A fuzzy control method for optimal cutting temperature of pure iron

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Abstract: Pure iron material is greatly affected by temperature, which leads to poor control effect of cutting temperature of pure iron material. This paper studies the optimal cutting temperature control of pure iron material. The cutting speed of the pure iron material cutting tool is determined by obtaining the position of the cutting tool and the separation time of the cutting vibration. The influence factors of the cutting temperature are determined by obtaining the cutting heat and chip ratio of the pure iron material. The fuzzy control method is introduced to control the cutting temperature threshold of pure iron material as a membership function, and the temperature threshold of pure iron material is output to realise cutting temperature control. The results show that the average maximum value of the average control value of the cutting temperature is 98, and the minimum correction error of the temperature control value is 1%.

Keywords: fuzzy control; pure iron material; material cutting; optimal temperature control; balance control.

Reference to this paper should be made as follows: Long, H. and Sheng, J. (2021) 'A fuzzy control method for optimal cutting temperature of pure iron', *Int. J. Materials and Product Technology*, Vol. 63, Nos. 1/2, pp.1–15.

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1 Introduction

In industry, iron with carbon content less than 0.025% is called pure iron. The structure of the material is mainly ferrite, which belongs to the category of steel. Pure iron has soft ground, good plasticity and good ductility. It can be drawn into wire with low strength and hardness. Therefore, it is easy to forge and weld. Pure iron material is mainly used in various precision instruments, spaceships and components of national defence cutting-edge science and technology, with good vacuum and airtightness. In the process of practical application, the physical and mechanical properties of pure iron require high material thickness to ensure the safety and reliability of the equipment (Cai et al., 2019). However, due to the poor rigidity, large size and high material removal rate of pure iron parts, and because of the effect of clamping force, cutting force, cutting heat and participating stress in the actual production and manufacturing process, the bending, twisting and other processing deformation occur, which makes the finished products difficult to meet the design requirements. Therefore, high efficiency and precision cutting of parts with pure iron as raw material is of great significance to improve the performance of industrial equipment such as national defence and aerospace technology, and is also the research focus in the field of mechanical processing and academic field. The cutting process of pure iron material is to use tools or grinding wheels and other equipment to cut off a part of the original pure iron material workpiece. Because of the high temperature and high pressure contact among the chip, workpiece and the front and rear cutter surface of the tool, and the chemical activity is large, the chemical elements on the contact surface will diffuse, which will change the chemical composition and material structure of the two, resulting in different degrees of wear. The cutting process of pure iron materials involves many fields, such as mechanical, thermal, chemical, physical and so on. Among them, cutting temperature has a decisive impact on the wear of workpiece and props (Gokhman and Kondria, 2019; Saurav et al., 2018). Too high cutting temperature will aggravate the wear degree of workpiece and tool, while too low temperature will lead to the failure of cutting process. Therefore, in the actual cutting process, it is necessary to strictly control the construction temperature. On the premise of ensuring the smooth progress of the cutting process, the wear of the workpiece and cutting tools caused by high temperature should be reduced as far as possible. Therefore, researchers in this field have done a lot of research on the optimal cutting temperature control of materials.

In Wang et al. (2019), a cutting temperature modelling method based on fish swarm optimisation BP neural network is proposed. This method analyses the problem that BP neural network is easy to appear deadlock in the cruise, and uses artificial fish swarm algorithm to optimise the existing problems effectively. Through the least square fitting method, the paper constructs the univariate model of cutting speed-temperature and depth of metal materials. On this basis, the multivariate model of material cutting temperature is constructed. Finally, the multiple model of cutting temperature is constructed by genetic algorithm to realise the optimal control of material cutting temperature. On the basis of cutting temperature modelling, this method can effectively improve the control of cutting temperature, but the process of modelling is complex, and the input and output of the model are not complete, resulting in poor control effect. The method of cutting temperature simulation and parameter optimisation of superalloy is proposed in Tao et al. (2020). According to the cutting parameters of superalloy, the genetic algorithm is used to optimise the cutting parameters. On this basis, taking the back feed, feed rate, cutting speed and other related parameters, taking the highest temperature of cutting tool as the response value, and combining with multiple regression fitting technology, a quadratic polynomial regression equation prediction model is established. With the highest tool temperature as the optimisation objective, the genetic algorithm is applied to optimise the cutting parameters. This method can effectively control the cutting temperature by optimising the relevant parameters in the cutting process. However, the operation process of this method is more complicated and the detailed optimisation of each parameter takes a long time. In Calik et al. (2019), the cutting temperature control of ultra-fine grain cemented carbide tool for turning stainless steel is proposed. The research object of this method is ultra-fine grain cemented carbide tool, which has high hardness and good bending resistance, and has good cutting effect for difficult to machine materials in the field of material cutting. Due to the influence of temperature in the cutting process, the temperature distribution of the cutting tool surface is obtained. The high-speed cutting process of materials is simulated by DEFORM simulation analysis software. The influence law of cutting speed, feed rate and back feed on tool temperature is analysed, and the temperature control in the cutting process is realised. By analysing the most common cutting parameters and analysing the temperature distribution in cutting, the temperature control in cutting can be realised. However, it is difficult to determine the temperature distribution accurately in the actual cutting, which easily leads to the problem of low precision of temperature control in cutting.

In order to solve the problems existing in the application process of the traditional temperature control method, the cutting speed of pure iron material is determined by obtaining the tool position of pure iron material cutting and the first separation time in cutting a vibration curve; the heat generated in the cutting process of pure iron material, the chip ratio and the ratio of inflow chip are calculated to obtain pure iron material cutting. The temperature threshold of pure iron material in different cutting factors is determined by temperature integral method. According to the average temperature of expected pure iron material cutting, the actual cutting temperature of pure iron material is set to determine the temperature threshold of pure iron material cutting. The fuzzy control method is introduced to control the cutting temperature threshold of pure iron material as a membership function. The temperature threshold value of pure iron material is output, and the temperature threshold error caused by fuzzy control is corrected to realise the optimal cutting temperature control of pure iron material. The specific route of this paper is as follows:

1 The cutting speed of pure iron material is determined by obtaining the cutting tool position and the first separation time in a vibration curve; the heat generated in the process of cutting pure iron material, the chip ratio and the ratio of chip inflow are calculated to obtain the influence factors of cutting temperature of pure iron material.

2 Temperature integral method is used to determine the temperature threshold of pure iron material affected by different cutting factors. According to the average temperature of expected pure iron material cutting, the actual cutting temperature of pure iron material is set to determine the temperature threshold of pure iron material cutting.

3 The fuzzy control method is introduced to control the cutting temperature threshold of pure iron material as a membership function. The temperature threshold value of pure iron material is output, and the temperature threshold error caused by fuzzy control is corrected to realise the optimal cutting temperature control of pure iron material.

4 Experimental analysis.

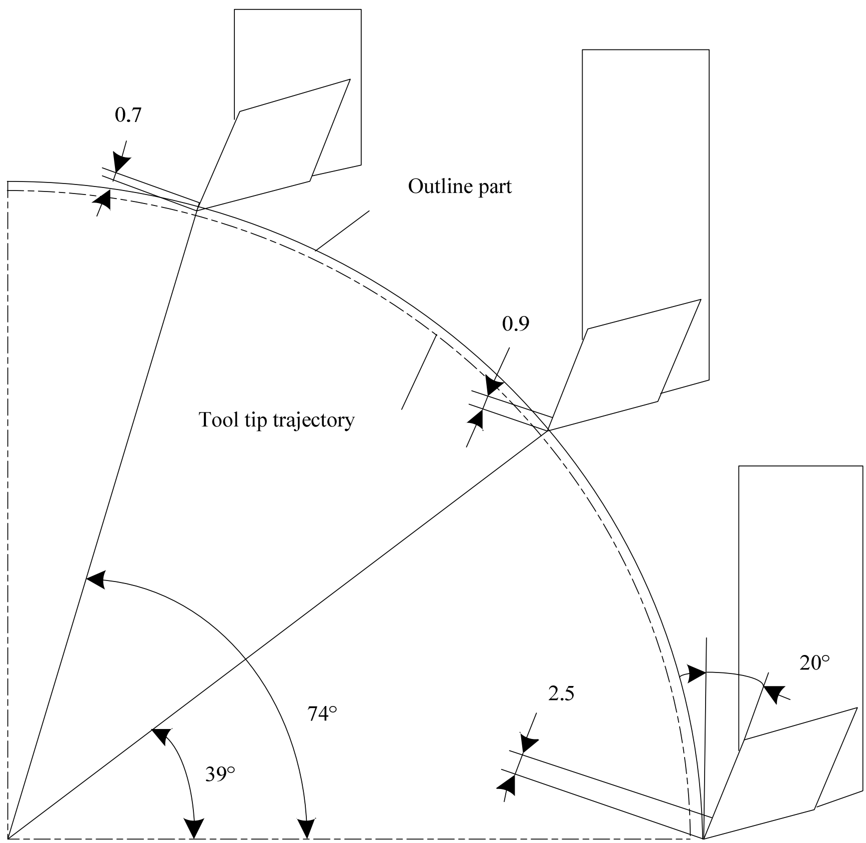
5 Conclusion and future prospects.

2 Analysis of influence factors on cutting temperature of pure iron material

2.1 Analysis of cutting speed of pure iron material

In order to determine the cutting temperature change of pure iron material, it is necessary to determine the influence of speed change on temperature in pure iron material cutting. In this paper, the cutting speed of pure iron material is analysed to determine the specific influence of speed on temperature in the process of pure iron material cutting. In the pure iron material cutting, the motor drive control is its running speed (Saito et al., 2018; Gong et al., 2020). By changing the cutting tool position and changing the installation angle of the blade on the cutter body, the cutting angle of the blade in the pure iron material part is increased to about 20°. The cutting process of the blade is shown in Figure 1.

Figure 1 Schematic diagram of pure iron cutting



In the whole cutting process of pure iron, the length of cutting edge participating in cutting is determined to be 0.7 mm–2.5 mm. In this case, the position of the cutting tool can be expressed as follows:

$$y = A\sin \omega t \tag{1}$$

where *y* is the displacement of the cutting tool in the pure iron cutting coupling, *A* and *ω* are the amplitude of the driving motor and the angular velocity of the cutting tool respectively.

When the vibration speed of the cutting tool is equal to the moving linear velocity of the workpiece at the designated position of pure iron cutting, the first separation time in a vibration curve is as follows:

$$t_1 = \frac{1}{2\pi f}\cos^{-1}\left(\frac{-v}{2\pi af}\right) \tag{2}$$

where *v* is the linear velocity of the workpiece made of pure iron, and *a* represents the proportional coefficient.

On the basis of the above analysis, it can be concluded that the running speed expression of cutting tool is as follows:

$$V = A\omega \cos \omega t \tag{3}$$

where *V* is the speed of the cutting tool.

The cutting speed of pure iron is determined by calculating the tool position and the first separation time in a vibration curve. The cutting temperature of pure iron material is affected by the cutting speed. It is important to determine the temperature in operation for the optimal control of cutting temperature.

2.2 Heat analysis in the cutting process of pure iron materials

On the basis of obtaining the cutting speed of pure iron material, the cutting temperature of pure iron material is affected. The ratio of heat generation in cutting, the ratio of heat generated in cutting area to chip and the ratio of heat generated by chip friction flowing into chip have a great influence on the cutting temperature of pure iron material under the heat generation and transfer. This paper analyses these influencing factors and completes the optimal cutting temperature control of pure iron material.

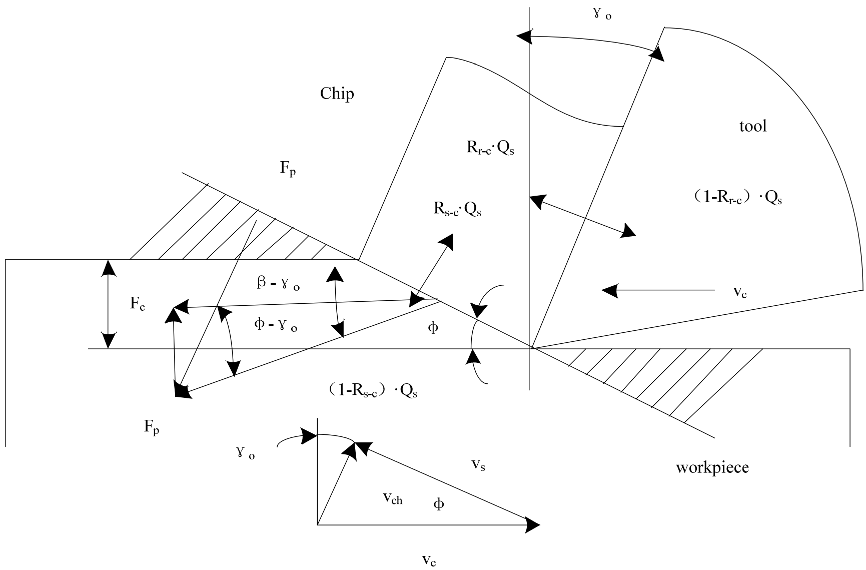
Firstly, the total work of cutting force of pure iron material is obtained, that is, the heat generated in the cutting process. That is

$$Q_s = F_c tv - (1 + 0.023k)tflk_r\gamma \tag{4}$$

where F_y is the cutting force applied to the pure iron workpiece, *l* is the perimeter of the pure iron workpiece, *t* is the cutting time, *f* is the feed rate, *k* and k_r are the specific constants and the main deflection angle of the cutting tool respectively, and *γ* is the surface energy per unit area of pure iron (Gao et al., 2018; Jinfu and Zhanqiang, 2018; Ning and Liang, 2019).

On the basis of obtaining the cutting temperature of pure iron material, the heat in pure iron material cutting is reasonably distributed, as shown in Figure 2.

Figure 2 Heat distribution in cutting process



In Figure 2, F_p is the back force, ϕ is the shear angle, γ_o is the rake angle of the cutting tool, v_c is the cutting speed, and J is the thermal work equivalent (Uysal, 2018). R_{s-c} is the ratio of heat generated in the cutting area to the chip, which is:

$$R_{s-c} = \frac{1}{1 + 1.328\left[\frac{\lambda_{w1}\Lambda_h}{v_c h_D}\right]^{\frac{1}{2}}} \tag{5}$$

where λ_{w1} is the thermal conductivity of the pure iron workpiece, and Λ_h and h_D are the chip deformation coefficient and the thickness of the cutting layer respectively (Lin et al., 2019). In the same way, it can be concluded that the heat generated by chip friction on the front part of the tool flows into the chip as follows:

$$R_{T-c} = \frac{R_T - \theta_s + \theta_{mn}}{R_T + C_T} \tag{6}$$

where θ_s and θ_{mn} are the average temperature and ambient temperature on the cutting surface, respectively. The calculation formulas of B_T and C_T can be expressed as follows:

$$\begin{cases} B_T = \dfrac{Q_T}{l_{con} b_D}\left(\dfrac{l_{con} A_x}{\lambda_{tool}}\right) \\ C_T = 0.754 \dfrac{Q_T}{\rho_{w2} c_{w2}\left(v_c h_D b_D\right)} \cdot \left(\dfrac{v_c h_D^2 \Lambda_h}{l_{con} \lambda_{w2}}\right)^{\frac{1}{2}} \end{cases} \tag{7}$$

where Q_T represents the heat generated by chip friction on the rake face, l_{con} is the chip contact length, b_D is the cutting width, and λ_{w2}, c_{w2} and ρ_{w2} are the thermal conductivity, specific heat and material density of the cutting material, respectively. λ_{tool} is the thermal conductivity of cutting tool material, and A_x is the shape coefficient of moving plane heat source.

Based on the determination of the cutting heat of pure iron material and the ratio of heat generated in the cutting area into the chip and the ratio of heat generated by chip friction flowing into the chip, the final cutting temperature of pure iron material is determined, namely

$$\frac{\partial}{\partial x}\left(\kappa\frac{\partial\theta}{\partial x}\right)+\frac{\partial}{\partial y}\left(\kappa\frac{\partial\theta}{\partial y}\right)-\frac{\partial(\rho c\mu v\theta)}{\partial x}-\frac{\partial(\rho c\mu v\theta)}{\partial y}+s=0 \tag{8}$$

where θ is the cutting temperature of pure iron, κ is the thermal conductivity, ρ is the density of the pure iron workpiece, c and s are the specific heat and heat source respectively. μ and v are the cutting speed of the tool in X and Y direction respectively.

3 Realisation of fuzzy control for optimal cutting temperature of pure iron material

3.1 Obtaining cutting temperature threshold of pure iron material based on temperature integral method

In order to achieve the optimal control of the cutting temperature of pure iron material, the temperature threshold is determined based on the above obtained cutting temperature, that is, the optimal temperature value. In this paper, temperature integral method is used to determine the temperature threshold of pure iron under different cutting speed and other factors (Ucak and Cicek, 2018). The temperature integral method mainly sets the actual cutting temperature of pure iron material according to the average temperature of expected pure iron material cutting. It is assumed that the initial cutting stage of pure iron is $F(1, 2, \ldots m)$ and the average cutting temperature is φ_F, namely

$$\varphi_F=\frac{\int_{l-F}^{l}A(t)dt}{F} \tag{9}$$

where $A(t)$ represents the temperature at any time in the cutting stage F of pure iron material.

Suppose that A_i represents the actual average cutting temperature of pure iron material in each cutting stage, and A_i^e represents the expected average temperature of pure iron material in each cutting stage.

$$\varphi_F=\frac{\sum_{i=1}^{F}A_i}{F}=\frac{\left[A_i^e+\sum_{i=1}^{F-1}A_i\right]}{F} \tag{10}$$

According to the above analysis, the value of A_i can be obtained by replacing the actual temperature with the expected average temperature in different stages of pure iron cutting, namely

$$A_i = F \times A_i^e - \int_{t-F+1}^{t-1} A_i(t)dt \tag{11}$$

where t is the current cutting stage of pure iron material and $A_i(t)$ is the actual cutting temperature.

In the pure iron material cutting stage, there is a certain difference in the temperature produced in each stage, so the expected average value of cutting in the N^{th} stage, namely the threshold value of cutting temperature, can be determined as follows:

$$B_N = \frac{n \times A_i^e - \int_l^{N-1} B_{n(i)}(t)dt}{n - N + 1} \tag{12}$$

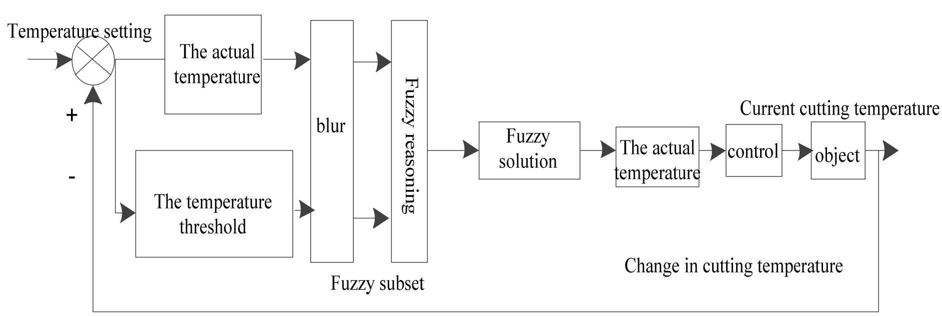
where $B_{n(i)}$ represents the average temperature of pure iron cutting in stage i.

Through the temperature integral method, the temperature threshold of pure iron material affected by different cutting speed and other factors is determined. According to the expected average temperature of pure iron material cutting, the actual pure iron material cutting temperature is set, and the temperature value of pure iron material cutting is finally determined.

3.2 Realisation of optimal temperature control of pure iron material based on fuzzy control

Fuzzy control method is a method of controlling by the basic thought and theory of fuzzy mathematics. In the traditional control field, the accuracy of the dynamic mode of the control system is the most important factor affecting the control quality. The more detailed the dynamic information of the system is, the more accurate the control can be achieved. In this paper, according to the dynamic fuzzy data set, the optimal control of the cutting temperature of pure iron material will be realised through the above determined cutting temperature threshold (Šuba et al., 2018). The principle of fuzzy control is shown in Figure 3.

Figure 3 Principle of fuzzy control



In the fuzzy control of pure iron material, the optimal cutting temperature is controlled by the function of fuzziness and deblurring. By determining the input and output variables of fuzzy control, the corresponding universe, membership function and quantitative parameters are determined, and the fuzzy control rules are determined to realise the optimal temperature control of pure iron cutting.

The precise cutting temperature of pure iron is fuzzified. The mapping relation existing on a universe U is defined as follows:

$$\left(\overleftarrow{A}, \vec{A}\right):\left(\overleftarrow{U}, \vec{U}\right) \rightarrow [0, 1]\times[\leftarrow, \rightarrow], \left(\overleftarrow{u}, \vec{u}\right) \mapsto \left(\overleftarrow{A}(\overleftarrow{u}), \vec{A}(\vec{u})\right) \tag{13}$$

where $\left(\overleftarrow{A}, \vec{A}\right)$ is the dynamic fuzzy set of $\left(\overleftarrow{U}, \vec{U}\right)$. Using the normal form of quantitative analysis, the membership function is used to process the data a in the temperature threshold for dynamic fuzzy processing. The process can be expressed as follows:

$$a \overset{DF}{=} \left(\overleftarrow{a}, \vec{a}\right) \tag{14}$$

The development and change trend of a's state is shown intuitively. It is assumed that the temperature data of real-time pure iron cutting can form multiple dynamic fuzzy data sets, that is, all DF sets on U are:

$$DF(U) = \left\{\left(\overleftarrow{A}, \vec{A}\right) \middle| \left(\overleftarrow{A}, \vec{A}\right), \left(\overleftarrow{u}, \vec{u}\right) \mapsto [0, 1]\times[\leftarrow, \rightarrow]\right\} \tag{15}$$

Through the operation between two DF subsets, the temperature balance control is regarded as the corresponding operation of its membership function. The real-time temperature data T_t and the optimal cutting temperature calculation result T_j are input into the dynamic fuzzy data set, and the output temperature balance control value is as follows:

$$Cq = \left|T_t - T_j\right| \tag{16}$$

When using fuzzy control to control the cutting temperature of pure iron material, the cutting temperature value is constructed as a fuzzy subset. Assuming that the membership functions of these fuzzy subsets are $F^1(x)$, $F^2(x)$ and $F^n(x)$, in this case, the product reasoning rule of fuzzy control is adopted, and the fuzzy control of cutting temperature of pure iron material is as follows:

$$p' = \frac{\sum_{i=1}^{m} r\left(\prod_{i=1}^{2} F^1(x)\right)}{\sum_{i=1}^{m}\left(\prod_{i=1}^{2} F^n(x)\right)} \tag{17}$$

where r is the control value of cutting temperature of pure iron material.

Under the operation of the controller, the optimal cutting temperature of pure iron can be controlled. In order to improve the control precision and control effect, it is necessary to correct the control error.

The limit amplitude of the optimal cutting temperature threshold is η. If the control error obtained by the controller exceeds the set limit amplitude, it is necessary to reduce the temperature error as soon as possible, namely

$$\eta' = \Delta e \times Cq \tag{18}$$

If the product of temperature threshold control error and control error change Δe is greater than 0, the results are compared according to the size of error and measurement threshold η'.

After the above correction, the temperature threshold error is the final output of fuzzy control, namely

$$\eta_0' = \frac{\int_{\eta'} \eta' u_{\eta'}(\eta') d\eta'}{\int_{\eta'} u_{\eta'}(\eta') d\eta'} \tag{19}$$

where u_η represents the fuzzy control quantity of pure iron material cutting.

In the cutting temperature control of pure iron material, this paper uses the fuzzy control method, regards the cutting temperature threshold of pure iron material as the membership function to carry on the corresponding control, outputs the temperature threshold control of pure iron material and corrects the error after the fuzzy control, finally realises the optimal cutting temperature control of pure iron material.

4 Experimental analysis

4.1 Experimental environment

The experimental object is pure iron material, which is provided by a factory. There are 200 workpieces in the experiment. The size, shape, internal structure and chemical content of each workpiece come from the same manufacturing model. Therefore, the physical and chemical properties of the workpiece are basically the same. The high precision CNC machine tool is selected as the working machine, and the cutting tools are divided into cermet and coated cemented carbide. Optical microscope with CCD camera is selected to observe the changes of cutting edge, rake face and material cutting section before and after cutting pure iron. Figure 4 shows that the workers are cutting pure iron materials.

Figure 4 Cutting environment of pure iron material (see online version for colours)

4.2 Experimental parameters

In the experimental process, the dynamic fuzzy controller is set up by using the FuzzyLogic Toolbox graphical tool design platform, and the input and output values of the controller such as proportion, integral and differential are adjusted for dynamic fuzzy processing. The dynamic fuzzy universe and corresponding rule base of temperature variable value are set on the platform. In addition, the experiment is divided into several groups by adjusting the cutting data of pure iron materials. The setting of cutting parameters is shown in Table 1.

Table 1 Cutting parameters

Experimental group	*Cutting speed*	*Feed rate*	*The amount of knife on the back*
1	22.5	0.08	0.25
2	22.5	0.12	0.3
3	32	0.08	0.4
4	32	0.12	0.5
5	45	0.08	0.25
6	45	0.12	0.3
7	63	0.08	0.4
8	63	0.12	0.5

4.3 Experimental scheme

The optimal cutting temperature is 360°C. Before the start of the experiment, the temperature change data without any control method is counted, as shown in Table 2.

Table 2 Change of cutting temperature without control method

Experimental group	*Initial cutting temperature/°C*	*Average temperature after stabilisation/°C*	*Maximum temperature after stabilisation/°C*
1	10	294	521
2	0	313	504
3	0	353	491
4	0	366	483
5	10	409	462
6	0	425	511
7	0	398	479
8	0	382	482

By comparing the optimal cutting temperature with the actual cutting temperature, the control value of temperature balance can be determined. Using three temperature control methods, the results of optimal cutting temperature balance control of pure iron material are obtained by comparison.

4.4 Experimental indexes

1 Average control value of cutting temperature: the average control value of cutting temperature refers to the average value in the overall temperature control. The greater the average value of control value is, the better the control effect is. The calculation formula is as follows:

$$\overline{p} = \frac{p_1 + p_2 + \dots p_n}{n} \tag{20}$$

where $\overline{p}$ represents the average control value of temperature, $p_1, p_2, \dots, p_n$ represents the control quantity of variation in cutting, and n represents the total number of controlled quantities

2 The correction error of cutting temperature balance control value refers to the effective control degree of temperature in pure iron material cutting, and its calculation formula is as follows:

$$R = \frac{R_i}{n} \times 100\% \tag{21}$$

where R_i is the precision value of cutting temperature control.

4.5 Analysis of test results

4.5.1 Analysis of average control value of cutting temperature

The proposed method, the cutting temperature modelling method based on fish swarm optimisation BP neural network, and the cutting temperature simulation and parameter optimisation method of superalloy are tested and analysed. The average control value change of the cutting temperature of pure iron material is tested and analysed. The experimental results are shown in Table 3.

Through the statistics and calculation of the data in Table 4, with the continuous change of iteration times, there are some differences in the average control value of cutting temperature of pure iron materials among the proposed method, cutting temperature modelling method based on fish swarm optimisation BP neural network, and cutting temperature simulation and parameter optimisation method of superalloy. When the number of iterations is 5, the average temperature control value of the proposed method is 36°C, the average control value of the cutting temperature control method of fish swarm optimisation BP neural network is 14°C, the average control value of the cutting temperature control method for the high temperature alloy cutting temperature simulation and parameter optimisation method is 27°C; when the iteration number is 8, the average temperature control value of the proposed method is 20, the average temperature control value of the cutting temperature control method of fish swarm optimisation BP neural network is 11°C, and the average control value of cutting temperature control method of high temperature alloy cutting temperature simulation and parameter optimisation method is 2°C; in contrast, the average temperature control value of the proposed method is more, which verifies the scientific effectiveness of the proposed method.

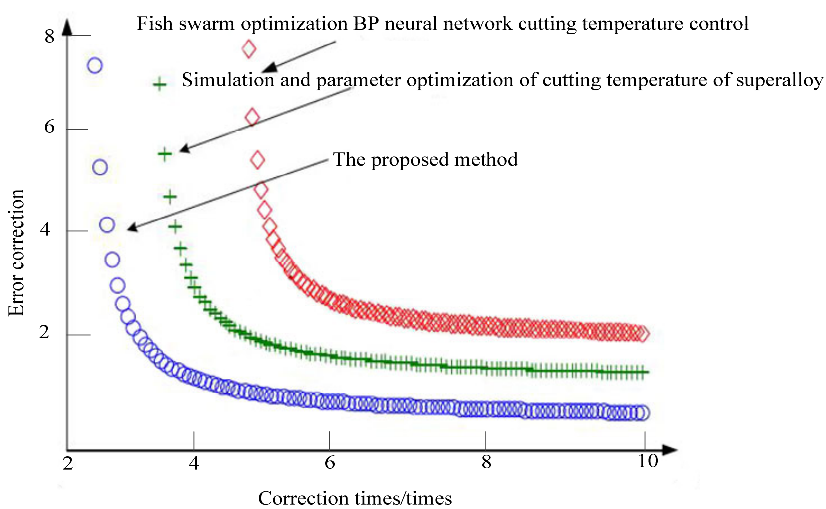
Table 3 Comparison of average control value of pure iron material's cutting temperature with different control methods

Iterations /times	*Cutting temperature control based on fish swarm optimisation BP neural network*		*Cutting temperature simulation and parameter optimisation of superalloy*		*The proposed method*	
	Control quantity/°C	*Average temperature after stable cutting/°C*	*Control quantity/°C*	*Average temperature after stable cutting/°C*	*Control quantity/°C*	*Average temperature after stable cutting/°C*
1	12	306	21	315	33	327
2	5	308	1	312	31	344
3	2	311	2	324	15	356
4	12	390	11	332	35	362
5	14	395	27	382	36	373
6	18	307	35	328	68	357
7	52	312	71	327	98	342
8	11	393	2	384	20	365

4.5.2 Correction error analysis of cutting temperature balance control

In order to further verify the effectiveness of the proposed method, the cutting temperature control method based on fish swarm optimisation BP neural network and the cutting temperature balance control error of high temperature alloy cutting temperature simulation and parameter optimisation method are tested and analysed. The experimental results are shown in Figure 5.

Figure 5 Correction error comparison of cutting temperature balance control (see online version for colours)



It can be seen from Figure 5 that under the same experimental environment, the errors of the proposed method, the cutting temperature control method of fish swarm optimisation BP neural network and the superalloy cutting temperature simulation and parameter optimisation method to correct the cutting temperature balance control value are different. Among them, the minimum correction error of the proposed method is about 1%, while that of the other two methods is 1.5% and 2%, respectively. It can be seen that the correction error of the proposed method is small and the correction accuracy of the proposed method is improved.

5 Conclusions

Temperature, cutting tool and cutting speed are important factors to determine the cutting quality of pure iron. The cutting speed of pure iron material is determined by obtaining the cutting tool position of pure iron material and the first separation time in cutting a vibration curve; the heat generated in the cutting process of pure iron material, the chip ratio and the ratio of flowing chip are calculated to obtain pure iron material. According to the average temperature of the expected pure iron material, the cutting temperature of the actual pure iron material is set to determine the temperature threshold of the pure iron material cutting. The fuzzy control method is introduced to control the cutting temperature threshold of pure iron material as a membership function. The temperature threshold value of pure iron material is output, and the temperature threshold error caused by fuzzy control is corrected to realise the optimal cutting temperature control of pure iron material. Compared with traditional methods, the proposed method has some advantages

1 The average control maximum value of the cutting temperature of pure iron material is 98, and the control effect is good.

2 The minimum error of the proposed method to control the cutting temperature of pure iron material is about 1%, which has certain credibility.

However, in order to obtain high-quality pure iron products, it is necessary to further control the cutting speed and optimise the cutting tools.

Acknowledgments

This work was supported by the middle-aged and young teacher scientific project of Fujian Provincial Education Department under grant no. JT180448.

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