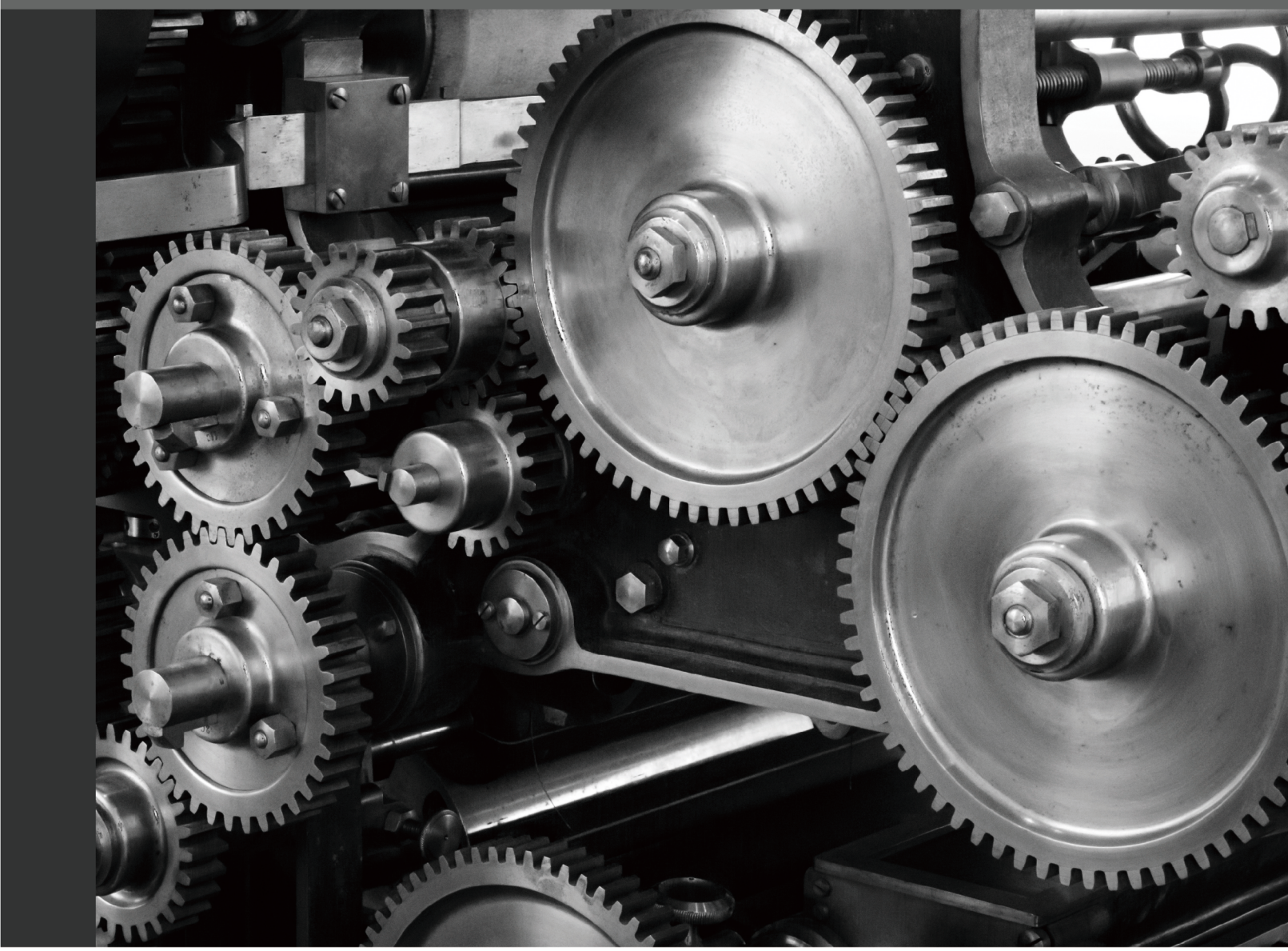
BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

02

Journal of Mechanical Engineering Research

Volume 2 | Issue 2 | September 2019 | ISSN 2630-4945 (Online)



BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Volume 2 Issue 2 • September 2019 • ISSN 2630-4945 (Online)

Journal of Mechanical Engineering Research

BILINGUAL PUBLISHING CO.

Pioneer of Global Academics Since 1984

BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Volume 2 | Issue 2 | September 2019 | Page 1-25
Journal of Mechanical Engineering Research

Contents

Article

Review

BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Journal of Mechanical Engineering Research
http://ojs.bilpublishing.com/index.php/jmer

ARTICLE

Numerical Simulation of Gear Heat Distribution in Meshing Process Based on Thermal-structural Coupling

Peixiang Xu* Yihua Cao Wensong Nie

School of Aeronautic Science and Engineering, Beihang University, Beijing, 100191, China

ARTICLE INFO

Article history
Received: 4 June 2019
Accepted: 12 August 2019
Published Online: 30 November 2019

Keywords:
Thermal-structural coupling
Transient simulation
Heat distribution

ABSTRACT

The thermal balance state of high-speed and heavy-load gear transmission system has an important influence on the performance and failure of gear transmission and the design of gear lubrication system. Excessive surface temperature of gear teeth is the main cause of gluing failure of gear contact surface. To investigate the gear heat distribution in meshing process and discuss the effect of thermal conduction on heat distribution,a finite element model of spur gear is presented in the paper which can represent general involute spur gears. And a simulation approach is use to calculate gear heat distribution in meshing process. By comparing with theoretical calculation, the correctness of the simulation method is verified, and the heat distribution of spur gear under the condition of heat conduction is further analyzed. The difference between the calculation results with heat conduction and without heat conduction is compared. The research has certain reference significance for dry gear hobbing and the same type of thermal-structural coupling analysis.

1. Introduction

With the development of machinery industry, the requirement of gear transmission is increasingly raised, and gear transmission is developing towards high speed and heavy load [1]. The friction of gear engagement will produce a large amount of heat in high power transmission with high speed or low speed and heavy load. Thus thermal deformation and thermal stress will dominate the gear stress distribution and further cause failure or pitting gear scuffing [2].Gear surface temperature is an important factor affecting the gluing of gear surface and has an important influence on the performance and failure of gear transmission [3]. Therefore, it is crucial to study the temperature field of gear surface and establish an accurate gear analysis model for the thermal design and verification of high-speed and heavy-duty gears.

Many scholars at home and abroad use different analytical methods and means to study the temperature of the contact surface of gear teeth. At present, the most influential international standards for calculating the transmission capacity of gears, such as AGMA American Gear Standard [4], have established the calculation criteria for the anti-gluing ability of the tooth surface according to the flash temperature theory of tooth surface proposed by H. Blok in 1973 [5] and the theory of partial temperature on the tooth surface proposed by H. Winter in 1975 [6]. The theoretical analysis method gives the estimated

**Corresponding Author:*
Peixiang Xu,
School of Aeronautic Science and Engineering, Beihang University, Beijing, 100191, China;
Email: 2118227284@qq.com

 DOI: https://doi.org/10.30564/jmer.v2i2.725

value of gear tooth temperature under hypothetical conditions [7], but it is not suitable for the analysis of complex practical systems. The experimental measurement technology provides the temperature value of the discrete points of the gear contact surface under the actual operating conditions[8], but the measurement technology is complex and requires special testing equipment and measuring equipment. The numerical simulation, which combines finite element analysis with theoretical calculation, can accurately solve the temperature field and heat flux distribution by establishing accurate meshing model and thermal boundary conditions, and can provide more effective means for gear meshing [9].

In order to accurately obtain the instantaneous heat of gears in meshing process, a Thermal-Solid coupling transient finite element model is established in this paper. The transient heat and heat flux of gears in meshing process are calculated by using finite element software *ABAQUS*. By comparing with theoretical calculation, the correctness of the simulation method is verified.

And the analysis theoretical method generally does not consider the heat conduction of gears when calculating the meshing heat flux density of gears,which is inconsistent with the actual situation. To discuss the effect of thermal conduction on heat distribution,subsequently the thermal conduction is added to numerical simulation,and their different behaviour will be explained in more detail later.

2. Determination of Thermal Boundary Condition

2.1 Thermal Conductivity and Heat Transfer Coefficient

The thermal conductivity is expressed as the modulus of the heat flux density passing through a unit temperature gradient, which reflects the thermal conductivity of an object. It is an important thermal physical parameter of a substance. In engineering calculation, the values of thermal conductivity of various substances applied to practical analysis are obtained by experimental measurements. Referring to the relevant literature, the thermal conductivity of carbon steel can be calculated by the following empirical formulas:

$$\lambda = 70 - 10.1C - 16.7Mn - 33.7Si \tag{1}$$

Note: In above formula, C is carbon content in steel; Mn denotes manganese content in steel; Si represents silicon content in steel.

Convective heat transfer refers to the heat transfer in the condition where fluid and solid contact directly. In calculating the temperature field of gears, the heat transfer coefficient of gears mainly depends on the operating conditions and lubrication modes. The convective heat transfer coefficients of different surfaces of gears are different, which are mainly divided into two parts: the heat transfer coefficient of tooth surface and the heat transfer coefficient of end surface. Under the condition of no lubrication, the temperature of the end surface is consistent with that of the environment, mainly considering the heat exchange between the tooth surface and the environment. For the determination of heat transfer coefficient of gear tooth surface, many scholars at home and abroad have made theoretical analysis and research on it, and summarized some empirical formulas. The computational formula of forced convection heat transfer coefficient between tooth surface and fluid is as follows[10]:

$$\alpha_i = 0.228 R_e^{0.731} p_r^{0.333} \lambda / L \tag{2}$$

Note: In the formula, R_e is the Reynolds number; P_r devotes the Prandtl number of fluid; λ presents the Thermal conductivity of fluid; L refers to the setting size of gear.

2.2 Friction Coefficient

The friction coefficient of the gear tooth surface varies with the change of speed and contact load, and is affected by the meshing position of the gear, the roughness of the tooth surface, the dynamic viscosity of lubricating oil and the average temperature of the gear [11]. For any meshing position C, the friction coefficient can be expressed as [12]:

$$\mu = 0.002\left[F_t/(b\times 0.001)\right]^{0.2} \times \left[\frac{2}{\cos\alpha\,(V_1+V_2)\,\rho_e \times 0.001}\right]^{0.2} \eta^{-0.05} X_r \tag{3}$$

Note: In the formula, F_t is the tangential load of gear meshing point; b denotes the tooth width of gear meshing point; X_r represents the tooth surface roughness factor; η refers to the dynamic viscosity of lubrication oil.

2.3 Material Property

The material used in this paper is $12CrNi4A$. Gear parameters are shown in Tables 1 and 2. The speed of driving gear is 4200 r/min, and the resistance moment of driven gear is 500 $N{\cdot}m$.

Table 1. Geometric parameters of gear

Tooth Number Z_1	Tooth Number Z_2	modulus m/mm	Center Distance a/mm	Pressure Angle α/m(°)
33	34	4	96	20

DOI: https://doi.org/10.30564/jmer.v2i2.725

Table 2. Material parameters of gear

Poisson Ratio μ	Density / (t/mm^3)	Thermal Conductivity λ_1,λ_2/(mW/(mm·K))	Specific Heat Capacity c/ (mJ/(t·K))	Thermal Expand Coefficient/ α_1/(1/K)
0.3	7.85×10^{-9}	30.98	0.5×10^{-9}	1.3×10^{-5}

3. Theoretical Calculation of Gear Friction

This paper uses the finite element software *ABAQUS* to simulate the gear friction heat. In order to compare the correctness of the results, the theoretical formulas for calculating the friction heat generation in gear meshing are given below.

3.1 Calculation of Gear Sliding Speed

Tangential velocity of gear contact point is affected by angular velocity and meshing point position. As shown in Figure 1, the relative sliding speed of each point on the meshing line is different. Tangential velocity of driving and driven gears can be expressed as:

$$v_{t1} = v_{k1}\alpha_{k1} = \omega_1 r_{k1}\sin\alpha_{k1} = \omega_1\overline{N_1K}$$
$$v_{t2} = v_{k2}\alpha_{k2} = \omega_2 r_{k2}\sin\alpha_{k2} = \omega_2\overline{N_2K}$$

Then the relative motion velocity of gears:

$$v_{21} = v_{t2} - v_{t1} = \omega_2\overline{N_2K} - \omega_1\overline{N_1K} = (\omega_2+\omega_1)\overline{CK}$$

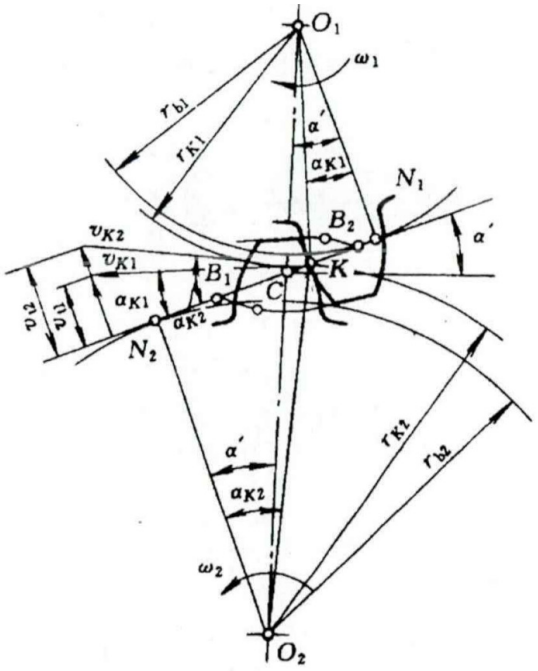


Figure 1. Gear meshing relative motion model

According to the calculation, the tangential velocity of the meshing point are obtained shown as Figure 2

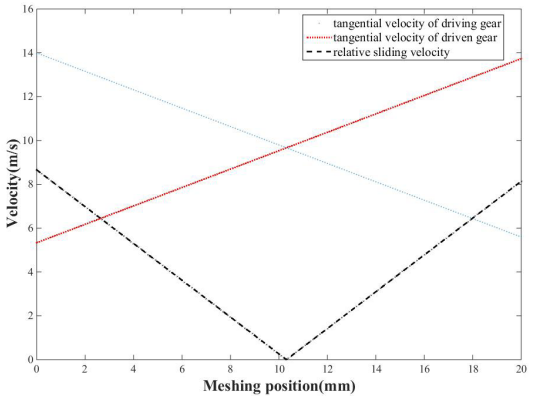


Figure 2. Relative motion velocity of gears

3.2 Heat Flux Distribution

The friction heat per unit time per unit area produced by the gear meshing (i.e. density of heat flow rate) is as follows:

$$q = \frac{1}{J}p_e\mu v \tag{4}$$

In the formula, q is the total friction heat flux density; J denotes thermal work equivalent; p_e presents average contact pressure of the tooth surface; μ refers to surface friction coefficient; v is relative sliding speed of the tooth surface.

Assuming that the heat distribution coefficient is ψ ,the friction heat of big gear and small gear is respectively:

$$\begin{cases} q_1 = \psi q \\ q_2 = (1-\psi)q \end{cases} \tag{5}$$

Thermal distribution coefficient ψ is expressed as [13]:

$$\psi = \frac{\sqrt{\lambda_1\rho_1 c_1 v_{t1}}}{\sqrt{\lambda_1\rho_1 c_1 v_{t1}} + \sqrt{\lambda_2\rho_2 c_2 v_{t2}}} \tag{6}$$

In the formula, λ_1、λ_2 are the thermal conductivity of the material for two transmission gears, ρ_1、ρ_2 denotes the density of the material for two transmission gears, c_1、c_2 present the specific heat capacity for two transmission gears, v_{t1}、v_{t2} refer to the tangential velocity at the meshing point for two transmission gears.

Thermal distribution coefficient ψ shows the heat flux distribution rules of master-slave gears at each meshing point shown as Figure 3. The gear with large tangential velocity at meshing points have larger distribution coefficient and can be allocated more heat. And at the picth line where their tangential velocity are equal,they have the same distribution coefficient. To compare with numerical

 DOI: https://doi.org/10.30564/jmer.v2i2.725

simulation conclusion,the friction heat flux of driving gear by theoretical calculation method is displayed on Figure 4.

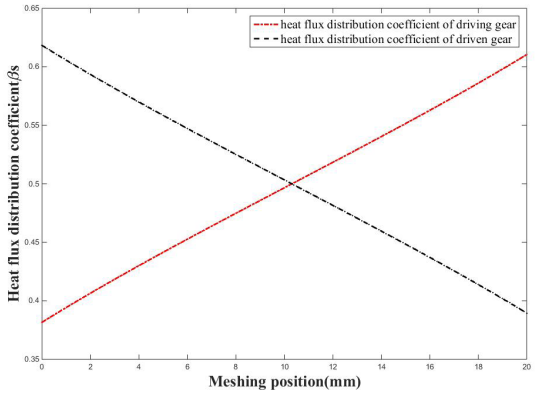


Figure 3. Heat flux distribution coefficient(Ψ) of gears

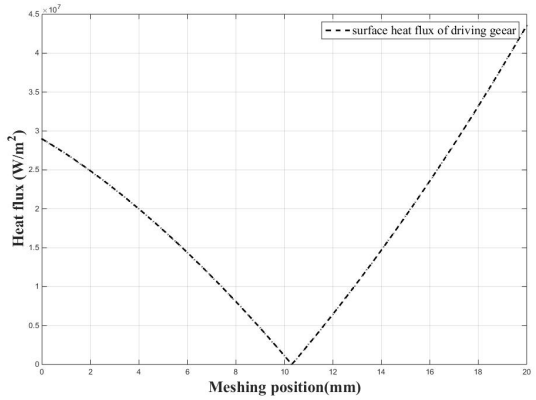


Figure 4. Friction heat flux of driving gear

The above analysis shows the following results: (1) The heat flux density at the pitch line is zero, because the relative sliding velocity at the pitch line is zero. (2) The heat flux of the driving gear is higher than that of the driven gear. The main reason is that the driving gear has fewer teeth and higher speed, and produces more heat per unit time. (3) The heat flux density at the root of the driving gear and driven gear exceeds that at the top of gears. (4) Heat production and heat distribution formulas do not involve heat conduction within gears and heat exchange between gears and environment.

4. Finite Element Simulation

4.1 Basic Equation

Because of frictional heating and plastic deformation,the gear temperature increases during in rotating. The thermal conduction equation with internal heating will be employed as follows:

$$\frac{\partial}{\partial x}\left(k_x\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(k_y\frac{\partial T}{\partial y}\right)+\frac{\partial}{\partial z}\left(k_z\frac{\partial T}{\partial z}\right)+\dot{q}=\rho c\frac{\partial T}{\partial t}$$

where $\dot{q}$ is the internal heat intensity, ρ is the density, c the specific heat,and k_x, k_y, k_z are the thermal conductivity in the x, y and z directions,respectively.

If $k_x = k_y = k_z = k$,and the k is constant,then

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}+\frac{\dot{q}}{k}=\frac{1}{\alpha}\frac{\partial T}{\partial t}$$

Where $\alpha = k/\rho c$ is the heat conduction coefficient.

4.2 Pretreatment Stage

First of all, the standard spur gear geometrical model with 33 and 34 teeth numbers in UG (Unigraphics NX) is established and subsequently discretized in Hypermesh. The minimum size of the grid is $1mm$, and the number is 500 thousand. The grid element adapts “temperature-displacement coupling” thermal element C3D8RT: “An8-node thermally coupled brick,trilinear displacement and temperature,reduced integration”.

Subsequently,material properties are assigned to model as shown in Table.2. Release only Y-direction rotation constraint on gears. The boundary conditions choose convection and heat transfer with air and setting room temperature $20^{\circ}C$. Meanwhile,setting “power, temperature-displacement, display” analysis steps,driving wheel speed $4200r/\min$, driven wheel resistance moment $500N\cdot m$. The finite element mesh model of gear meshing.

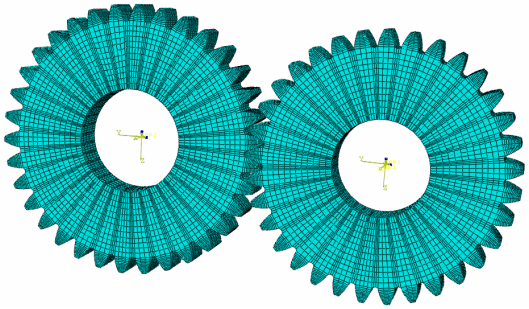


Figure 5. Finite element mesh model of gear meshing

Because the theoretical calculation method does not consider the influence of heat conduction and thermal expansion, in order to facilitate the comparison and ensure the correctness of simulation results, the gear meshing model simulation is divided into two parts: not considering heat conduction and considering heat conduction.

4.3 Simulation Results without Heat Conduction

The calculation results of meshing temperature field of spur gears without heat conduction are shown in Figure 6

DOI: https://doi.org/10.30564/jmer.v2i2.725

and Figure 7. Figure 6 and Figure 7 are the simulated temperature nephogram of the whole model when the calculation is completed. In order to study the temperature time history of the gear tooth surface, the temperature-time history curves of three points near the root, top and boundary are respectively extracted, as shown in Figure 8.

From Figure 6 Figure 7 and Figure 8, it can been seen that: (1) No heat is generated at the pitch line and the temperature remains constant at room temperature. (2) The temperature increases gradually along the two sides of the pitch line away from the pitch line and reaches the maximum at the root and the top of the tooth. (3) The temperature of the root of the tooth is higher than that of the top of the tooth, which is consistent with the trend of theoretical calculation. (4) Without heat conduction, the temperature could not be transmitted after the gear meshing is completed, and remains unchanged until entering the next meshing. Therefore, the temperature-time curve of the gear surface presents a "ladder" growth trend.

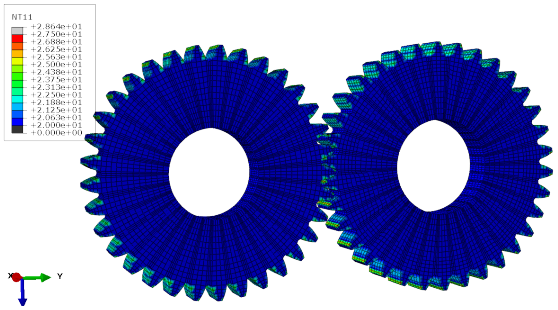


Figure 6. Temperature nephogram of friction heating

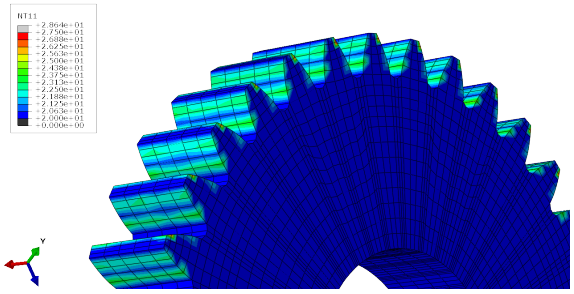


Figure 7. Temperature nephogram of drivinggear

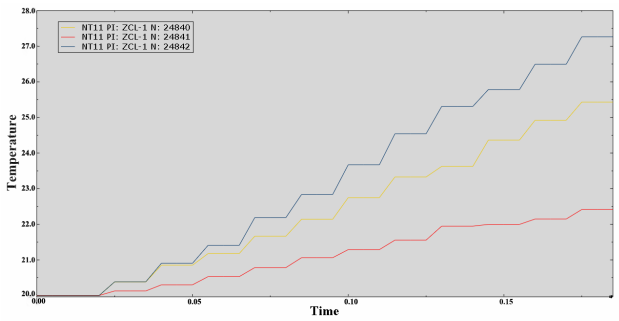


Figure 8. Temperature time history curve of meshing area

By further extracting the surface temperature-time diagram of a certain gear tooth of the driving wheel, and obtaining the surface heat flux of the driving gear through conversion, and then the finite element simulation results are compared with the theoretical calculation results, as shown in Figure 9.

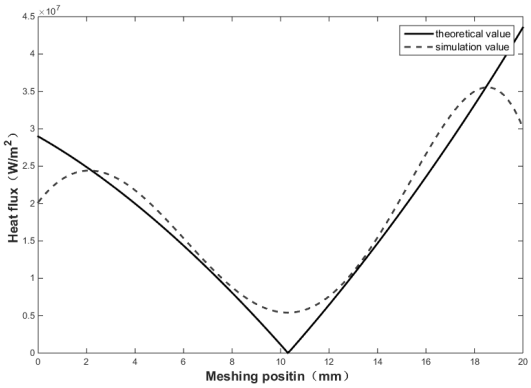


Figure 9. Heat flux diagram of driving gear tooth surface

The comparison of the curves shows that the simulation results are in agreement with the theoretical analysis. The heat flux reaches the maximum value at the root and top of the teeth, and the minimum one at the pitch line. The biggest difference lies in the root and top of the teeth. It is mainly because of the deviation while contacting, which makes the simulation value deviate from the calculation value slightly.

4.4 Simulation Results with Heat Conduction

In actual working conditions, heat conduction exists in the material, which has a certain influence on the temperature distribution of gears. Therefore based on the above simulation, heat conductivity is added to observe the change of tooth surface temperature and its trend with time.

Figure 10 and Figure 11 are transient temperature simulation nephogram of gears with heat conduction. Friction heat flux mainly distributes in meshing area. Similarly, selecting the elements near the top, root and pitch line as the example of analysis, the temperature time history curves of three points are shown in Figure 12.

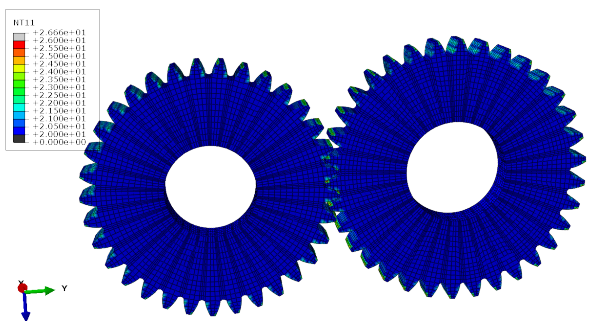


Figure10. Temperature nephogram of friction heating

DOI: https://doi.org/10.30564/jmer.v2i2.725

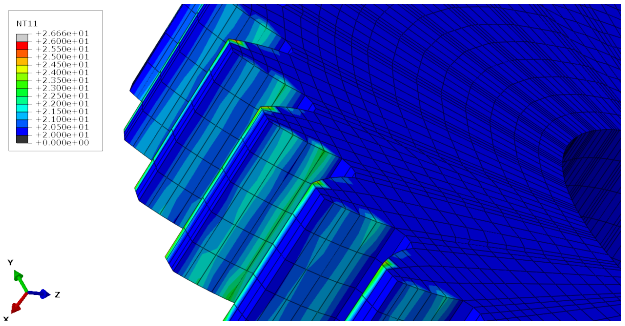


Figure 11. Temperature nephogram of driving gear

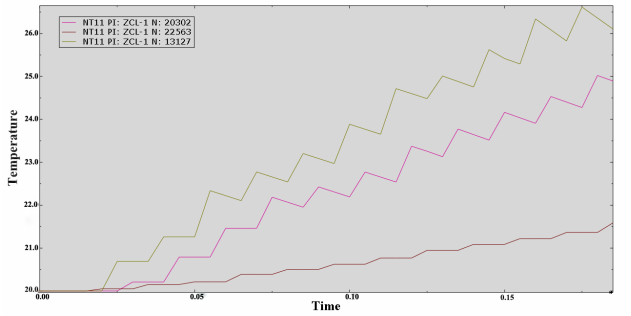


Figure 12. Heat flux diagram of driving gear tooth surface

Comparison of temperature distributions with and without heat conduction shows that: (1) During the same meshing period, the temperature variation of the model with thermal conductivity is smaller than that without thermal conductivity; (2) Because of the existence of heat conduction, the temperature of the model with thermal conductivity increases in the meshing area, and it decreases gradually in the non-meshing area, showing a "zigzag" growth trend as shown in Figure12, while the model without thermal conductivity presents a "ladder" trend in Figure 8; (3) Because of the existence of thermal conductivity, the heat transfer from the tooth surface to the inner and tooth width, and the temperature in the middle of tooth width is slightly higher than that at the edge of tooth.

5. Conclusion

While calculating the heat flux on the meshing surface of gears by analytic method, the influence of heat conduction and expansion is not taken into account, and the results are idealized. Numerical simulation can more truly simulate the situation and take all kinds of factors into consideration. Thus numerical simulation on gear heat flux distribution in meshing process based on thermal-structural coupling analysis technique is apparently expected and it is increasingly paid to attention.

Finite element analysis of gear meshing based on thermal-structural coupling in this paper shows that the temperature distribution of meshing tooth surface is basically symmetrical along gear pitch line. When considering heat conduction, the temperature conducts towards the tooth edge and internal structure, and the intermediate temperature of tooth structure is slightly higher than the temperature on the side surface of tooth.

Because the heat generated by each meshing is equal, but when the thermal conductivity is added, the heat generated by the meshing friction of the gear will be transferred to the internal direction, the direction of tooth width and the direction of tooth height. Therefore, the temperature in the meshing area will decrease. So the trend of the temperature-time curve with the thermal conductivity model increases first and then decreases, showing a "zigzag" shape, while the non-thermal conductivity model shows a "ladder" shape.

References

[1] Tsay C B, Fong Z H. Computer simulation and stress analysis of helical gears[J], Mechanism and Machine Theory, 1991, 26(2): 145-154

[2] Yang Shuzhen, Dong Bin. Thermal-structural coupling analysis of planetary gear set based on Workbench[J]. Manufacturing Automation, 2015, 37(12): 75-76+96

[3] Han Yuyong, Han Wen, Di Ruimin. Gear surface gluing phenomenon and its prevention[J]. China Science and Technology Information, 2009 (01): 126+128

[4] AGMA. Gear Scoring Design Guide for Aerospace Spur and Helical Power Gears, 217.01, AGMA, 1965

[5] Blok, H. Theoretical study on temperature rise at surface of actual contact under oiliness lubrication conditions[C]/Proceeding of the General Discussion on Lubrication & Lubricants, 1937, London, UK. London: IME, 1937: 222-235.

[6] Winter, H; Michaelis, K. Freβsrsgfhigkeit von Stirnrdgetrieben. Antriebstechn. 14(1975): 405.

[7] Terauchi Y, Mori H. Comparison of theories and experimental results for surface temperature of spur gear teeth[J]. Transactions of the ASME, Journal of Engineering for Industry, 1974, 96(1): 41-50

[8] Long H, Lord A A, Gethin D T, et al. Operating temperatures of oil-lubricated medium-speed gears: Numerical models and experimental results[J]. Journal of Aerospace Engineering, 2003, 217(2): 87-106

[9] S. Stark, M. Beutner, F. Lorenz, et al. Heat Flux and Temperature Distribution in Gear Hobbing Operations. Procedia CIRP, 2013, 8: 456-461,

[10] C.Z.O Popiel and L.Boguolawski. Load Heat-Trans-

DOI: https://doi.org/10.30564/jmer.v2i2.725

fer Coefficient on the Rotating Disk in Still Air[J]. Journal of Heat Mass Transfer,1975, 18: 167-170.

[11] Longhui, Zhang Guanghui, Luo Wenjun. Analysis and Simulation of instantaneous contact stress and temperature of rotating gears[J]. Journal of Mechanical Engineering, 2004 (08): 24-29. (in Chinese)

[12] Handschuh R F, Kicher T P. A method for thermal analysis of spiral bevel gears [J]. Transactions of the ASME, Journal of Mechanical Design, 1996, 118(4): 580-585.

[13] Deng G, Kato M, Maruyama N, et al. Initial temperature evaluation for flash temperature index of gear tooth[J]. Transactions of the ASME, Journal of Tribology, 1995, 117(3): 476-481.

 DOI: https://doi.org/10.30564/jmer.v2i2.725

BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Journal of Mechanical Engineering Research
http://ojs.bilpublishing.com/index.php/jmer

REVIEW

The Change and Prospect of "Automobile Electromechanical Maintenance Skills Competition" under the Chinese Model

Jianguo Feng*

Sichuan Vocational And Technical College of Communications, chengdu,sichuan, 611130, China

ARTICLE INFO

Article history
Received: 9 August 2019
Accepted: 28 August 2019
Published Online: 30 November 2019

Keywords:
Automobile
Electromechanical maintenance
Skill contest
Change
Development

ABSTRACT

This paper analyzes the origin, status, changes and characteristics of the automotive electromechanical maintenance skills competition in China, and presents the developing trend in the future.

1. The Origin of Automotive Electromechanical Maintenance Skills Competition in China

With the advancement of China's reform and opening up, China's automobile industry has also developed rapidly in the 1990s, and the performance and high-tech content of automotive products have been significantly improved. As the use of automotive products, its performance will gradually decline, and the service life will be gradually shortened. In order to maintain the car's good performance and technical conditions and extend the service life of the car, the maintenance of automotive products has become an issue of public concern. The auto repair industry practitioners quickly changed from early single mechanical maintenance and electrical maintenance to mechatronics maintenance, that is, electromechanical maintenance. The occupational capacity and skill level of automotive electromechanical maintenance practitioners also became an urgent problem to be solved. The Ministry of Education recognizes that this is a matter of national prosperity so it take immediate measures to deal with it. For example, learning the "three-element system" in Germany, introducing the "TEAM 21" tutorial from Toyota, and organizing domestic experts to analyze and construct the knowledge system of such occupations as well as to promote and advance the level of professional skills by holding vocational skill competitions. In July 2007, the "First National Secondary Vocational School Automobile Application and Maintenance Skills Competition (Toyota Cup) [1] was successfully held by the Ministry of Education, FAW Toyota Co-organizer and Chongqing Industry Polytechnic College. Since then, the "Auto Maintenance Skills Competition" has been launched in China. In November 2009, it was spon-

**Corresponding Author:*
Jianguo Feng,
Sichuan Vocational And Technical College of Communications, chengdu,sichuan, 611130, China;
Email: 296001254@qq.com

DOI: https://doi.org/10.30564/jmer.v2i2.1123

sored by the Transportation Vocational Education Teaching Steering Committee,the first national transportation vocational college "FAW Toyota Cup" automobile maintenance skill competition was held in Chengdu, Sichuan province [2], which opened a new chapter in such kind of competition.

2. The Current Situation of Automotive Electromechanical Maintenance Skills Competition in China

2.1 Types and Holding Methods of Automobile Electromechanical Maintenance Skills Competition

Nowadays there are various kinds of automotive electromechanical maintenance skills competition in China, and its organizational form and participants have changed a lot.

Classified in accordance with the mode of organization and the scope of the participants: There is a skill competition within the unit, which is sponsored by an independent unit and aimed at holding the vocational skill competition among the internal personnel; There are county-level regional skill competitions, organized by county-level administrative departments. These competitions are designed for personnel (students or in-service employees) of relevant units within the administrative area; There are provincial-level skill competitions, organized by provincial administrative departments. These competitions aim for personnel of relevant units within the administrative area of the province. Due to the large number of participants and the long competition time, such competitions usually allocate fixed quota to each region and then conduct provincial-level competitions; There are national-level skill competitions, organized by the administrative departments of the relevant ministries and commissions of the state. These competitions involve relevant personnel from all over the country, such competitions will also allocate fix quotas of the participating teams to the provinces and municipalities directly under the Central Government, and then conduct national-level competitions. There are world-class skill competitions, which are undertaken by the state and are aimed at professional skill competitions involving people from the same industry around the world. Such competitions are also required to allocate the number of teams to all participating countries and then conduct competitions on the host countries.

Classification from the participants, there are two major categories: student skill competitions and in-service employee skill competitions. The skill competition for students in school is organized by the administrative department of education so as to evaluate and improve the teaching quality, encourage students to be more interested in their profession; The in-service employee skill competition consists of two types: the teaching skill contest of the professional teachers in and the automobile maintenance skill competition of the front-line employees. Such kind of competitions usually organized by the the internal organization of the unit or local industry associations and trade union organizations.

2.2 The Changes of Automobile Electromechanical Maintenance Skill Contest Competition

In July 2007, the competition for the first secondary vocational student auto repair skill competition was divided into two types: individual project and group project: the personal project is the basic skill competition for automobile maintenance, that is, the inspection of engine parts, including the dismantling and installation of the cylinder head of Toyota 5A engine, the inspection of engine cylinder wear and the fault diagnosis of the electronic control system of Toyota Vios engine; The group project is a two-person joint maintenance project for Toyota Vios Auto for 40,000 kilometers [3]. In November 2009, the first vocational high school student auto repair skill competition included two practical projects, one was the disassembly and repair of the A340E automatic transmission, and the other is to diagnose and eliminate the fault diagnosis of automotive power modules (including engine electronic control system and automatic transmission control system) [4]. Nowadays, whether it is a skill contest for students in school or a skill contest for in-service employees, the form of the competition has changed from simple content to fault diagnosis of complex control systems in vehicles [5].

2.3 The Characteristics of the Automotive Electromechanical Maintenance Skills Competition

Nowadays China's Automotive Electromechanical Maintenance Skills Competition presents the following characteristics:

(1) A wide range of participants with a large number of participants. In a county-level administrative region, there are dozens or even hundreds of enterprises engaged in automobile maintenance business, and hundreds or thousands of employees engaged in mechanical and electrical maintenance. If each enterprise sends 1 or 2 people to participate in the competition, there will be more than 100 people in each competition. If a provincial motor maintenance skill contest is held for employees, the number of participants can be imagined. Therefore, this kind of competition is also called a "skills contest for millions of workers in * regions". For the students in the school, the motor vehicle

 DOI: https://doi.org/10.30564/jmer.v2i2.1123

maintenance skill contest is held at least in the administrative region of the local urban area, besides the intra-school competition, and then at the provincial level and the national level. As far as Sichuan Province is concerned, there are as many as 222 schools with automobile specialty, of which 56 secondary vocational schools with automobile specialty are established under the direct management of Sichuan Human Resources and Social Security Department, and 166 higher schools with automobile specialty are established under the direct management of Sichuan Education Department [6]. This shows that the number of students participating in each skill competition is large.

(2) Each competition will cost a lot of manpower and financial resources so these competitions are often sponsored by companies or government authorities.Each competition will spend a lot of manpower and financial resources, often enterprises sponsor the competition or the competent government departments allocate special funds to support the competition. As mentioned above, owing to the large number and wide range of participants, it is time-consuming, laborious and costly to organize a skill competition. In order to solve this outstanding problem, in the early skills competitions, enterprises often provide equipment sponsorship, technical support or financial support, and crowned with the "×× Cup" skills competition. Nowadays, with the enhancement of national strength and the prosperity of the industry, the competent government departments often allocate special funds for competitions to support competitions, such as those organized by local trade unions. The skills competition for millions of employees and the competition organized by the competent departments of the people's and social sciences. Skills Competition for Secondary Vocational Students and Competition organized by the competent department of Education College Students Skills Competition, etc.

(3) The top contestant will finally stand out after strict selection, earnest assessment.High-level competitions need to select contestants from the middle level of low-level competitions, and ultimately determine the level. Because of the large number of participants, wide range, time-consuming, laborious and money-consuming in each competition, in order to avoid lengthening the front and reducing the fairness of the competition, the measures of allocating the number of participants first and then concentrating the competition are often adopted to organize the competition. First of all, the low-level competition screens the Lady, and then in the high-level competition to select the best, ranking.

(4) The setting of each competition event fully reflects the will of the expert team in the organizer and the contractor, and request wich the technical method in the competition is the only feasible way. Through the competition, we can check the skill level of the competitors in certain aspects of automobile maintenance and repair, and it is the only way to select the person with ability. Several factors should be considered in the setting of events: (A) the equipment conditions provided by the organizers; (B) whether most of the participating units have the equipment designated by the organizers; (C) what the organizers and the expert teams of the organizers intend to let the competitors compete, which reflects the will of the expert teams; (D) whether the organizers have the equipment designated by the organizers. In order to check the regularity and rationality of the players' maintenance operation, the team of experts should consider that the players can only adopt the only feasible path to complete the competition operation when setting the content of the competition, and not solve many problems (or can not complete the same maintenance and inspection work in many ways).

For example, in the basic skills of mechanical and electrical maintenance, the project of "engine cylinder wear detection" should be set up. It is necessary to check whether the athletes can use measuring tools regularly, whether the process of testing operation is reasonable, and whether they can read measuring tools quickly and accurately. Correct and reasonable operation specifications should be as follows:

(a) Check whether all the preparatory items are in place, including cloth, maintenance and inspection work sheet, measuring tools (vernier calipers, micrometers, internal diameter scale), workpiece to be tested (engine cylinder block and work bench), etc.

(b) Use clean cloth to clean the workpiece (engine cylinder to be tested) and measuring tool.

(c) Check and align the "zero" or "zero marking" of vernier calipers.

(d) Use vernier calipers to measure the diameter of cylinder head of the cylinder to be measured (the measuring position is shown in Figure 1). Fill the readings in the inspection work sheet quickly and accurately, and lock the vernier calipers temporarily, place them reasonably on the workbench and wait for use.

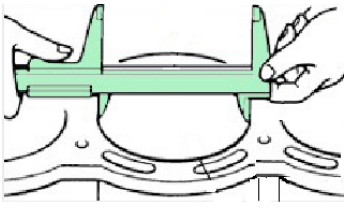


Figure 1. Measuring the diameter of cylinder head with vernier caliper

(e) Assemble the inner diameter scale and make sure

DOI: https://doi.org/10.30564/jmer.v2i2.1123

that the length of the measuring rod in free state is 0.5-1.0 mm larger than that measured by vernier caliper. The correct form after assembling is shown in Figure 2.

Figure 2. Internal Diameter Scale Assembled

(f) Calibrating the "zero position" of the micrometer, even using the standard measuring rod to calibrate the reference reading of the micrometer, the method of calibrating the micrometer is shown in Figure 3, and then using the readings measured by the vernier caliper as the basic size to set the reading of the micrometer and calibrate the length of the micrometer to measure the rod.

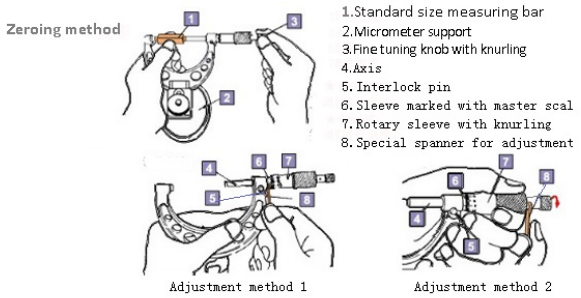


Figure 3. Zero-calibration method of micrometer

This shows that the above steps of (e) and (f) can be interchangeable without harming elegance and ultimately will not affect the detection accuracy.

(g) The assembled inner diameter gauge is placed in the micrometer which has set the basic size, and the percentage indicator of the inner diameter gauge is zeroed, that is to say, the percentage indicator is aligned with the "0" marking of the dial. The calibrated percentile state of the inner diameter gauge is shown in Figure 4.

Figure 4. Percentimeter status after calibration of internal diameter scale

(h) The calibrated inner diameter gauge is put into the cylinder to be tested according to the method shown in Figure 5. When the inner diameter gauge pointer is in the most shrinking position, the indicator reading is read and recorded in the maintenance and inspection work sheet.

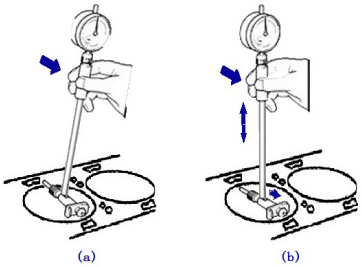


Figure 5. Correct method of inserting inner diameter gauge into cylinder

(i) After all the test data are obtained, the whole contest test work will be completed by calculating and perfecting the work order.

It is worth noting that when the inner diameter gauge is put into the cylinder for testing, the upper, middle and lower detection sections should be determined correctly, and each section should be measured at least one point in two measuring reference directions. That is, the crankshaft axis direction and transverse direction (perpendicular to the crankshaft axis direction). Usually the upper section is 10-15 mm away from the cylinder head (the upper plane of the cylinder block), the middle section is in the middle of the cylinder, and the lower section is 10-15 mm away from the bottom of the cylinder. In order to improve the accuracy of locating the maximum wear position in the cylinder, each measuring reference direction of each section should be deflected from right to left at a certain angle (15 to 20 degrees is appropriate), and the maximum reading is used as the measurement value in this direction.

For example, in the comprehensive troubleshooting of automotive mechanical and electrical maintenance, the power assembly, active safety (including braking and lighting) and comfort system (air conditioning) are set up. Mainly examines the contestants from the acceptance of work tasks, to the fault detection, diagnosis, elimination of the whole process of work ideas. For on-the-job employees, they should independently complete all the tasks of contest maintenance. For the students in school, three groups are often used to complete the task of competition maintenance. One of them is responsible for fault diagnosis and maintenance work flow (train of thought), and the other two cooperate with the implementation of the task of fault detection, diagnosis and elimination.

It is also worth mentioning here that in the course of the competition, the actual operators and report writers

 DOI: https://doi.org/10.30564/jmer.v2i2.1123

lack on-site communication, and the evaluation of the report is a separate referee, which is also not on-site. Therefore, there are some limitations in the evaluation of the team's overall performance.

There are many technical details on the issues discussed above, which will not be elaborated here.

(5) Any competitor is not only an individual, but also a team. The team includes competitors, coaches, logisticians and so on. Every competing team wants to be successful in the competition, so the level of performance of the competitors in the competition reflects the level of the competing team from one side. The following questions will be reflected by the contestants in the end.

(A) The attention, concern and support of the leaders of the units are indispensable to the success of the participating teams in the competition. If the leader only delivers the target task with a caring attitude, usually less than on-site supervision or care, it will inevitably affect the morale of the coaches and competitors as a whole team, then the winning ticket will not be grasped. Leaders should not only pay attention to their concern, but also to their peripheral work. They should probe into the interior of the formulation of the technical plan of the competition and make good relations so that they can obtain first-hand materials than other teams, or even lead the formulation of the technical plan, and even understand the composition of the referee team and other important information.

(B) The selection of coaches is a key link to achieve the goal. This requires leaders to have a deep vision, a clear understanding of the autumn, be good at learning horses from Bole, and employ people appropriately.

Those who can be selected as coaches must also possess the following basic qualities:

(a) Only with a high degree of Ideological and political awareness can we recognize the importance of achieving the goals and tasks.

(b) Only with a strong sense of responsibility and mission can we carefully study the technical documents of the competition in the coaching work, tighten every small link, tighten the wonderful string of "details determine success or failure", and regard the completion of coaching work as the current historical mission.

(c) Only by possessing excellent professional accomplishment and knowing how to teach and what to teach, can we not disgrace our mission.

(d) To have a noble sense of teachers' morality, to cultivate and educate people as their own responsibility, to accomplish the task of the target task first, and to form a good mentor-friend relationship with the players, coaches and players all want to think about one place, strive for one place, and ultimately can be invincible.

(C) The selection of competitors is the most important link in the overall work of the competition. The selection of players can be carried out in many ways, forming a echelon construction mechanism within the unit, making the selection of players a benign mode of operation. First, the principle of voluntariness, in line with the basic requirements of the competition (such as age, length of service) in the collection of volunteers to fill in; secondly, individual recommendation, unit leaders, colleagues according to the usual assessment and observation can recommend potential personnel to the ranks of competitors; thirdly, the preliminary screening of personnel to do the corresponding. Basic knowledge testing, and stratified training, so that players firmly rooted, and gradually grow. At the same time, the selected competitors should also have corresponding qualities, such as broad national feelings, love for the motherland and home, sober understanding and ideological awareness of the correct relationship between everyone and family, confidence and determination to obey command, to be able to fight and to win in battle, good physical quality and automobile opportunities. Electrical maintenance is also a very hard work to test the physical fitness and endurance of practitioners. Therefore, players preparing for battle should strengthen physical exercise and strengthen their health consciousness.

(D) Logistics support system and the staffing of security personnel are also important links that can not be ignored in the formation of participating teams. In the logistic support system, we should fully consider the supply and replenishment of materials and consumables needed in training, and also consider the incentive measures to the team, to solve the worries of the participants, and to promote all members to advance bravely, overcome difficulties and finally achieve brilliant victory.

(E) Each contest will have two major events: theoretical test and skill contest. Therefore, contestants are required to have solid theoretical foundation and excellent skill level.

(F) First, second and third prizes will be set up in every competition. Usually the first prize accounts for 10% of the teams (or players), the second prize for 20% and the third prize for 30%.

(G) The original intention of each competition is competition style (team cooperation spirit, execution level of members), competition quality (whether the competitors can reflect the quality consciousness of customer first, safety production first, product quality first) and competition level (whether the competitors have a certain degree of comprehensiveness in mastering relevant knowledge or not). Width and depth, race skills (competition competitors in vehicle maintenance skills in the normative and

DOI: https://doi.org/10.30564/jmer.v2i2.1123

proficient level, etc.).

3. The Future Development Trend of Automotive Mechanical and Electrical Maintenance Skills Competition in China

Throughout the above-mentioned motor vehicle mechanical and electrical maintenance skills competitions, relevant technical documents will be issued before the competition, and the setting of the events and the scope of the competition will be limited to a certain extent. In my opinion, there are still considerable limitations, which is not conducive to the real selection of outstanding talents or large-scale craftsmen. Therefore, the future automotive electromechanical maintenance skill contest will be normalized in order to comply with the requirements of the 20 articles of the State Council vocational education. Competition will be organized by a third party to'... Invitational tournament or'... Challenge competition can be organized in the form of students and staff competing on the same platform. The pre-competition technical documents only mention the scope and basic requirements, and do not mention specific event settings. Relevant personnel within the organizer of the competition do not participate in any competition, and the organizer or the main responsible person should comply with the People's Republic of China. The confidentiality law [8] restricts the completion of the relevant work, and can not be related to the interests of any participating units and competitors, ultimately ensuring the openness, fairness and fairness of the competition.

4. Summary

Although the form of motor vehicle maintenance skill contest is various, the core of the contest is to promote the improvement of professional level and skill ability of motor vehicle maintenance and testing posts, and to play an active role in the development and growth of China's automobile maintenance industry, in shaping the position of technical experts and craftsmen in the industry, and in revitalizing the motherland. Effect. In order to truly reflect the selection and reuse of talents, a more fair and just competition mode will be adopted.

Referrences

[1] Department of Education, Faculty and Staffing Office. Notice on Holding the "Toyota Cup" Automobile Application and Maintenance Skills Competition for the 2007 National Secondary Vocational Schools, 2007, 4.

[2] China Communications News, the first national transportation vocational college "FAW Toyota Cup" student car repair skills competition, 2009.11.09.

[3] Technical documents of the first national secondary vocational school student auto repair skill competition in 2007 by the Ministry of Education.

[4] Traffic Class Higher Vocational College Automobile Professional Teaching Steering Committee 2009 First National Transportation Vocational College "FAW Toyota Cup" Student Car Maintenance Skills Competition Technical Document.

[5] 2019 National Higher Vocational College Auto Maintenance Skills Competition Document.

[6] Sichuan teach letter, 2019, 122.

[7] Notice of the State Council on Printing and Distributing the Implementation Plan for the Reform of National Vocational Education, Guofa, 2019, 4, referred to as 20 Vocational Education, The People's Republic of China Secrecy Law, 2019.

[8] The People's Republic of China Secrecy Law 2019.

 DOI: https://doi.org/10.30564/jmer.v2i2.1123

BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Journal of Mechanical Engineering Research
http://ojs.bilpublishing.com/index.php/jmer

ARTICLE

Research on Ecological Assessment and Dynamic Optimization of Energy-saving and New Energy Vehicle Business Model Based on Full Life Cycle Theory

Peipei Chao[1*] Yisong Chen[2] Yanping Yang[3]

1. China Automotive Engineering Research Institute Co., Ltd, Chongqing, 400000, China
2. School of automobile, Chang'an University, Xi'an, Shanxi, 710064, China
3. Mechanical College of Hunan University, Changsha, Hunan, 410082, China

ARTICLE INFO

Article history
Received: 31 October 2019
Accepted: 5 November 2019
Published Online: 30 November 2019

Keywords:
Life cycle assessment theory
Energy-saving and new energy vehicles
Technical route
Business model
Dynamic optimization

ABSTRACT

The rapid development of China's automobile industry has brought ever-increasing impact on resources, energy and environment, the energy-saving and new energy vehicles come into being accordingly. This article firstly systematically introduces the technical route of energy-saving and new energy vehicles of China, focusing on the key bottleneck problems arising from the construction process of current assessment system of the technical route for energy-saving and new energy vehicles, establishes the energy-saving and new energy vehicle business model assessment index system afterward based on the comparative analysis on energy-saving and new energy vehicle business assessment model and the full life cycle theory, and finally makes prospects and forecasts on vital problems of system boundary, dynamic optimization, simulation system of full life cycle assessment of energy-saving and new energy vehicle.

1. Introduction

Confronted by increasingly tight energy security and deteriorating ecological environment, countries adopt differentiated technical routes in different fields of energy-saving and new energy vehicles. In the face of the differentiated technical routes, how to evaluate the technical route of energy-saving and new energy vehicles is significant. In addition, as an emerging sector of strategic importance, energy-saving and new energy vehicles represent the important development direction of future vehicles, and business model innovation plays a crucial role in the leapfrog development of new energy vehicles. In the context of intensifying competition and growing business models in the energy-saving and new energy vehicle industry, evaluating the business model of energy-saving and new energy vehicles is expected to provide useful policy reference for government departments in facilitating business model innovation, and promoting long-term healthy and stable development of the industry.

At present, life cycle assessment of vehicles is common at home and abroad. For example, in 1996, Volkswagen AG [1] for the first time completed the full life cycle energy consumption and emission analysis of a Golf car, providing an important reference for the research of vehicle life cycle assessment. Daimler AG [2] began to issue environment evaluation certificates for each model in 2009, covering the environmental impact from material production to scrap recycling. German Volkswagen, Daimler, BMW, GM, Volvo, Honda, Toyota and other world-renowned auto groups [3]

**Corresponding Author:*
Peipei Chao,
China Automotive Engineering Research Institute Co., Ltd, No.9, Jinyu Avenue, Liangjiang New District, A205, Chongqing, 400000, China;
Email: chaopeipei@caeri.com.cn

DOI: https://doi.org/10.30564/jmer.v2i2.1363

conducted life cycle studies on their new cars and released relevant life cycle environmental impact assessment reports. Huang Zhijia et al. [4] established a vehicle fuel life cycle assessment model based on overseas studies. In terms of life cycle assessment of auto parts and finished vehicles, Wang Shoubing et al. [5] studied the energy consumption and environmental emissions of traditional gasoline cars of China during the whole life cycle. Xu Jiefeng [6] established the life cycle assessment model of radial tyres and evaluated the whole life cycle. Chen Xiaoru et al. [7] proposed a green manufacturing mode with the life cycle assessment of parts and components as the main technical route.

In recent years, business model study has also gained widespread attention from the academic circles. For example, Wang Yuning et al. [8] (2005) divided business models into three types: R&D enterprise-led, operation enterprise-led and government-led type, and then compared and analyzed these three types. Ye Ruike et al. [9] (2010) conducted studies from the perspectives of economy and technology, and proposed the commercialization path of new energy vehicles from the perspectives of public policy, technology development and fundamental guarantee. Ye Qiang and Wang Hewu [10] (2012) put forward suggestions for the construction of business model of new energy vehicles from the perspective of system theory, and drew a roadmap for the commercialization and promotion of new energy vehicles in China.

From the above, although there are many studies on life cycle assessment and business model of energy-saving and new energy vehicles at home and abroad, most of them only focus on a single aspect and thus cannot reasonably evaluate the entire ecosystem from technical route selection to commercial operation of energy-saving and new-energy vehicles. Based on the life cycle theory, this paper analyzes and solves the key problems of energy-saving and new energy vehicles, and establishes a reasonable technical route evaluation system, and then summarizes and compares the existing business models, and finally puts forwards a complete and systematic evaluation system. Through the dynamic combination of technical route life cycle assessment and business model life cycle assessment, it is feasible to realize dynamic evaluation and optimization of the wholes system of energy-saving and new energy vehicles, which can provide a reference for China to scientifically formulate the development direction of its energy-saving and new energy industry.

2. Assessment Method

2.1 Definition of Objectives and Scope

At present, LCA method is widely used to quantify the impact related to energy and material consumption and environmental emissions of a product or service during its life cycle. With the help of LCA, we can comprehensively understand the impact of various aspects of a product or service and seek actions to reduce the aforesaid negative impact. Based on the LCA method theory, the paper innovates and extends the method so that it not only stays at the product level, but also focuses on the life cycle impact assessment of energy-saving and new energy vehicles. In this way we can seek effective actions to optimize the negative effects of the whole system dynamically based on the research and analysis of key problems.

This paper aims to provide reference for the optimization allocation of technical resources in the automobile industry and technology R&D under industry-university-research cooperation, provide direction for the R&D department of automobile enterprises, and provide reference for the scientific formulation of business model development direction of China's energy-saving and new energy industry . This paper firstly divides the whole ecosystem of energy-saving and new energy vehicles into two subsystems, namely, technology planning of and business model of energy-saving and new energy vehicles. Among them, technology planning of energy-saving and new energy vehicles also includes the raw materials acquisition stage, parts manufacturing stage and assembly stage of vehicle production; the business model of energy-saving and new energy vehicles also includes vehicle operation and use stage and scrap recycling stage. The system boundary is shown in Figure 1.

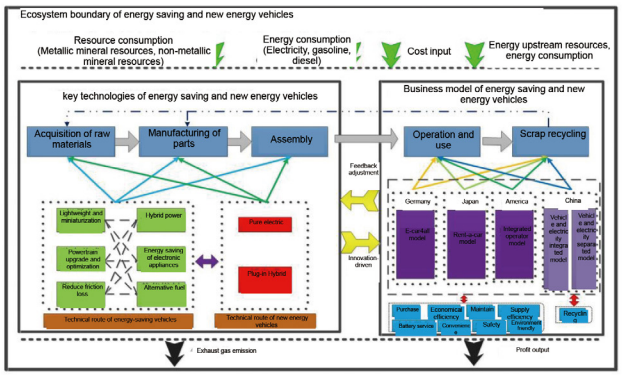


Figure 1. Ecosystem boundary conditions of energy-saving and new energy vehicles

2.2 Assessment Objects and Functional Unit

It is crucial for life cycle assessment to select appropriate assessment objects which determine whether the assessment result is representative and accurate. The assessment objects of this paper is extended to energy-saving

 DOI: https://doi.org/10.30564/jmer.v2i2.1363

and new energy vehicles of various technical routes.

Based on the above boundary conditions, the functional unit is extended into the whole life cycle of energy-saving and new energy vehicles from driving on China's roads through to scrapping through various business models under various technical routes.

3. Technical Route of Energy-Saving and New Energy Vehicles

3.1 Overview of Technical Route of Energy-saving and New Energy Vehicles at Home and Abroad

In terms of energy-saving vehicle technology, Japan primarily popularizes the technical route of "miniaturization + hybrid", and will energetically develop the optimization of gasoline engine with natural aspiration and multi-speed AT, DCT and other technologies. In the future, the United States will implement the technical route of "engine optimization + transmission upgrading + electronic and electrical energy saving + hybrid power", comprehensively develop energy-saving technology, and achieve the goal of fuel economy regulations. The fuel economy standard in Europe is very rigor. At present, Europe implements the technical route of "clean diesel engine + 48V system", and it is expected to develop multi-speed transmission, low friction and other technologies in the future. In general, foreign countries follow the technical path of taking advanced electronics & electrical appliances, optimized power assembly and the vigorous development of miniaturization and hybrid vehicles as the energy-saving skills.

In terms of new energy vehicles, the United States follows the technical route by taking the development of electric vehicles (mainly hybrid) as the supplement and the exploitation of "bioethanol + biodiesel" as the main. The hybrid technology in Japan has been very mature, and the plug-in vehicles that the typical representative is Toyota Prius plug-in hybrid are developed rapidly based on it. Represented by Audi A6e-tron and BMW 530Le, the development of plug-in hybrid in Europe is relatively mature. In conclusion, the development of international electric vehicles mainly takes into account lightweight, reliability, intelligence and battery safety, and incompletely concentrates on improving driving range. Plug-in hybrid electric vehicle is mainly to improve the efficiency of hybrid engine, showing the trend of more compact coupling mechanism, integrated control unit, consideration of power performance and safety, as well as the coexistence of special engine to high compression ratio, high thermal efficiency value and lightweight multi-technical route.

According to the current development status of energy-saving and new energy vehicles, in order to achieve the goal of reducing fuel consumption, China has implemented the overall path of paying equal attention to structure and technology, advanced electronic and electrical technology to support the optimization and upgrading of hybrid power assembly, and development of alternative fuel vehicles when it comes to energy-saving vehicles. The overall technical path of new energy vehicles mainly takes into account electric vehicles (EV) and plug-in hybrid electric vehicles (PHEV), as shown in the figure 2 below.

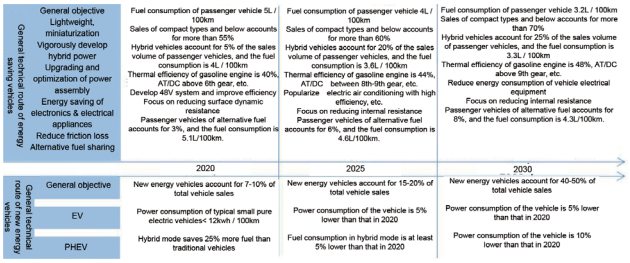


Figure 2. Overall technical route of energy-saving and new energy vehicles

As can be seen from Figure 2, the energy-saving technologies of passenger vehicles in China are mainly concentrated in six major paths.

Lightweight and miniaturization. vigorous development of hybrid vehicles, optimization and upgrading of power assembly, energy-saving of electronic & electrical appliances, reduction of friction loss, and sharing of alternative fuels. The overall route of new energy vehicles is mainly embodied in two main paths: pure electric and hybrid.

The general technology roadmap of energy-saving vehicles is subdivided into traditional power passenger vehicles, hybrid power passenger vehicles and alternative fuel passenger vehicles for description, as shown in the following figure 3.

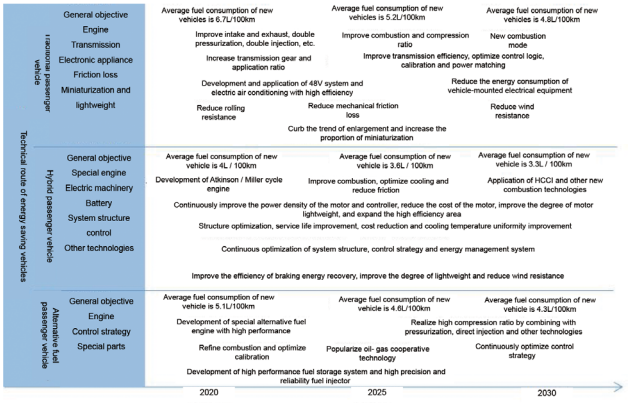


Figure 3. Technology roadmap of energy-saving vehicles

In the field of energy saving of traditional power passenger vehicles, it mainly concentrates on five aspects.

DOI: https://doi.org/10.30564/jmer.v2i2.1363

Engine: develop advanced intake and exhaust technology, and turbocharged direct injection technology to improve thermal efficiency in the preliminary stage. In the medium stage, twin turbo, GDI + PFI double injection and other technologies will be developed to improve the compression ratio. In the later stage, HCCI and other combustion technologies are developed, and electronic control logic is continuously optimized. Transmission: development of multi-speed automatic transmission and continuous optimization of transmission control logic and calibration, so as to optimize the matching with the engine and improve combustion efficiency. Electronic & electrical appliances: the 48V system is adopted to reduce the energy consumption of the vehicle. On this basis, electric air conditioning and other technologies are developed to continuously reduce the electric energy loss of the vehicle-mounted electrical equipment. Friction loss: low rolling resistance tyres are adopted in the first place, oil with low viscosity is adopted to reduce friction loss in the second place, and wind resistance coefficient is mainly reduced in the end. Miniaturization and lightweight: effectively limit the trend of enlargement and increase the proportion of compact vehicles.

In the field of hybrid passenger vehicles, five parts are placed particular emphasis. Special engine: at present, such special engines as Atkinson / Miller cycle are mainly developed to improve combustion level and reduce friction, and HCCI technology is adopted to improve compression ratio. Motor: the efficiency of drive motor is improved through miniaturization, lightweight, winding improvement and other ways, and carry out the goal of high power density and reasonable price in different stages. Battery: gradually reduce the weight and volume of battery in different stages, and finally achieve the goal of boosting power density and life, reducing cost and boosting the homogeneity of cooling temperature. System structure control: continuously optimize the hybrid system structure and battery control strategy, and combine with the intelligent network technology in the middle and later stage to dynamically optimize the power system and reduce energy loss. Other technologies: focus on the development of special transmission in the early stage, continuously improve the efficiency of special coupling mechanism and braking energy recovery, and gradually reduce the quality and wind resistance coefficient.

In the field of alternative fuel passenger vehicles, it focuses on three major paths. Engine: in the near future, it is necessary to focus on the development of special engines for alternative fuels. In the middle and later stages, it is necessary to combine advanced pressurization and intake and exhaust technologies to achieve high compression ratio. Control strategy: continuously optimize vehicle control strategy, and refine combustion and oil-gas collaborative technology to boost combustion efficiency based on fuel characteristics. Special parts: at present, the focus is on the development of high-performance fuel storage system. In addition, the exception is to accelerate the development of such special parts as nozzles with high reliability and high precision, so as to improve the overall performance of the vehicle.

The overall technical route of new energy vehicles is subdivided into EV and PHEV, as shown in the following figure 4.

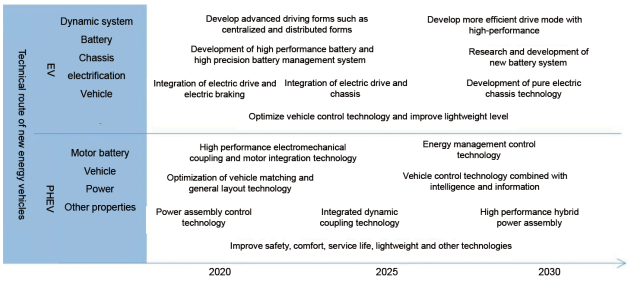


Figure 4. Technology roadmap of new energy vehicles

It can be seen from Figure 4 that the technical route of EV in China focuses on chassis and power system. In the aspect of chassis, it is necessary to research the technology of electric drive, electric braking system, integrated design of chassis system in the preliminary stage to finally realize the integrated design of chassis, so as to improve the performance of the vehicle. In the aspect of power, it mainly focuses on the research of driving forms, especially the research and development of high-performance driving system, and drive motor with high-efficiency and high specific power in the middle and later stage. System integration and optimization technology, improve vehicle control technology, research new materials and new structures, and form large-scale production capacity of the vehicle. Energy management system is the research emphasis, and the high-performance battery and high-precision battery management system shall be developed to optimize control strategy, so as to improve vehicle energy efficiency.

The PHEV is still in the preliminary stage of industrialization in China, and there is a big gap compared with the PHEV with foreign advanced level in terms of reliability and driving smoothness. In terms of power assembly, the focus is to research the electromechanical coupling mechanism with compact structure and high transmission efficiency, and develop the motor with high-performance, as well as the technology of coupling mechanism and motor integration. At the same time of

 DOI: https://doi.org/10.30564/jmer.v2i2.1363

researching and developing the power system, it is necessary to carry out matched research on the power control system and other auxiliary functions, such as driver intention recognition, fuel control, management strategy of system efficiency, etc., so as to realize the optimal control of the vehicle. In addition, in order to improve safety, comfort and prolong service life, technologies such as remote fault diagnosis and high-precision energy management system shall be developed.

3.2 Application of Life Cycle Assessment in Technical Route Analysis of Energy-saving and New Energy Vehicles

3.2.1 Key Problems of Boundary Division

By sorting out the technical route of energy-saving and new energy vehicles, the evaluation system boundary includes the production stage of raw materials, parts manufacturing and assembling stage of energy-saving and new energy vehicles. Through the evaluation of the three stages of technology item and typical technology combination of energy-saving and new energy vehicles, the life cycle analysis of technical route subsystem of energy-saving and new energy vehicles is completed. As shown in Figure 1 above.

3.2.2 Key Problems of System Modeling

According to the idea of full life cycle assessment of "from cradle to gate", a life cycle dynamic evaluation model of technical route subsystem of energy-saving and new energy vehicles from raw material acquisition to vehicle production is constructed, which is based on the dynamic model of linear matrix algorithm and nonlinear system dynamics, and can carry out accurate LCA evaluation and calculation. The demonstration data of different technology item and typical technology combination substitute into the evaluation model for calculation. Based on the calculation results, a scientific and systematic solution can be provided for enterprises to achieve the goal of energy saving and emission reduction. The key problems of system modeling are shown in Figure 5.

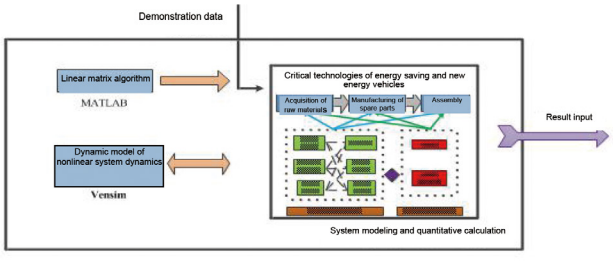


Figure 5. Key problems of system modeling

3.2.3 Key Problems of System Development

By taking technical route subsystem of energy-saving and new energy vehicles as research object, based on the dynamic model of life cycle assessment, and the use of Simulink simulation module of MATLAB platform, a optimization and simulation system of technical route of energy-saving and new energy vehicles is constructed according to the characteristics of technology item and typical technology combination of various energy-saving and new energy vehicles. The system can carry out scenario simulation and optimization and simulation on various technology items and typical technology combinations, which is an upgrading, extension and innovation of traditional life cycle assessment methodology.

4. Energy-saving and New Energy Vehicle Business Models

4.1 Summary of Energy-saving and New Energy Vehicle Business Models

At present, typical overseas business models include e-car4all model in Germany, time-based sharing mode in Paris, France, rent-a-car mode in Nagasaki, Japan, Tesla Model in the U.S.A. and so on.

The demand of markets at different layers should be considered in the innovation of electric vehicle business models in China. The electric vehicle use models include leasing and purchasing; the energy supply models include battery charging and replacing models. At present, many domestic cities actively explore the business operation models of electric vehicles and obtain the following typical business models by arrangement and combination of leasing, purchasing, replacing and charging: i.e. Potevio Financing & Leasing Model in Shenzhen, battery leasing and replacing model in Hangzhou, directional purchasing mode in Hefei, etc.

The analysis of advantages and disadvantages of all models is shown in Table 1.

In the field of public transport, the "quick charge" mode in Chongqing can be promoted. At present, the leasing mode is mainly adopted in the taxi field and private car field. The leasing mode includes financing leasing, time-based leasing, complete vehicle leasing, vehicle (without battery) + battery leasing, etc. Because the time-based leasing mode is cheaper and more convenient than the traditional leasing mode, it will become more convenient and flexible after becoming into large scale. Therefore, it is easily promoted in private car field. At present, the financing leasing mode is widely used in taxi field. However, in the future, the time-based leasing mode may

DOI: https://doi.org/10.30564/jmer.v2i2.1363

Table 1. Comparison of main business models at home and abroad

Business model		Main characteristics	Payment	Ownership	Subsidies	Applicable scope
(Germany) e-car4all model		The company or organization provides 24h convenient services to the fixed users or members. The renting is rapid and the management is convenient. Only one smart card is required. The vehicle utilization rate is high.	The user pays the management person the rent based on use time and driving mileage.	What the user buys is the right to use the car. The ownership entirely belongs to the manager.	——	Only being leased in demonstration city
(Japan) rent-a-car model		The advanced intelligent management system has high information transfer efficiency and convenient management; the division of works of government, agents, distributors, leasing companies and end users is clear. The risks are effectively shared.	End users or taxi passengers pay rent or taxi fees; agencies pay commissions to local committees.	The ownership entirely belongs to local committee.	The state government grants the subsidies to local committee to introduce the electric vehicles and PHEV.	Leased
(U.S.A.) Integrated operation model		The integration operator is executor and the government is mainly responsible for supervision and management. Functions of all bodies are clear.	The buyer pays vehicle fees.	The vehicle ownership entirely belongs to the buyer.	The government grants subsidies to technology R&D persons and battery buyers	Private vehicle and leased
(China) Vehicle and battery integration	**Complete vehicle sales**	The purchase cost pressure is high and the vehicle use risks are high.	The buyer pays vehicle fees.	The vehicle ownership entirely belongs to the buyer.	The government directly grants subsidies to the buyer.	
	Complete vehicle operating lease (Time-based leasing and long-term leasing)	The leasing company establishes an operation network and is responsible for the daily charging and maintenance of vehicles.	The lessee pays certain rent to the leasing company based on driving mileage or time.	The ownership belongs to the leasing company	——	Private vehicle and leased
	Complete vehicle financing leasing	The leasing company acts as an agency and is responsible for maintenance of faults not caused by human factors. It effectively transfers all risks and rewards related to the ownership of assets.	The lease term and lease fees are determined based on ROI of this business of the leasing company.	Consumers can get the car free of charge after the car rental period reaches the period specified by the leasing company.	Subsidies from governments at all levels belong to the leasing company.	Leased
(China) Vehicle and battery separation	**Vehicle (without battery) operation leasing + battery service**	The financial leasing company purchases vehicles (without battery) to provide vehicle (without battery) rental services, and the charging facility operator purchases batteries to provide charging services.	The lessee pays the rent of vehicle (without battery) and charging service fee.	Vehicle (without battery) and battery belong to corresponding leasing companies.	——	——
	Vehicle (without battery) financing leasing + battery service	The charging facility operator cooperates with the financial leasing company to provide the financing leasing services of vehicle (without battery) to the enterprise. It can effectively reduce the financial pressure of enterprises.	Charge the principal and interest in installments at the level not higher than the loan interest rate of the bank in the same period. The payment is changed from lump sum to payment in 8 years. The charging service fees shall be paid.	After the expiration of the term, the vehicle (without battery) belongs to the lessee.	——	Public transport and municipal services
	Vehicle (without battery) sales + battery operation leasing	Only the vehicle (without battery) is purchased. The battery is purchased by the professional battery leasing company and leased to the consumers. It can reduce the purchasing costs. As time goes on, consumers will pay less and less for replacing the battery.	After paying a certain amount of deposit to the leasing company, when the battery runs out, the lessee can replace the battery in the battery replacement outlet by paying the charging fees and battery depreciation based on the driving mileage.	The vehicle (without battery) belongs to the buyer and the battery belongs to the leasing company.	——	——

 DOI: https://doi.org/10.30564/jmer.v2i2.1363

be promoted. As for the private directional purchasing mode, due to its simple market, it is more suitable for the consumers who have fixed routes and need single purpose. In order to expand the market, multiple vehicle models should be developed to adapt to wider consumer groups.

4.2 Research on Assessment Indicators of Energy-saving and New Energy Vehicle Business Model

4.2.1 Construction Idea of Assessment Indicator System

On the basis of analysis of connotation of energy-saving and new energy vehicle industry business models, combining the life cycle assessment method, based on the thought from source to recovery, the assessment indicator system shall be constructed in aspects of vehicle, electricity and battery, purchase, use, maintenance and recovery, economic efficiency, convenience, safety and environmental friendliness, etc., as shown in Figure 6.

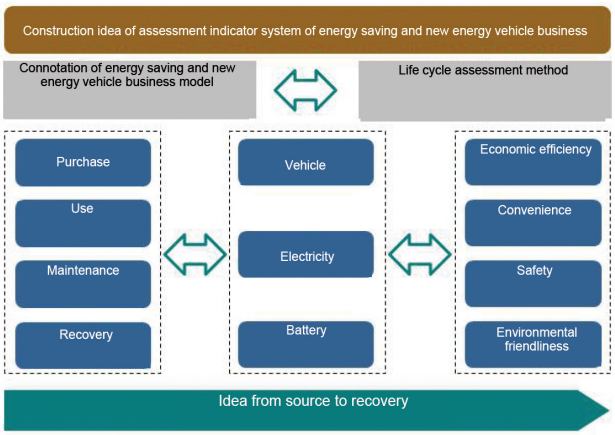


Figure 6. Construction idea of assessment indicator system of energy-saving and new energy vehicle business model

4.2.2 Composition of Assessment Indicator System

The assessment indicator system constructed based on connotation of energy-saving and new energy vehicle business model and full life cycle assessment method mainly includes two levels, i.e. first level indicators and second level indicators. The first level indicators include internal and external elements of enterprise operation in energy-saving and new energy vehicle business model. The second level indicators are further explanation and description of all elements. Finally, the indicator system shown in Table 2 is constructed to assess the energy-saving and new energy vehicle business model.

Table 2. Assessment indicator system of energy-saving and new energy vehicle business model

	First level indicator	Second level indicator
Energy-saving and new energy vehicle business model	Main structure	Production costs of vehicles
		Electricity supply efficiency
		Battery service
	Consumption cycle	Purchase
		Use
		Maintenance
		Recovery
	Use performance	Economic efficiency
		Convenience
		Safety
		Environmental friendliness

The main structure is assessment of production costs of vehicles, electricity supply efficiency and battery service from the perspective of energy-saving and new energy vehicle product structure. The consumption cycle involves the whole consumption process of energy-saving and new energy vehicles ranging from purchase, use, maintenance to final recovery. The performance is a key element concerned by consumers and can measure consumers' using feeling and satisfaction, including economic efficiency, convenience, safety, environmental friendliness and other performance indicators.

4.3 Application of Life Cycle Assessment in Research on Assessment of Energy-saving and New Energy Vehicle Business Models

4.3.1 Combination of System Boundary and Assessment Indicators

It can be known from assessment indicators of energy-saving and new energy vehicle business models that the system boundary includes manufacturing stage, use stage and recovery stage of energy-saving and new energy vehicles. The assessment indicator in manufacturing stage is production costs of vehicle. The assessment indicators in use stage are electricity supply efficiency, battery service, purchase, use, maintenance, economic efficiency, convenience, safety, environmental friendliness, etc. The assessment indicator in recovery stage is recovery. As shown in Figure 1.

4.3.2 Combination of System Modeling and Quantitative Calculation

Based on the life cycle assessment idea from production "from gate to regeneration" to scrap, the life cycle dynamic assessment model for typical energy-saving and new energy vehicle business model sub-system shall be built. The model is a dynamic model based on linear matrix algorithm and nonlinear system dynamics. Accurate LCA assessment calculation can be carried out. Substitute the empirical data of business models of different enterprises

DOI: https://doi.org/10.30564/jmer.v2i2.1363

into the assessment model for calculation. The calculation result can provide the scientific and systematic solutions for realizing the energy saving and emission reduction objective of an enterprise. The system boundary and quantitative modeling are shown in Figure 7.

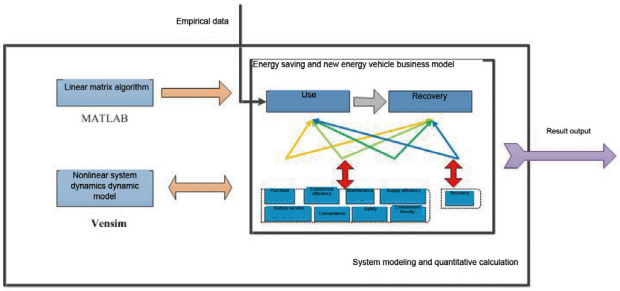


Figure 7. System modeling and quantitative calculation

4.3.3 Combination of System Development and Assessment System

The energy-saving and new energy vehicle business model sub-system is regarded as the research objective. An energy-saving and new energy vehicle business model optimization and simulation system is constructed by combining the assessment indicator system of energy-saving and new energy vehicle business model, based on life cycle assessment dynamic model, by utilizing Simulink simulation module on MATLAB platform and considering the characteristics of energy-saving and new energy vehicle business models. The system can simulate and optimize many kinds of business models, and it is also the extension and innovation of traditional life cycle assessment methodology.

5. Conclusions

Through the research on assessment of ecological benefits of the whole ecosystem of energy-saving and new energy vehicle technical routes as well as business model based on life cycle theory, the following results are mainly obtained:

The energy-saving and new energy vehicle technical routes in China are summarized. The passenger vehicle energy-saving technologies in China mainly have 6 routes, i.e. lighter and smaller, vigorous development of hybrid vehicles, optimization and upgrading of powertrain, energy saving of electronic and electrical products, reduction of friction loss, and alternative fuels. The general new energy vehicle technical path mainly includes PEV and PHEV.

The typical energy-saving and new energy vehicle business models at home and abroad are analyzed and advantages and disadvantages of all business models are compared. It can be seen that "vehicle and battery separation, financing leasing and real-time monitoring" mode is applicable to public transport and municipal services and other fields in uniform procurement; in public transport field, the "quick charge" model in Chongqing can be promoted. The leasing model is mainly adopted in taxi field and private car field.

The establishment of system boundary and life cycle dynamic assessment model for energy-saving and new energy vehicle technical routes and business model full life cycle assessment, the development of assessment indicator system and optimization simulation system of energy-saving and new energy vehicle business model as well as key factors influencing the assessment are researched so as to carry out scenario simulation and optimization simulation of the influence of multiple technology items and typical technology combinations in multiple business models. The business models are driven by innovation of technical routes and the technical routes are adjusted based on the dynamic feedback of business model. It is the upgrade and innovation of traditional life cycle assessment methodology and can provide the scientific and systematic solution to realize the energy saving and emission reduction objective of an enterprise.

References

[1] Schweimer G W, Schuckert M. Life Cycle Inventory of a Golf[R]. Germany: Volkswagen AG, Wolfsburg, 1996.

[2] Weiss M A, Heywood J B, Elisabeth M. Drake, et al. On the Road in 2020- A life-cycle analysis of new automobile technologies.pdf[R]. Energy Laboratory, 2000.

[3] TOYOTA. Prius Environmental Declaration[R]. Europe: Toyota Motor Corporation, 2009.

[4] Zhijia Huang, Xu Zhang. Model of Life Cycle Assessment of Vehicle Fuel [J]. Journal of Tongji University (Natural Science), 2003, 31(12): 1472-1476.

[5] Shoubing Wang, Hui Dong, Rusong Wang, et. al. Energy Consumption and Emission Characteristics of A Model of Chinese Car [J]. Journal of Fudan University (Natural Science), 2006, 45(3): 328-334.

[6] Jiefeng Xu. Research on Life Cycle assessment of Radial Tyre. [D]. Northwest University, 2010.

[7] Xiaoru Chen, Xiang Li, Haibo Dong, et. al. Green Manufacturing of Auto Parts based on Life Cycle Assessment [J]. Environmental Engineering, 2015, 33(12): 116-120.

[8] Yuning Wang, Xiaojie Lan, Jing Leng, et. al. Re-

 DOI: https://doi.org/10.30564/jmer.v2i2.1363

search on Comparison of Electric Vehicle Business Operation Models SAIC Motor, 2005(6): 6-8.

[9] Ye Ruike, Ou Wangbin, Lyu Chenrong, Jianqiang Bao. Research on Electric Vehicle Business Models based on Economic and Technical Analysis [J]. Future and Development, 2010(11): 31-35.

[10] Qiang Ye, Wang Hewu. Theoretical Thinking on Electric Vehicle Business Model System [J]. Forum on Science and Technology in China, 2012(01): 44-48.

[11] Li Shuhua. Life Cycle Analysis and Environmental Benefit Assessment of Electric Vehicles [D]. Jilin University, 2014.

[12] Changling Zhang, Tonghui Wang, Hongsong Yang. Advantages of Business Model Innovation of New Energy Vehicle Industry in China [J]. Auto Industry Research, 2013(9): 34-35.

[13] Bo Zhang. Research on B2C Business Model Assessment [D]. Harbin University of Science and Technology, 2009.

[14] Qing Ye, Hewu Wang. Theoretical Thinking on Electric Vehicle Business Model System [J].Forum on Science and Technology in China, 2012(01): 44-48.

[15] Jianqiu Li, Chuan Fang, Liangfei Xu. Research Status and Development of Fuel Cell Vehicles [J]. Journal of Automotive Safety and Energy,2014(01):17-29.

[16] Xiaoxiao Liu, Guohai Lian. Research on Commercialized Operation Models of Electric Vehicle Charging Facilities [J].Hunan Electric Power, 2011(01): 59-62.

[17] Zicong Xie. Analysis of Commercial Energy Supply Model of Electric Vehicles [J]. Electric Bicycle, 2010(06): 5-6+21.

[18] Hao Su. The battery replacement business model is a rapidly developed solution for electric vehicles in fuel shortage and low carbon economy [J].Economic Vision, 2011(04): 49-50.

[19] Jian Liu. Preliminary Exploration of Electric Vehicle Charging Modes and Business Operation Models [J]. Auto Engineer, 2011(01): 19-23.

[20] Ruike Ye, Xiumiao Chen, Fangsiyu Zhu, Wang Li. Research on "Electric Vehicle-Internet of Vehicles" Business Model [J]. Journal of Beijing Institute of Technology (Social Sciences Edition), 2012(06): 39-44.

[21] Yingqi Liu, Jingyu Wang, Ari Kokko. Electric Vehicle Demonstration Operation Policy and Business Model Innovation: Experience in the World and Practice in China [J]. China Soft Science, 2014(12): 1-16.

DOI: https://doi.org/10.30564/jmer.v2i2.1363

BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Journal of Mechanical Engineering Research
http://ojs.bilpublishing.com/index.php/jmer

REVIEW

The Results of Research to Determine the Parameters of Hardening Working Area of the Gin and Linter Grates

Mirsolikh Agzamov Rakhmatov Mashkhur Bakhtiyarovich Mirkhosil Mirsalikhovich Agzamov*

Department of Technological Machines and Equipment, Tashkent Institute of Textile and Light Industry, Tashkent, Republic of Uzbekistan

ARTICLE INFO

Article history
Received: 31 October 2019
Accepted: 5 November 2019
Published Online: 30 November 2019

Keywords:
Cotton fiber
Processing of raw cotton
Cotton ginning
ginning machine
Gin and linter grates
Quenching of grates
Steel grates
Hardening with high frequency current (HFC)

ABSTRACT

The article provides substantiation of the choice of the quenching parameters for the working zone of gin and linter grates and the quenching parameters. The results of bench and industrial tests of the grate with a hardened working zone are also given.

1. Introduction

Modern and new business conditions require a constant reserve search productivity growth declines operational costs and cost products, release competitive products. Due with this current value It has improvement of technology and technology of processing raw cotton, ensuring high quality fiber, preserving him natural properties and reduce the loss of strand fiber with waste.

Earlier studies have found that one of the main reasons for reducing the natural properties of fiber is the unfavorable state of the technological surfaces of the working bodies of machines interacting with processed cotton [1]. It leads to destruction and to a decrease in fiber length, to mechanical damage and reduce their strength to growth defects and the content in the pulp fluff.

This in turn leads to a decrease in the spinning properties of the fiber, manifested in an increase in breakage in the spinning industry, a decrease in the strength of the yarn and the quality of the fabric produced, which causes significant losses in the textile industry.

The number of the most consumed spare parts in the

**Corresponding Author:*
Mirkhosil Mirsalikhovich Agzamov,
Department of Technological Machines and Equipment, Tashkent Institute of Textile and Light Industry, Tashkent, Republic of Uzbekistan;
Email: agzamov85@mail.ru

 DOI: https://doi.org/10.30564/jmer.v2i2.1574

process of cotton preprocessing includes gin and linter grates. The annual need of the industry is more than 100 thousand of gin and 200 thousand of linter grates. Grate undergoes rapid deterioration in the due to the friction of them drank and fibrous material. The working area of currently used cast iron grates is bleached in order to increase wear resistance. But, at the same time due to the shortcomings of the bleaching process, hardens mainly the "bed" of the grates and only partly, quickly wearing out, the lateral surface and this reduces their service life.

Experience of using steel grate by making proxy steel 45 based on the application of methods rolling with subsequent machining on machine tools gave good results. But they had one major drawback - rapid wear during operation due to the lack of heat treatment.

2. Materials and Methodology

Studies have shown that the most optimal of ways enhance durability of steel grate bars is an surface hardening of the working area.

Currently in engineering applied high-frequency heat treatment for products with a hard, wear-resistant surface layer and a relatively soft and viscous core.

Due to a significant decrease in the tendency to brittle fracture, achieved during the transition from through to surface hardening, increasing the tolerance limits of hardness and resistance to wear.

The second advantage of quenching with surface heating is a significant reduction in strain. during heating and cooling achieved by the stiffness of the cold core.

The third advantage is the almost complete elimination of decarburization, which, while reducing the strain, in some cases, allows the hardening of finally finished parts without grinding.

When superficial hardening, applied for the manufacture of grates of steel grade 45, it is possible to obtain a hardness HRC 58-62. However, fluctuations in the composition of the steel, quenching modes, as well as the need for self-tempering or tempering to crack cracks, lead to the lower the permissible limit of hardness in practice it may be understated to about one level I hardness of chilled cast iron grate.

Important role for quality hardening working The surface of the grate has the right choice of basic parameters - the design and dimensions of the inductor, heating rates frequencies current, heating time, cooling system, etc.

With surface induction heating up excerpt at in most cases, it is unacceptable or undesirable, since the effect of surface heating is lost due to thermal conductivity. A limited heating time may not be sufficient to complete the phase, structural transformations when heated to temperatures recommended this steel. The completeness or degree of transformations is determined, in addition to the final heating temperature, by the residence time of the steel in the temperature range of phase transformations - the total time of austenization.

For surface hardening, the hardening depth is selected first, and it is usually recommended about 10% of the part size.

The method of high-frequency surface hardening allows to obtain a solid surface layer different depths in a very short time. Therefore, the choice of the depth of the hardened layer is determined primarily not technical opportunities and operating conditions. Based on the operating conditions of the grate, was selected depth and 2 mm, because after wear of such a layer and increase the distance between the grate bars can be a passage of seeds between the grate bars, such grates already unsuitable to further exploitation.

When surface hardening of the working area of the grate (up to a depth of 2 mm.) with a width of 17 mm, it may occur that the core is heated at low heating rates. The use of coolant will dramatically accelerate the cooling process.

Cooling the grate by immersion in a liquid (water) is not advisable, since until temperature the surface significantly (hundreds of degrees) exceeds the boiling point of the liquid on the cooled surface is created and the vapor film is held (film boiling period). This film reduces the intensity of the cooling process.

The most convenient method of cooling during hardening of the grate is cooling with a water shower.

At the same time hardening the shower allows you to produce cooling in place without transferring to quenching tank, whereby cooling can begin through split second after heating.

Another important parameter is the quenching temperature.

Features introduced by rapid induction heating in the kinetics of phase transformations, determines the level of temperature required to complete the austenization process.

3. Experimental Results and Discussion

For the grate made of steel stamps 45 hardening temperature selected at surface 960^0C and at the boundary of the heated layer 850^0C.

Based on complex shape grate (curvilinear work area) a consistent heating method was chosen. In this method, a

DOI: https://doi.org/10.30564/jmer.v2i2.1574

ribbon inductor is produced, equipped with a water shower, and the working area is heated with the movement of the grate.

With high-frequency surface hardening a large role playing mode quenching. To ensure the quenching mode, first of all, the current frequency must be selected. It is selected in accordance with the size of the grate and the selected depth of the hardened layer - 8000 hertz.

Based on the selected parameters, an inductor with a water shower was designed, design documentation was developed, he prototype was made and mounted on the HFC generator.

In order to determine the quality quenching p Static preparation surface grates, studies have been conducted to determine hardness and wear resistance. Hardness was measured at two plots - on hardened and not hardened, for comparative evaluation.

As the test results showed, by hardening the surface of the working zone, a surface hardness of up to HRC 55 is achieved, which allows to increase the life of the grate by more than two times.

Comparative wear of steel after quenching and cast iron grates were investigated on a special bench installation [2]. The research results are summarized in the table 1.

Table 1. The results of studies on the comparative wear of hardened steel and serial pig-iron grid bars

№	Time, min.	Hardened steel grate		Serial cast iron grate	
		Wear, um	Contact area mm 2	Wear, um	Contact area mm 2
1	4	55	29	104	35
2	6	80	33	100	40
3	12	115	66	130	72
4	30	210	84	250	93
5	60	270	132	310	140
6	90	350	165	380	174
7	120	380	190	450	194

Analysis of results: As can be seen from the data in the table, hardened steel grate had less wear for the same period of time due to hardening of the side surface.

On two genies of the Bektemirsky experimental cotton mill, five hardened and not hardened steel grates were installed in the grate drawn from cast iron grates.

As a result of observations for three months, it was established that the service life of hardened grid-irons is more than 2 times higher than that of non- hardened. Such indicators allow the use of one set of grates during one season during an overhaul, as opposed to the use of two sets that currently have. Based on research data, it is recommended to use hardened grid-irons in industry.

4. Conclusions

(1) Implemented selection of the main parameters of the surface hardening of the working area of the genie and lining grates.

(2) Comparative tests of grates with a hardened working area using the selected quenching parameters showed that their life is increased by more than 2 times.

References

[1] Makhkamov R.G.. The study of the surfaces of the working bodies of cotton machines and the optimization of their parameters in order to improve the quality of the fiber. Moscow, Abstract of doctoral dissertation, 1974.

[2] Ismailov A.A., Makhkamov R.G., Ibragimov A.S., Agzamov M.. Investigation of the wear of various types of genre grates. Tashkent, J. Problems of textiles, № 3, 2005.

[3] Agzamov M.. Agzamov M.M., Madgidov G.F.. Ways for improvement of cotton fiber quality in process of ginning, 2007, 3(3): 34-37.

[4] Agzamov, M.. Studying of new gin stand with small size ginning box. 2007(1): 26-29.

[5] Makhkamov R.G., Agzamov M.. Sampling quenching parameters of ginning and linter grid bars. , 2006, 3(2): 101-104.

[6] Agzamov, M.M., Yunusov, S.Z., Gafurov, J.K.. On the technological development of cotton primary processing, using a new drying-purifying unit. IOP Conference Series: Materials Science and Engineering, 2017, 254 (8): 082017.

[7] Siti A. Ismail, Guangnan Chen, Craig Baillie, Troy Symes. Energy uses for cotton ginning in Australia. Biosystems Engineering, 2011, 109(2): 140-147.

 DOI: https://doi.org/10.30564/jmer.v2i2.1574

Author Guidelines

This document provides some guidelines to authors for submission in order to work towards a seamless submission process. While complete adherence to the following guidelines is not enforced, authors should note that following through with the guidelines will be helpful in expediting the copyediting and proofreading processes, and allow for improved readability during the review process.

Ⅰ. Format

- Program: Microsoft Word (preferred)
- Font: Times New Roman
- Size: 12
- Style: Normal
- Paragraph: Justified
- Required Documents

Ⅱ. Cover Letter

All articles should include a cover letter as a separate document.

The cover letter should include:

- Names and affiliation of author(s)

The corresponding author should be identified.

Eg. Department, University, Province/City/State, Postal Code, Country

- A brief description of the novelty and importance of the findings detailed in the paper

Declaration

v Conflict of Interest

Examples of conflicts of interest include (but are not limited to):

- Research grants
- Honoria
- Employment or consultation
- Project sponsors
- Author’s position on advisory boards or board of directors/management relationships
- Multiple affiliation
- Other financial relationships/support
- Informed Consent

This section confirms that written consent was obtained from all participants prior to the study.

- Ethical Approval

Eg. The paper received the ethical approval of XXX Ethics Committee.

- Trial Registration

Eg. Name of Trial Registry: Trial Registration Number

- Contributorship

The role(s) that each author undertook should be reflected in this section. This section affirms that each credited author has had a significant contribution to the article.

1. Main Manuscript

2. Reference List

3. Supplementary Data/Information

Supplementary figures, small tables, text etc.

As supplementary data/information is not copyedited/proofread, kindly ensure that the section is free from errors, and is presented clearly.

Ⅲ. Abstract

A general introduction to the research topic of the paper should be provided, along with a brief summary of its main results and implications. Kindly ensure the abstract is self-contained and remains readable to a wider audience. The abstract should also be kept to a maximum of 200 words.

Authors should also include 5-8 keywords after the abstract, separated by a semi-colon, avoiding the words already used in the title of the article.

Abstract and keywords should be reflected as font size 14.

Ⅳ. Title

The title should not exceed 50 words. Authors are encouraged to keep their titles succinct and relevant.

Titles should be reflected as font size 26, and in bold type.

Ⅳ. Section Headings

Section headings, sub-headings, and sub-subheadings should be differentiated by font size.

Section Headings: Font size 22, bold type

Sub-Headings: Font size 16, bold type

Sub-Subheadings: Font size 14, bold type

Main Manuscript Outline

Ⅴ. Introduction

The introduction should highlight the significance of the research conducted, in particular, in relation to current state of research in the field. A clear research objective should be conveyed within a single sentence.

Ⅵ. Methodology/Methods

In this section, the methods used to obtain the results in the paper should be clearly elucidated. This allows readers to be able to replicate the study in the future. Authors should ensure that any references made to other research or experiments should be clearly cited.

Ⅶ. Results

In this section, the results of experiments conducted should be detailed. The results should not be discussed at length in

this section. Alternatively, Results and Discussion can also be combined to a single section.

Ⅷ. Discussion

In this section, the results of the experiments conducted can be discussed in detail. Authors should discuss the direct and indirect implications of their findings, and also discuss if the results obtain reflect the current state of research in the field. Applications for the research should be discussed in this section. Suggestions for future research can also be discussed in this section.

Ⅸ. Conclusion

This section offers closure for the paper. An effective conclusion will need to sum up the principal findings of the papers, and its implications for further research.

Ⅹ. References

References should be included as a separate page from the main manuscript. For parts of the manuscript that have referenced a particular source, a superscript (ie. [x]) should be included next to the referenced text.

[x] refers to the allocated number of the source under the Reference List (eg. [1], [2], [3])

In the References section, the corresponding source should be referenced as:

[x] Author(s). Article Title [Publication Type]. Journal Name, Vol. No., Issue No.: Page numbers. (DOI number)

Ⅺ. Glossary of Publication Type

J = Journal/Magazine

M = Monograph/Book

C = (Article) Collection

D = Dissertation/Thesis

P = Patent

S = Standards

N = Newspapers

R = Reports

Kindly note that the order of appearance of the referenced source should follow its order of appearance in the main manuscript.

Graphs, Figures, Tables, and Equations

Graphs, figures and tables should be labelled closely below it and aligned to the center. Each data presentation type should be labelled as Graph, Figure, or Table, and its sequence should be in running order, separate from each other.

Equations should be aligned to the left, and numbered with in running order with its number in parenthesis (aligned right).

Ⅻ. Others

Conflicts of interest, acknowledgements, and publication ethics should also be declared in the final version of the manuscript. Instructions have been provided as its counterpart under Cover Letter.

About the Publisher

Bilingual Publishing Co. (BPC) is an international publisher of online, open access and scholarly peer-reviewed journals covering a wide range of academic disciplines including science, technology, medicine, engineering,education and social science. Reflecting the latest research from a broad sweep of subjects, our content is accessible worldwide – both in print and online.

BPC aims to provide an analytics as well as platform for information exchange and discussion that help organizations and professionals in advancing society for the betterment of mankind. BPC hopes to be indexed by well-known databases in order to expand its reach to the science community, and eventually grow to be a reputable publisher recognized by scholars and researchers around the world.

BPC adopts the Open Journal Systems, see on http://ojs.s-p.sg

Database Inclusion

Asia & Pacific Science Citation Index

Creative Commons

China National Knowledge Infrastructure

Google Scholar

Crossref

MyScienceWork

BILINGUAL
PUBLISHING CO.
Pioneer of Global Academics Since 1984

Tel:+65 65881289
E-mail:contact@bilpublishing.com
Website:www.bilpublishing.com

ISSN 2630-4945
02
9 772630 494191