... 30 mm.

In the situation when there is not an inner tube of the same size with the tire at a tractor or car with flat tire the defective inner tube should be replaced provisionally with one similar in size. In this case, at the inner tube choice must consider that a too large air

chamber creasing inside the tire, rubs against its walls and get damaged, and an inner tube too small stretches too much, its walls is getting thinner too much and breaks.

That's why, is always chosen for replacement an inner tube with a balloon size with a size immediately below to the balloon size tire, but with a diameter equal to the diameter of the rim (for example the inner tube of 6.50 - 20'' instead of 7.50 - 20'' or 11.2 – 28'' instead of 12,4 – 28'').

- **The correct assembly and disassembly**

The life time of tires depends largely on its correct mounting and dismounting from the rim.

For the agricultural tires are used both demountable rims and non-removable rims. Installing and removing of tires on non-removable rims is difficult and request the most attention. The operation of mounting and dismounting on such rims is made by forcing the tire bead over the rim edge. If inadvertently the forcing is too strong can be damaged the tire bead. The order of operations is as follows: introducing the bead on the rim begins from the opposite side of the valve at mounting, and removing the bead from the rim starts from the valve side when removing.

When removing, the most difficult operation is the separation of the tire bead from the rim. This can be done correctly but without too much effort using the special devices designed for this operation.

The use of these devices facilitates greatly the work and avoids the deformation of the rim edge as well as the deterioration of the tire bead, as it happens when these are hammered. Hammering can be avoided when removing the tire. Hitting with a rubber hammer may be allowed only at mounting on the last portion of the bead, when with the lever is pulled the bead and is achieved its passage over the rim edge. A special operation at mounting, to which is not given much attention is the tire inflation, which must be made in such a way as the bead to sit well on the rim edge. This issue is very important at the traction tires at which the bead must have on the rim edge a good tightening, so the tire can not rotate on the rim while working. At these tires, for the bead to be firmly seated on the rim edge, the inflating must be initially done at a pressure of about 1.5 bar higher than the regime pressure.

Some manufacturers of tires indicates a pressure for good seating of the bead on the rim up to 3.5 bar. After positioning the the bead, the pressure is reduced to the normal working value. It is preferable that the tire change to be made in the vulcanizing workshops which are usually equipped with special devices which avoid the potential damage of the rim or of the tire.

CONCLUSIONS

For a proper exploitation of tires for reducing the specific consumptions and of the environmental pollution, must pursue the following:

- the use of the tires at an internal pressure in accordance with :
  - the nature and condition of the surface on which it runs preponderantly and the traveling speed, influencing reduction of pressure on soil and its compaction;
  - the tyre load, the correlation between load, tires size and working pressure leading to the reduction of rolling resistance and consequently of the fuel consumption with further influence on the reduction of noxious emanations into the atmosphere;
- using the correct size of the tires depending on the nature and state of the surface with influences on reducing of the soil compaction, of the tractive force at the driving wheels, of the rolling resistance, of the fuel consumption and of the quality of rolling;
- the use of tires with adequate tread profile with influence on the traction, running quality and stability;
- using as far as possible of the rims recommended by the tire manufacturers.

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