**UDC 629.114.2**

# APPLICATION OF SEPARATE CYCLE FOR CONTINUOUS MOVEMENT OF THE VEHICLE WHEEL MOVERS STUDY.

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*The questions of the transformation of the deformed tire in to the work of rolling motion of wheel mover can be used to assess the movement of the vehicle. Mathematical dependencies for gradually released system that describes the rolling of wheel mover on the bearing surface and implementation of deformation of tire elements against the resistance can be used in the calculation of quality indicators of wheel movers.*

**Keywords:** *power* work, released system, wheel, surface.

**Introduction.** Towing vehicle moves in the consequence of action of various forces directed on it , which can be divided into forces that contribute to its motion and the forces that resist its movement.

The main force that contributes to the movement of the towing vehicle, is traction force applied to the drive wheels. Traction force or tangential tractive effort is caused by operation of energy device of the pull and energy means, which converts chemical energy of fuel into mechanical, caused by the interaction of the the drive wheels with the support surface.

**Problem.** . The article considers the problem of energy transfer from the compressed area of the tire to the extended area of the deformed tire of the rolling wheel with its subsequent transformation into the tangential tractive effort of the technological process of the vehicle movement. The mathematical analysis has been conducted and the results have been obtained for the energy estimation of the possibilities of the rolling wheel mover.

**Analysis of recent researches and publications.** Vehicle is characterized by such basic parameters as: tangential tractive effort, torque and power, that define quality indicators of wheel mover. In general in the result of the interaction of wheel mover with the bearing surface these parameters can vary. For studying the process of moving the vehicle considerable interest is paid to it obgervation at the constant value of one of the parameters. Such processes are basic. They include:

- tangential tractive effort P = const;
- torque on wheel movet M = const.

The general research method of the basic workflow is as follows:

- formulates features that take into account the order of this process;
- installs the dependencies between the main parameters of the workflow at its beginning and its end.

The tire is in contact with the road with a large number of points, forming the contact area the resultant of the elementary forces acting from the side of the road on the wheel in the contact area, is the road reaction on the wheel that can be represented in the form of three components:

- normal Z perpendicular to the road;
- tangent X, which acts in the plane of the wheel;
- crosswise Y, which lies in the plane of the road and is perpendicular to the plane of the wheel.

The rolling wheel, has the resultant Z offset from the vertical diameter of the wheel at a certain distance. When the elastic wheel rolling on a strong road, external losses are absent, and the resultant offset due to the loss of energy to overcome internal friction in the tire. The lower part of the rolling wheels (tires) that is compressed, stretched, Fig. 1. Between the parts of the tire occurs friction, generates heat, which dissipates. The work that is spent on the tire deformation does not return in full when you later restore the shape of the tire.

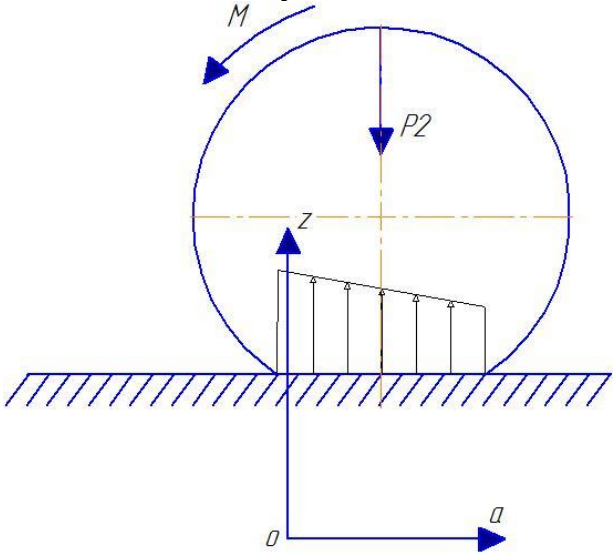


Fig. 1. The resistance to deformed tire rolling

If we denote the deformation of the tire Δ, then its dependence on the process of increasing load in the vertical direction will be described by the curve orl, Fig. 2. When reducing the load on the tire, the same deformations correspond to smaller values of the load curve lmn. Square loop oln is the work that involves not rotating losses in the tire. When the wheel rolling deformation at the front of the tire increases, and in the back reduces. Therefore, the elementary normal reaction in the front of the contact is larger than in the rear, which causes the displacement of the resultant Z at distance A.

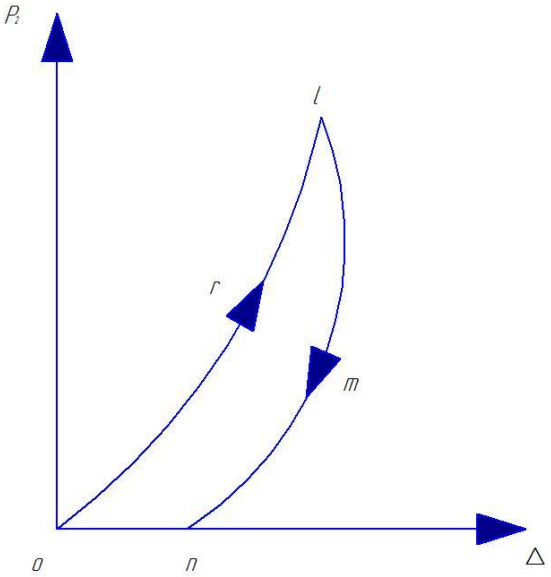


Fig. 2. The dependence of the losses charge in the tire from the influence of vertical load on the tire deformation

**Purpose of research:** Development of rolling wheel mover energy model.

**The main material:** Let`s find the balance between work of changing tire wheel mover in the area of the contact spot and useful external work of wheel mover, that is, movement of the vehicle.

In differential form, this will look as follows:

$$Pдdυ = d\,(Pд \cdot υ) - υdPд \quad (1)$$

where $Pд$ is the tangential tractive effort;

υ is the change of the tire volume in the area of the contact spot.

Carry out the integration of both parts of equation (1):

$$\int_{υ1}^{υ2} P_д dυ = (P_д 2υ2 - Pд1υ1)' - \int_{P1}^{P2} υdP_д \quad (2)$$

External useful work will be found from the expression:

$$l' = -\int_{P1}^{P2} vdP \quad (3)$$

Imagine that the tire and the road (the external environment) is in thermal and mechanical interaction. Then the workflow of rolling tires and the road is accompanied by the exchange of energy between the tire and the road is in the form of heat and mechanical work.

The work of the pressure forces of the weight of the vehicle acting on the deformed part of the tire surface from F to F+dF, which is determined by the elements of the deformation part of the tire. This work is numerically equal to the energy, which element of the deformed part of the tire when moving the vehicle will be shared with the undeformed part of the tire from which the deformed part of the tire is selected.The weight of the vehicle, acts on the compressed part of the tire pressure, which is evenly distributed on the surface F, the pressure P + dP acts on the stretched part of the tire. The work which is done by pressure on both parts of the deformed tire elements is different.

The work on the compressed side of the tire mathematically will have:

$$dL_F = - P_T dV = - (P_T \cdot \upsilon) dm, \quad \frac{Н}{м^2} \cdot м^3 = \frac{Н}{м^2} \cdot \frac{м^3}{кг} \cdot кг \qquad (4)$$

where υ is the specific volume of the deformed (compressed) part of the tire;

dm - element mass of compressed tire.

Let us introduce the notation:

$$P_T = f_1(x) \qquad (5)$$

$$\upsilon = f_2(x) \qquad (6)$$

Then: $$P \cdot \upsilon = f(x) \qquad (7)$$

Analytically, we obtain the formula for work on the stretched part of deformed tire element :

$$dL_{F + dF} = f(x + dx)dm \qquad (8)$$

**Research results:** Total work of element of deformed tire part on which acts the mass of the vehicle dm:

$$dL_F = dL_{F + dF} - dL_F = [ f(x + dx) - f(x)]dm \qquad (9)$$

Decompose the function f(x + dx) in Taylor series:

$$f(x + dx) = f(x) + f'(x) \frac{dx}{1!} + f''(x) \frac{dx}{2!} + \ldots + f^n(x) \frac{dx}{n!} \qquad (10)$$

If we keep to the first two members of Taylor series, we get:

$$f(x + dx) - f(x) = f'(x)dx \qquad (11)$$

Otherwise: $$f(x + dx) - f(x) = d(P\upsilon) \qquad (12)$$

Then change of work from the action of the weight on the deformed part of the tire will be written by the formula:

$$dL_p = d(P \cdot \upsilon)\, dm \qquad (13)$$

specific work:

$$dl_p = d(P \cdot \upsilon) \qquad (14)$$

Specific useful work of the compressed tire will be find from the expression:

$$l_p = \int_{P1}^{P2} \upsilon d \qquad (15)$$

Chart P - υ Fig. 2 this work is numerically equal to the figure square . Bounded by a line process, abscissae boundary points and the axis of pressure. This work will be positive when the deformation of the tire goes in the direction from the compressed part to the stretched part. The pressure in the compressed area of the deformed part will be reduced in the direction of the stretched area of the deformed tire part .

The physical meaning of the work, which performs the deformed tire of the wheel mover is as follows. The element of deformed part of the tire allocated from rolling wheel mover and the wheel mover we merge into the concept "gradually released system".

**Conclusions:** The interaction between the deformed tire wheel mover and bearing surface will be expressed in the exchange of energy in the form of work (dlp), which is performed by deformed element of the tire against the forces, resistance to wheel mover rolling, this leads to changes of energy accumulated in the ared of compression of the tire in the direction of the stretching area of the deformed tire on the value of d(P•υ).

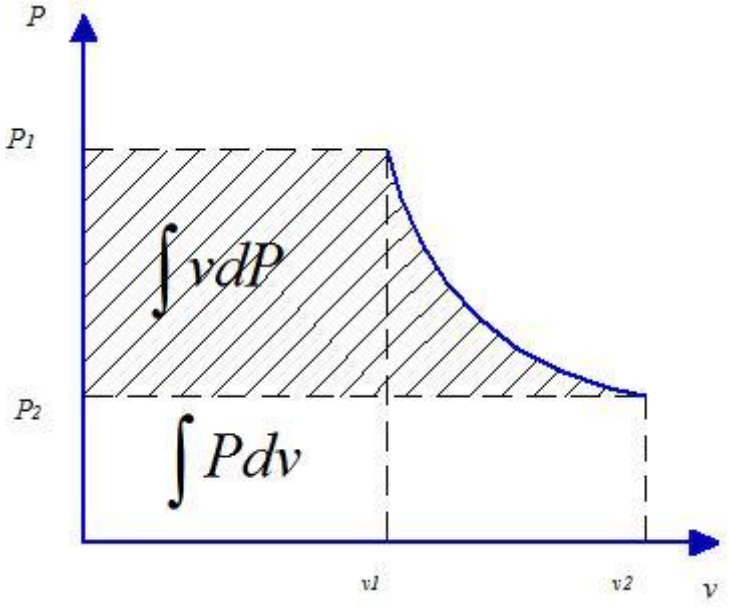


Fig. 3. Chart

Thus, the change of energy from the compression ared to the zone of expansion of the deformed tire element, which characterizes the energy of gradually released system that is spent on moving the vehicle.

**References**

1. Guhman A.A. Application of similarity theory to the study of the processes of heat and mass transfer. Transport processes in moving environment): CTL, 2010. - 330 C.

2. Kudinov C. A., Kartashov E. M. Stefaniuk E. C. Technical thermodynamics and heat transfer. - M.: writ, 2011. - 560 C.

3. Bazhenov, S. P., Kazmin B. N., Nosov, S. C. Principles of automobiles and tractors operation and repair. - M.: Academy,2011 - 336 C.

## ПРИМЕНЕНИЕ ОТДЕЛЕННОГО ЦИКЛА ДЛЯ ИЗУЧЕНИЯ НЕПРЕРЫВНОГО ДВИЖЕНИЯ КОЛЕСНОГО ДВИЖИТИЛЯ ТРАНСПОРТНОГО СРЕДСТВА

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**Ключевые слова:** силовая работа, система, колесо, поверхность.

Резюме

*Рассмотрены вопросы преобразования деформированной части шины в работу качения колесного движителя могут быть использованы для оценки перемещения транспортного средства.*

**SEPARATE APPLICATION CYCLE STUDY OF CONTINUOUS MOVEMENT WHEEL MOVERS VEHICLE**

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**Key words:** work force, released by the system, the wheel surface.

Summary

*The questions of the transformation of the deformed tire in the wheel bearing job engine can be used to assess the movement of the vehicle.*