COMPARATIVE ANALYSIS OF ENERGY CONSUMPTION BY MODERN CARS AND FUTURE QUANTOMOBILES

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Abstract

Features of the theory of Superunification, used in formation of quantum engine (QE) concepts, are briefly described in the article. Schemes of thrust formation in QEs are considered. A concept of a quantum car (quantomobile) as a vehicle with a quantum engine, preserving supporting idle wheels, is introduced.

Complete removal of idle wheels in a quantomobile leads to a concept of a flying car. Analytical comparison of Kamaz-4326 truck horizontal thrust and energy consumption with indicators of hypothetical quantomobile and flying car (based on such car) concepts is conducted.

Keywords

Car, quantum engine, quantomobile, flying car, quantum thrust, energy consumption.

Introduction

Efforts of scientists in search of a new paradigm of energy supply for humanity over the past decades (Einstein (1963), Tesla (2009), Dirac (Dirac, 1927, 1930; Sanyuk, 2009), Parker (1991), Davies (1985), Puthoff (2010), Veinik (1991), Petrov (2015), Shawyer (2006), McCulloch (2014), Fetta (2014), Tajmar (2018), and others) were crowned with unveiling of the structure and energy density of the physical vacuum, super-strong electromagnetic interaction (SEI). An insight into the above-mentioned subjects is provided by the t*heory of Superunification* suggested by Leonov V.S. (Leonov, 2002, 2010a, 2010b, 2018).

The ability to draw energy from the global physical vacuum will result in a new technological paradigm involving the transport sector as well. Quantum engines will replace internal combustion and jet engines; the existing propulsion devices of vehicles will improve.

In his publications (Kotikov, 2018a, 2018b), the author of the article considered basic provisions of the theory of Superunification, suggested by Leonov, in general terms, described aspects of QE development, predicted some features of cars with QEs (quantomobiles), and reviewed stages of research and practical implementation of QEs and quantomobiles.

The purpose of the article is to create a methodology to compare energy consumption indicators and perform a comparative quantitative assessment of energy consumption by modern cars and future (hypothetical) quantomobiles.

Ideas of the theory of Superunification promoting QE creation

In the author’s opinion, fundamental theoretical developments of Leonov V.S. and his theory of Superunification (Leonov, 2010a) referring to the process of such quantization of Einstein's space-time, which allowed uniting electromagnetic, gravitational, nuclear and electroweak forces into one field entity (Superforce (Davies, 1985)) (at the time, Einstein made similar attempts but failed due to objective reasons — the lack of

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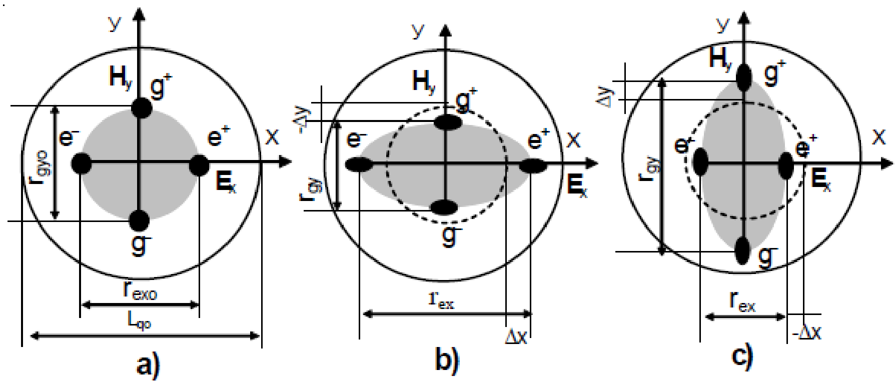

Figure 1. Electromagnetic polarization of the quanton upon the passage of an electromagnetic wave: (a) equilibrium (zero) state of the quanton; (b), (c) perturbed polarized state of the quanton (Leonov, 2010a).

developments in physics), are the most successful works in the field of investigating the structure of the physical vacuum. Leonov borrowed the concept of a quark (an elementary component of the primordial matter) from the Standard Model and simplified it by removing quarks with fractional electric charges. Four quarks made up the quanton structure. The quanton (the only universal four-dimensional particle) became the carrier of time and space.

Quantization is an energy process. The global physical vacuum — the quantized space-time (QST) (including real insertions) — is densely filled with quantons that are mobile within their small neighborhood.

A quanton is a quadrupole consisting of two dipoles — an electric one and a magnetic one — orthogonally placed inside it. Generation or conduction of an electromagnetic wave is carried out by changing the axial distances (arms) between the charges (quarks) of each of the dipoles (see Figure 1) (Leonov, 2010a).

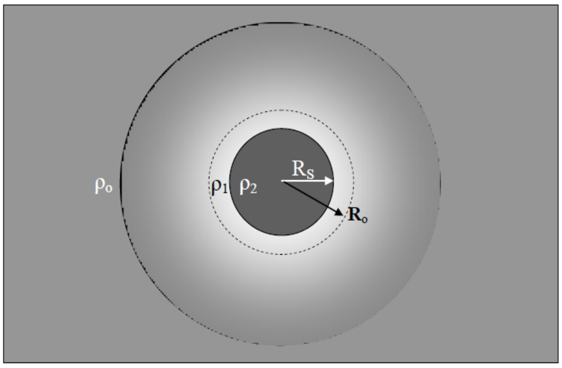

Figure 2. Modeling of elementary particles in the form of regions of spherically deformed QST: RS — gravitational medium interface; ρ_1 — tension field (light-colored), ρ_2 — compression field (dark-colored) (Leonov, 2010a).

Gravitational transformations of the unified field of QST represent spherical Einstein's curvatures of QST due to displacement of quantons in their small neighborhood (their concentration around some short-time pole within a fragment upon simultaneous rarefaction of the fragment periphery) (see Figure 2) (Leonov, 2010a).

The ensemble of quantons in spherically deformed QST ensures ponderomotive (force) interaction between electromagnetism and gravity, which was confirmed experimentally. Actual anti-gravity effects were found (Leonov, 2010a).

If we introduce a perturbing electric charge into QST, quantons will be attracted to that electric charge. QST, being an elastic medium, tends to compress near the perturbing charge. However, this is possible only due to tension in a distance from the central charge. A process of spherical deformation of the quantized medium occurs (Leonov, 2010a).

The theory of Superunification considers mass movement as wave transfer of QST spherical deformation.

QST can also be characterized as a scalar field with the distribution of the medium quantum density ρ (x, y, z). The medium quantum density represents the concentration of quantons per unit of volume. Then the emergence of an elementary particle as a result of compression/tension of the medium from the perspective of vector analysis is the divergence of the gradient of the quantum medium density (Leonov, 2010a).

An equation characterizing an elementary particle in QST is as follows (Leonov, 2010a):

$$\operatorname{div}\left(\operatorname{grad}\rho\right) = \mathrm{k_o}\rho_\mathrm{m} \tag{1}$$

where k_o — proportionality coefficient;

ρ_m — matter density, kg/m^3.

Let us note that *div* is an operator, projecting the vector field to the scalar field. The gradρ gradient which is a part of (1) represents the medium deformation vector **D** when the scalar field ρ (x, y, z) is used to create a vector field upon deformation, characterizing gravity emergence (Leonov, 2010a):

$$\mathbf{D} = \operatorname{grad}\rho \tag{2}$$

Equation (2) shows that deformed QST, being a carrier of SEI, is the basis of gravity (Figure 2). Gravity is basically electromagnetic in its nature.

Leonov expresses the force of gravitation F_m through the deformation vector **D** of QST (Leonov, 2010a):

$$\mathbf{F}_\mathrm{m} = \frac{C_0^2}{\rho_0}\mathrm{m}\cdot\operatorname{grad}\rho = \frac{C_0^2}{\rho_0}\mathrm{m}\cdot\mathbf{D} \tag{3}$$

where C_0^2 is the maximum gravitational potential of the unperturbed QST;

ρ_0 is QST density.

The deformation vector **D** in (2) and (3) is an analogue of the gravitational field strength vector **a** (where **a** is free-fall acceleration) (Leonov, 2010a):

$$\mathbf{a} = \frac{C_0^2}{\rho_0}\mathbf{D} \qquad (4)$$

According to the theory of Superunification, gravity cannot emerge outside QST, and it is based on the real deformation of QST. A gravitational pit forms around any object having a mass. The considered proof mass *m* affected by the gravitational force $\boldsymbol{F}_m$ rolls down into the gravitational pit to the perturbing mass *M*, implementing their mutual gravitational attraction (Leonov, 2010a).

Concepts of thrust formation in quantum engines

The technology of creating the force of artificial gravitation has already been implemented by Leonov V.S. in a number of trial designs of quantum (field) engines that generate a thrust impulse due to the interaction of QE operating elements with QST without the ejection of the reactive mass (Leonov, 2002, 2010a, 2010b, 2018).

In the field theory, the direction and magnitude of the force vector **F** (being determined by the spatial gradient (grad) of energy W) are oriented towards a decrease in energy (Leonov, 2010a):

$$\mathbf{F} = \mathrm{gradW} \qquad (5)$$

Differentials in energy levels in space determined by the energy gradient (5) lead to the emergence of a force, to force interaction.

If the global energy field W is a scalar field, then the gradient (5) describes a vector force field having the direction and magnitude of the fastest change in energy W in partial derivatives and can be written with the use of the Hamiltonian operator (Heaviside, 1893; Leonov, 2018):

$$\mathrm{gradW} = \nabla \mathrm{W} = \frac{\partial \mathrm{W}}{\partial \mathrm{x}}\mathbf{i} + \frac{\partial \mathrm{W}}{\partial \mathrm{y}}\mathbf{j} + \frac{\partial \mathrm{W}}{\partial \mathrm{z}}\mathbf{k} \qquad (6)$$

where **i, j, k** are unit vectors along the x, y, z axes, respectively.

If we need forces to emerge, it is necessary to create energy level differentials in the energy field, when W ≠ const. The force modulus (6) is determined by the following equation (Heaviside, 1893; Leonov, 2018):

$$\left|\mathrm{gradW}^2\right| = \sqrt{\left(\frac{\partial \mathrm{W}}{\partial \mathrm{x}}\right)^2 + \left(\frac{\partial \mathrm{W}}{\partial \mathrm{y}}\right)^2 + \left(\frac{\partial \mathrm{W}}{\partial \mathrm{z}}\right)^2} \qquad (7)$$

The direction of the unit gradient vector (force direction) **n** is determined by the ratio of the function (6) to its modulus (7) (Heaviside, 1893; Leonov, 2018):

$$\mathbf{n} = \frac{\mathrm{gradW}}{\left|\mathrm{gradW}^2\right|} = \frac{\frac{\partial \mathrm{W}}{\partial \mathrm{x}}\mathbf{i} + \frac{\partial \mathrm{W}}{\partial \mathrm{y}}\mathbf{j} + \frac{\partial \mathrm{W}}{\partial \mathrm{z}}\mathbf{k}}{\sqrt{\left(\frac{\partial \mathrm{W}}{\partial \mathrm{x}}\right)^2 + \left(\frac{\partial \mathrm{W}}{\partial \mathrm{y}}\right)^2 + \left(\frac{\partial \mathrm{W}}{\partial \mathrm{z}}\right)^2}} \qquad (8)$$

Equations (5)...(8) are valid for calculations of the force when energy diffuses in space unevenly and energy differentials are observed, and when the function of energy distribution in space W = f (x, y, z) is known (Leonov, 2018).

The theory of Superunification provides the scientific basis for the creation of an artificial thrust (changing the direction of the force vector **n**).

In order to create an artificial thrust, it is necessary to create an energy gradient inside the proof mass (body) (QE operating unit) due to the redistribution of the medium quantum density (Leonov, 2018).

For instance, in 2002, in his patent, Leonov created an energy gradient (Leonov, 2002) due to the use of the conic shape of the operating unit and the effect of an external electromagnetic field with crossing electric and magnetic fields on the conical operating unit. So far, he has implemented a dozen of methods to create an artificial thrust in various designs of quantum engines: both with rotating and non-rotating operating elements (Leonov, 2018). Formation of directional wave motion of the QST curvature front, according to Figure 1 (Leonov, 2010a), represents a common feature for all methods and devices.

For instance, according to a design suggested by Shawyer (2006), the thrust **F** is created due to the interaction of the gradient SHF field with QST. The SHF field creates a gradient of the medium quantum density and energy inside the conical resonator (Figure 3) (Branderburg, 2017).

Both the magnetron, and conical resonator represent an integral part of QST, freely penetrating it. Under the influence of the gradient field, the effect of the "drawing-in" of QST quantons in the diffuser of the conical resonator is observed. Since QST is stationary, the "drawing-in" effect manifests as the movement of the quantum engine in space under the influence of the thrust **F** (Figure 3). It turns out that the quantum engine, creating the thrust

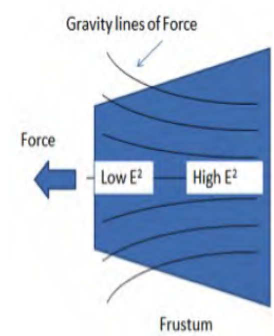

Figure 3. EmDrive microwave quantum engine with a conical resonator (Branderburg, 2017).

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F, kind of moves in QST (in the front), pushing off this space as from an elastic quantized medium (in the back) (Leonov, 2018).

The thrust **F** direction in Figure 3 is conventional. It can vary and even become reverse, depending on the design of the resonator, placement of channels leading from the magnetron to the resonator, characteristics of the SHF field (McCulloch, 2014).

Let us call the force **F** the "traction force" (denoting it as $\mathbf{F}_T$) (in terms of its application to vehicle's structural elements) as well as the "thrust force" (in terms of the field response to its perturbations in the resonator (the term is borrowed from rocketry).

In case the resonator is rigidly mounted onto the vehicle's body and there are no intermediate force transducers, both things will mean the same. However, if there are intermediate transducers (dampers, reduction gears, etc.), those forces may differ.

It should also be noted that the force (vector) can be decomposed into unit vectors:

$$F_T = F_{T_X} + F_{T_Y} + F_{T_Z} \tag{9}$$

The scalar form of this equation is as follows:

$$F_T = \sqrt{F_{Tx}^2 + F_{Ty}^2 + F_{Tz}^2} \tag{10}$$

We will consider the derivations presented above to be necessary and sufficient to create a method for comparative analysis of power drives of the existing and hypothetical vehicles.

Method for comparative power and energy analysis of vehicles with internal combustion engines (ICEs) and QEs

The purpose of the analysis is to estimate the levels of the required energy consumption in two options of power supply units (with ICEs and QEs) under the same load and driving modes.

We will confine ourselves to the basic driving mode of a long-haul vehicle: driving at a constant speed along a horizontal road section.

Let us start formation of analytical threads from the ICE crankshaft flywheel and QE resonator.

The classical equation of the vehicle's thrust balance for steady motion along a horizontal road section is as follows:

$$P_T = P_f + P_w \tag{11}$$

where P_T — thrust generated by the torque transmitted to the driving wheels, and applied to the frame of the vehicle through the wheel axis (wheel hub);

P_f — rolling resistance;

P_w — wind resistance.

Let us modify equation (11) for the quantomobile by replacing P_T with F_T (see Figure 4), where F_T — thrust generated by the QE and applied to the frame of the quantomobile (at the QE location):

$$F_T = F_f + F_w \tag{12}$$

Before we consider changes for each component of this force balance equation upon the transition from the automobile to the quantomobile, it is useful to compare processes of generating each of the thrust forces: P_T and F_T (the left side of equations). Let us review Figure 4.

Let us note that in contrast to academic courses (where thrust emerges on the axis of the driving wheel), in our case, P_T affects the Vehicle A from the side of the suspension. First, the suspension is an important element of a wheeled mover with energy consumption for vehicle oscillations and power circulation. Second, it serves to ensure that places of such force application are identical for both vehicles under consideration.

The internal combustion engine produces the effective torque output M_e (with the implementation of the effective power N_e at a given speed) which has to undergo a series of transformations in the clutch, gearbox, differentials, transfer gearboxes, final reduction gears, shaft lines, wheels (in their complicated contact with the road) prior to formation of the P_T thrust affecting the frame (body) from the side of the suspension; in each of those links, transformations occur, causing the loss of energy and efficiency coefficient decrease (transmission — η_{tr}, driving wheels — η_{dw}, suspension — η_{susp}), depending on numerous conditions.

The diagram in Figure 4 makes it possible to trace changes in power transmitted from the internal combustion engine through the elements of the power train to the

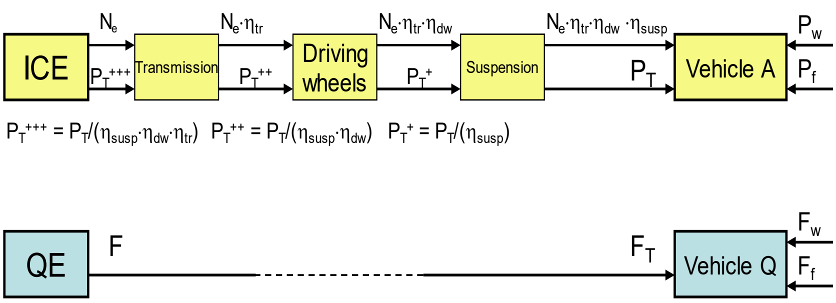

Figure 4. Diagrams of generating thrust forces for the automobile (Vehicle A) and quantomobile (Vehicle Q).

frame of the Vehicle A (in the upper connection layer). The losses are accumulated, which is analytically taken into account in the values of the corresponding efficiency coefficients. In the end, power $N_T = N_e \cdot \eta_{tr} \cdot \eta_{dw} \cdot \eta_{susp}$ is left for the implementation of Vehicle A movement. This power (at a given speed) corresponds to P_T thrust.

P_T force can be brought to the ICE crankshaft, taking into account inverse values of the efficiency coefficient of power components, namely: $P_T{+}{+}{+} = P_T/(\eta_{susp} \cdot \eta_{dw} \cdot \eta_{tr}) = P_T/\eta_{pt}$ where η_{pt} — power train efficiency coefficient.

The values of η_{tr}, η_{dw}, η_{tr} coefficients given in the following quantitative analysis were determined by the author on the basis of numerous models, including his own materials (Kotikov, 2006); the expert-based approach was also applied.

Out of seven wheel-rolling modes of the automobile (Kotikov, 2006) only the driven mode will remain for the wheels of the quantomobile. No power supply is spent on hysteresis losses in tires, work of tire/road external friction forces, interaxial and side-to-side power circulation; ventilation losses are reduced.

During the analysis, we will use the coefficient of rolling resistance of the driving wheel tire f_{tire} (Kotikov, 2006):

$$f_{tire} = P_f / Z = a_t / r_d + M_k (r_d - r_k) / (Z r_d \cdot r_k) = \frac{a_t}{r_d} + \frac{M_k}{Z r_k} \delta_w = f_{force} + f_k \quad (13)$$

where r_d — dynamic radius, r_k — kinematic radius, $f_{force} = a_t / r_d$ is a component of the coefficient f_{tire}, characterizing force losses associated with trail a_t of vertical reaction Z; $f_k = ((M_k/r_k)/Z)\delta_w$ is a component of the coefficient f_{tire}, characterizing kinematic losses associated with wheel slip $\delta_w = (r_d - r_k)/r_d$ leading to the reduction in the driving speed of the vehicle v. Coefficients f_{tire}, f_{force} and f_k are *energy, force* and *kinematic coefficients* of rolling resistance, respectively.

The value $((M_k/r_k)/Z)(r_d - r_k)) = a_k$ determines additional trail of normal reaction Z. Taking into account $(a_t + a_k) = a_{tire}$, the following can be written:

$$f_{tire} = (a_t + a_k) / r_d = ((P_{f\,force} + P_{f\,k}) / Z = \\ = \left(M_{f\,force} + M_{f\,k}\right) / Z r_k = \left(N_{f\,force} + N_{f\,k}\right) / Z v \quad (14)$$

where $P_{f\,force}$, $P_{f\,k}$, Mf_{force}, $M_{f\,k}$, $N_{f\,force}$ and $N_{f\,k}$ are force and kinematic components of the force P_f, torque M_f and power N_f of wheel rolling resistance.

As the wheel passes from the driving mode to the driven one, wheel slip virtually disappears as the values $(r_d - r_k)$, δ_w, f_k, a_k approach zero. Trail at of vertical reaction Z decreases (let us assume that it decreases by half).

During this analysis, the QE generates thrust F_T (see Figures 3 and 4; $F_T = F$). Throttling and damping functions of the QE control system — to ensure the F_T value sufficient to achieve the thrust balance according to equation (12) — are not considered yet, however, the possibility of introducing such element with account for $F_T \neq F$ is marked by a dotted line in Figure 4.

Taking into account the basic condition for comparing different options: $F_T = P_T$, the energy efficiency of quantomobile movement as compared to that of the automobile can be estimated with the use of the value $F_T / P_T{+}{+}{+}$. In other words, we can estimate how much/less the QE power can be than the ICE power to ensure required steady movement.

Let us represent aerodynamic resistance by the following well-known equation:

$$P_w = k_w \cdot F_{front} \cdot v_w^{\;2} \quad (15)$$

where k_w — wind shape coefficient, N·s²m⁻⁴; F_{front} — frontal area, m²; v_w — vehicle speed in relation to wind, ms⁻¹.

In case of the quantomobile, the following protruding parts are removed from the frontal area profile: drive axles, drive shafts, gearbox housing, muffler, fuel tank.

Aerodynamic characteristics of wheeled vehicles are greatly affected by the air flow pattern under the vehicle body. For quantomobiles and flying cars, we shall take into account reduction of losses under the vehicle body by decreasing the k_w coefficient.

Numerical example

To estimate quantomobile power characteristics compared to those of the modern car, we will consider a numerical example of comparing thrust and energy consumption by the KAMAZ-4326 truck (KAMAZ-master, 2018) (Figure 5) and the hypothetical laboratory quantomobile based on such truck (in steady movement at a constant speed of 100 km/h (27.8 m/s)).

Figure 5. KamAZ-4326 truck (participant of the Dakar Race).

The load is constant in all design cases; the total mass of the vehicle is reduced due to mass reduction upon the transition from the KAMAZ-4326 truck to the quantomobile, and then to the flying car (which corresponds to purposes of modernization).

Let us consider five design cases:

1) KamAZ-4326 truck with ICE YaMZ-7E846.10-07 — on a road with extremely low road resistance f = 0.01;

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Table 1. Comparative calculation results.

Indicator	Design cases				
	1. Automobile, ICE, f = 0.01, P_T	2. Automobile, ICE, f = 0.1, P_T	3. Quantomobile, QE, f = 0.01, F_T	4. Quantomobile, QE, f = 0.1, F_T	5. Flying car, QE F_{Tx}
G_{veh}, N	100,000	100,000	88,000	88,000	78,000
F_{front}, m^2	7.0	7.0	6.5	6.5	5.5
k_w, N·s^2/m^4	0.6	0.6	0.55	0.55	0.45
η_{tr}	0.85	0.92	-	-	-
η_{dw}	0.9	0.7	-	-	-
η_{susp}	0.97	0.9	-	-	-
η_{pt}	0.74	0.58	-	-	-
P_f, N	1,000	10,000	880	8,800	0
P_w, N	3,240	3,240	2,760	2,760	1,910
P_T (F_T, F_{Tx}), N	4,240	13,240	3,640	11,560	1,910
N_T (N_{Tx}), kW/hp	118/160	368/500	101/137	321/437	53/72
P_e+++ (F_T, F_{Tx}), N	5,730	22,830	3,640	11,560	1,910
N_e (N_{Tx}), kW/hp	159/216.5	634/862	101/137	321/437	53/72

2) KamAZ-4326 truck with ICE YaMZ-7E846.10-07 — on a road with rather high road resistance f = 0.1;

3) laboratory quantomobile based on KamAZ-4326, with a QE (instead of an ICE with conventionally the same mass), without a standard transmission, with a light-weight suspension with axle beams without a crankcase and with only driven carrying wheels, without fuel tanks and mufflers (the vehicle shall not be loaded up to the initial loading value) — on a road with road resistance f = 0.01;

4) laboratory quantomobile based on KAMAZ-4326, with a QE (instead of an ICE) with the configuration in accordance with item 3 — on a road with road resistance f = 0.1;

5) laboratory flying car based on KamAZ-4326, with a QE (instead of an ICE) with the configuration in accordance with item 3 but without supporting wheels, with a clad floor. Only horizontal directional thrust F_{Tx} (see (9) and (10)) is taken into account.

In each of the five options mentioned above, we shall achieve equal speed rates of the compared vehicles. Under this condition, we determine the difference between the required thrust forces P_T and F_{Tx}, as well as the difference between the values of the required efficient power of the ICE ($N_{e.ICE}$) and QE ($N_{e.QE}$).

Results of the calculations are presented in a summary table. In that table, G_{veh} is the mass of the vehicle with a constant load for all five options: options 1 and 2 — total mass of 10 tons; options 3 and 4 — mass reduction by 1.2 tons; option 5 — mass reduction by another ton.

Taking into account the fact that energy consumption in steady movement at a constant speed is proportional to the realizable power, it is possible to draw the following conclusions based on the table indicators. Energy consumption by the quantomobile with carrying wheels at a speed of 100 km/h is 1.5–2 times less than that of the KAMAZ-4326 truck (see the N_e (N_{Tx}) line of the table).

Energy consumption of the flying car for the horizontal component of the thrust force $\mathbf{F_{Tx}}$ is three times less than that of the truck under the lowest possible resistance of the horizontal road.

The absence of data on energy consumption for vertical suspension of the flying car (component $\mathbf{F_{Tz}}$ of thrust (9)) does not make it possible yet to compare the flying car with the truck during long-term movement under operating conditions.

Conclusion

Despite the lack of experience and statistics in the field of creation of quantomobiles in the world, the quantitative analysis of their energy consumption, in comparison with automobiles, has proved to be possible. The theory of Superunification, acting to overcome gravity and inertia forces, will undoubtedly be further developed and improved.

However, as we speak, this theory can become the basis of design methods and engineering solutions for future quantum engines and non-fuel vehicles, including ground vehicles.

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