Based on the analysis and discussion of heat conduction of machining in power system

Bo Tang\textsuperscript{1,a}, Chunyang Xie\textsuperscript{2,b}, Xuchang Zhang\textsuperscript{2,c}, Chuntao Li\textsuperscript{2,d}, Hanyu Zhang\textsuperscript{2,e}, Yujin Tian\textsuperscript{2,f}, Tiangeng Sun\textsuperscript{2,g}

\textsuperscript{1}Engineering Training Center, Shenyang Aerospace University, Shenyang 110136, China.
\textsuperscript{2}School of Aero-Engine, Shenyang Aerospace University, Shenyang 110136, China.
\textsuperscript{a}1092786432@qq.com, \textsuperscript{b}1403479818@qq.com, \textsuperscript{c}2305512495@qq.com,
\textsuperscript{d}2246635088@qq.com, \textsuperscript{e}3342073462@qq.com, \textsuperscript{f}1261893323@qq.com,
\textsuperscript{g}2338892188@qq.com

Abstract. Heat transfer process in power system applications mainly refers to the gas in the cylinder through the combustion chamber wall and related parts pass the process of cooling medium, the heat it mainly includes the gas flow and combustion in cylinder, cylinder internal boundary layer heat transfer (gas and wall heat transfer), heated component of thermal load and thermal conductivity, cooling medium heat transfer, and a series of process. Because it is closely related to the working process of the power system, the lubrication cooling system and the structural strength design of components, the heat transfer and its thermal load will directly affect the dynamic performance, economy and reliability of the system. Therefore, the heat conduction of machining in the power system has always been an important field in the power system research.

1. Introduction
Analysis of problems related to heat conduction in mechanical processing with the power system as the main part

\textbf{Table 1. Parameter list}

| Working parameters of each stage of the actual cycle of a four-stroke internal combustion engine | status | Intake completion | Compression completed | Burning completed | Do work done | Exhaust completion |
|---|---|---|---|---|---|---|
| diesel engine | Pressure kPa | 85–95 | 3000–5500 | 4500–9000 | 200–500 | 105–120 |
| Temperature K | 300–340 | 970–1170 | 1800–2200 | 1000–1200 | 700–900 |
| gasoline engine | Pressure kPa | 80–90 | 1500–2500 | 3000–6500 | 300–600 | 105–120 |
| Temperature K | 340–380 | 670–870 | 2200–2800 | 1200–1500 | 900–1100 |

First the blank, for example, in the most simple machining of metal, non-metallic no several etc. Various kinds of materials can be directly bring them here to use, in the most widely used casting,
casting and casting temperature control in the process of heat transfer in cooling process directly affect the casting internal phase organization structure and the corresponding machining performance and operational performance, and the surface of the casting quality of high and low. Then is blank or semi-finished products of all kinds of required heat treatment process, the heat transfer of time, space distribution, heat transfer rate and so on processing and the use of performance and life of the workpiece, such as axial parts surface quenching process, the influence of the hardening layer abrasion resistance of the parts, they wanted to keep the original organization and internal organization of toughness, and the thickness of hardening layer directly affect the comprehensive performance of the parts. The measurement and control of the workpiece temperature field, the influence of different working conditions, different material properties and geometric shapes on the variation of the workpiece temperature field, and the analysis and prevention of defects in the process are all restricted by the law of heat transfer. Heat dissipation in machining process is also an important factor limiting the efficiency of thermodynamic system. The heat dissipation of metal cutting tool and the strength of the tool determine the service life of the tool and the quality and precision of the machined surface.

![Engine system model overall structure](image)

**Figure 1. Structural table**

2. Analysis of heat conduction related problems in machining, which is mainly based on power system

During metal cutting, the work done by material elasticity and plastic deformation, as well as the work done by the friction between the front and rear cutting surfaces and the workpiece surface, all needs to be lost to the environment through chips, the workpiece, the cutter and the surrounding medium, while the wear of the cutting edge is most closely related to the speed of heat dissipation. When the workpiece material or tool material thermal conductivity is large, the cutting area heat dissipation is good, the wear of the tool is reduced, the service life is long, on the contrary, the tool due to high temperature tissue performance transformation, wear is intensified, so need to use different cutting fluid to speed up heat dissipation, prolong the life of the tool. At the same time, the heat dissipation of the cutting tool affects the choice of cutting parameters, and thus affects the quality of the machined surface, the heat transfer problem in the use of mechanical equipment can not be ignored. In mechanical structure, the heat generated by the friction power loss is the main source of the mechanical system performance when the system expansion deformation caused by the high temperature parts, make dimensional accuracy is reduced, thus affecting the cooperate relationship
between the parts and make the system in the machine tool accuracy is reduced, affect the workpiece machining accuracy. Heat transfer problems are more pronounced in hydraulic systems. If the heat generated by the friction between the hydraulic oil and the pipeline in the system is not lost in time, not only will the transmission accuracy be reduced, but also the hydraulic oil will deteriorate. In serious cases, the system will be paralyzed and the equipment will be in danger of safety.

3. Analysis on the heat conduction of nc machining based on power system

First of all, in order to effectively improve the machining efficiency and quality of cutter edge radiator, we must optimize and improve the original NC lathe machining process. The specific optimization improvements are as follows. Considering that the machining object is flaky structure and adopts intermittent cutting mode, technicians have carried out experimental comparison with high speed steel turning tool, machine clamped diamond turning tool and cemented carbide turning tool. Combined with the comparison, it can be determined that the low price high speed steel turning tool can not meet the needs of mass production, and the machine clamping diamond turning tool with long service life has the shortcomings of high demand for equipment and high cost. Therefore, finally, the cemented carbide lathe without highlight requirements and low price is selected, and the corresponding aluminum turning cemented carbide grain CNC lathe is selected and configured considering that the tool edge radiator machining belongs to light cutting, so the selection of CNC lathe focuses on the portable type, so the C6132 type of digital control lathe is selected, and the light, fast and flexible turning is guaranteed. In order to meet the needs of rapid production, the lathe chuck with automatic loosening structure and the tool holder with quick tool change are adopted. After determining the tool selection, NC lathe selection and configuration, the technicians carried out many experiments around the operation, clamping and cutting parameters involved in machining, and finally determined the following technological process. The main results are as follows: (1) the general production stage is improved. By improving the clamping mode and matching the steel ring chuck, the efficiency and quality of each link of the knife edge radiator are guaranteed. The improvement of clamping method redesigns the new circular clamping and square clamping, and welds the steel ring of the clamping part on the soft claw of the chuck to carry out the clamping.

4. Enhanced heat transfer technique

Because production and the development of science and technology need to strengthen the heat transfer from the 1980s has attracted widespread attention and development. In the design and manufacture of a variety of high-performance thermal equipment, aviation, aerospace and nuclear fusion cutting-edge technology, the computer dense layout of the electronic components of effective cooling. It is the above reasons that prompt people to carry out and for extensive research and discussion on heat transfer enhancement, from the 1980s to the present nearly more than 20 years, in the scientific field of the world, there are numerous research reports on heat transfer enhancement. Classification of enhanced heat transfer techniques

4.1. Enhancement of heat conduction process

Heat conduction is one of the three basic ways of heat transfer. Heat conduction is the transfer of energy by the movement of masses (molecules, atoms, or free electrons) in an object. The heat transfer between different temperature layers in the solid is a typical thermal conduction process, but there is contact thermal resistance between the solids, which reduces the transfer of energy. In the case of high heat flow, it is necessary to reduce the contact thermal resistance in order to get the heat as soon as possible. Generally, the following methods can be adopted:

To increase the area of contact by increasing the smoothness of contact surfaces or increasing the contact pressure between objects

Fill the contact surface with a gas (such as helium) with high thermal conductivity.
Soft metal coating or soft technical gasket is added to the contact surface electrochemically
4.2. Enhancement of radiant heat transfer
Radiation heat transfer are widespread in nature and many of the production process, as long as the object temperature above absolute zero, it will depend on the electromagnetic emission energy outward, so there is always the radiation heat transfer between objects and between objects under the condition of temperature difference is not very big, the radiation heat transfer can be ignored, but in the high temperature radiation is the main mode of heat transfer in the system. The factors that affect radiation heat transfer mainly include surface roughness, solid particles and materials.

4.3. Convection heat transfer intensification
The enhanced heat transfer by convection is related to many factors, such as the physical characteristics of the fluid, the flow state, the geometry of the flow passage, the presence or absence of phase transition and the surface condition of the heat transfer wall. The active enhancement of convection heat transfer can be divided into: the use of mechanical agitation to enhance the heat transfer between fluid and wall surface, fluid pulsation and convection heat transfer when the heat transfer surface is vibrating, convection heat transfer under the action of electromagnetic field, and wall heat transfer when mass passes through the porous wall. The passive heat transfer of convection heat transfer can be divided into: the enhancement of heat transfer by tube inserts, the enhancement of eddy flow heat transfer, the convection heat transfer of additives, the heat transfer between fluidized bed and buried pipe, and jet impact.

5. Heat transfer calculation formula for internal combustion engine
The formula for calculating the heat transfer in the cylinder of an internal combustion engine is described as:

Formula character meaning list

| Symbol | Explanation                      | Unit     |
|--------|----------------------------------|----------|
| q<sub>W</sub> | Cylinder wall heat flow          | W/m²    |
| t      | Time                             |          |
| α<sub>G</sub> | Heat transfer coefficient on the gas side of the cylinder wall | W/m² K |
| A      | Combustion chamber surface area  | m²       |
| T<sub>W</sub> | Cylinder wall temperature       | K        |
| T<sub>G</sub> | Gas temperature                 | K        |

The following is the empirical formula of heat transfer coefficient used in this paper.

5.1. Woschni and Woschni-HuberHeat transfer calculation formula
In 1965, Woschni tested and measured on a test machine to obtain a heat transfer formula with wide adaptability.

\[
\alpha_G = 130d^{-0.2}p^{0.8}T_G^{-0.53} (C_1 W)^{0.8}
\]  \hspace{1cm} (1)

Woschni and Huber corrected the velocity term w of the formula in 1991 and obtained a new heat transfer coefficient calculation formula, namely the Woschni-Huber heat transfer calculation formula [3], to improve the value calculated by the Woschni formula. Low condition when the engine is dragged down and low load.
5.2. Hohenberg Heat transfer calculation formula
In 1980, Professor Hohenberg obtained the following formula according to the relevant data obtained from the internal combustion engine test.

\[ \alpha_G = 130 V^{-0.06} P^{0.8} T_G^{-0.4} (c_m + 1.4)^{0.8} \]  

(2)

5.3. Bargende heat transfer calculation formula In 1991, Dr. Bargende made a large number of experimental studies on internal combustion engines, and derived the heat transfer calculation formula for gasoline engines.

\[ \alpha_G = 253.5 V^{-0.073} P^{0.78} T_m^{-0.477} W^{0.78} \Delta \]  

(3)

The calculation in this paper is based on the two-zone model, which divides the gas in the combustion chamber into two parts, one part is the burned gas and the other part is the unburned gas. Assume that the pressure in these two regions is the same and the temperature and gas composition (excess air coefficient) are different. In addition, it is considered that there is no combustion in the unburned area, and the excess air coefficient in the burned area is given. The two-zone model is applicable to the numerical simulation of the working process of gasoline and diesel engines with different temperature requirements. If the temperature of two different regions in the two-zone model is replaced by an average temperature, the excess air coefficient of the combustion region is still pre-determined. This model is a simplified two-zone model, which is suitable for thermodynamic analysis of gasoline engine. After testing the two engines (engine parameters are shown in table 1), the actual indicator diagram of each working condition point (including engine reverse towing condition) is obtained, and the heat flow test data of cylinder wall heat transfer is obtained for comparison with the calculated value. Acquired by using the measured indicator diagram, with the aid of numerical simulation program MOSES - II internal combustion engine, the diesel engine working condition of 14, 27 cases of gasoline engine heat transfer calculation, respectively in the process of calculation using the above four kinds of heat transfer calculation formula.

6. Engine technical parameters

| Engine type         | diesel engine               | gasoline engine            |
|---------------------|-----------------------------|----------------------------|
| Bore diameter       | Three-cylinder air cooling  | Four-cylinder water cooling |
| stroke              | 100mm                       | 80.6mm                     |
| Compression ratio   | 16.5                        | 10.3                       |
| Number of intake valves | 1                          | 1                          |
| Intake valve closing moment | 41 after bottom dead center | 48 after bottom dead center |
| Intake opening moment | 36 before top dead center  | 8 before top dead center   |
| Intake valve lift   | 9.76mm                      | 10mm                       |
| Intake seat diameter | 38mm                       | 45.25mm                    |
| Number of exhaust valves | 1                          | 1                          |
| Exhaust valve closing moment | 20 after top dead center  | 12 after top dead center  |
| Exhaust door opening moment | 65 before bottom dead center | 44 before bottom dead center |
| Exhaust valve lift  | 9.5mm                       | 10mm                       |
| Exhaust valve seat diameter | 35mm                       | 39.59mm                    |
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