Straight Shank Ball End Cutter Machining Simulation System
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Keywords: straight shank ball end mills; rake face; blade; Visual Basic; Solidworks

Abstract. Based on the Solidworks platform, using Visual Basic two development tool, according to the straight shank ball end cutter rake face grinding relationship, establish the simulation machining system, shorten the cycle of design, provide a basis for optimization of grinding parameters for later edge.

Introduction
In the process of complex curved surface, computer simulation technology has been widely applied. Straight shank ball end cutter rake face shape is more complex, its forming is achieved by strong grinding wheel, size, posture and wear process of grinding wheel will directly influence the use performance of ball end mills, in order to optimize the grinding parameters, the need to establish a rake face grinding machining simulation system.

Simulation system principle
In order to display graphics for qualitative, quantitative analysis of interference, the system uses a direct solid modeling method[1]. The three-dimensional model are established and the straight shank grinding ball end cutter blank, according to the processing diagram (Fig.1) set the grinding parameters[2], using CSG (Constructive Solid Geometry) method to record the blank and the wheel scan area, then the application of regional set difference from the Mao Pizhong order minus scanning[3] and the front knife straight shank ball nose end milling cutter with the cutting process is constantly updated, so as to complete the whole process simulation.

Fig. 1 The ball end cutter grinding process diagram

Straight shank ball end cutter blank and wheel parametric modeling
In order to optimize the grinding parameters or for error analysis, the establishment of a number of different dimensions of the grinding wheel cutter blank and various types of experimental needs, in order to avoid duplication of labor, shorten the period of development, must carry on the parametric design on it[4]. Combined with the intent of designers for to establish the entity structure analysis, determine the sequence characteristics of the
establishment of the. In order to avoid generating too much redundant code, make the
driving parameter size is as small as possible, as far as possible, the procedures of
establishing simplified characters. Open the macro recording\textsuperscript{[5]}, creating entity in SolidWorks and
uses the variable labeling parameter size, as shown in Fig.2 and in Fig.3. Macro recorded received
basic code entity established, according to the macro file objects and methods in their application in
a reasonable organization, slightly modified, the specific parameters used variables instead of
through the control of variables, this can realize the parameterized modeling straight shank ball
cutter blank and wheel, the operation results such as Fig. 4 and Fig. 5.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig2.png}
\caption{Fig. 2 Straight shank cutter grinding wheel blank}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig3.png}
\caption{Fig. 3 Sketch sketch}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig4.png}
\caption{Fig. 4 Straight shank ball end cutter blank}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig5.png}
\caption{Fig. 5 Grinding wheel}
\end{figure}

\textbf{Straight shank ball end cutter grinding simulation}

To realize the simulation of rake face grinding of using solid modeling function of SolidWorks
software. In accordance with the straight handle the ball end cutter location preperation formed right
exercise program, cutter grinding wheel blank entity and entity called parametric
modeling generated, using motion program control wheel deflection and mobile, set difference
operation through Boolean entity\textsuperscript{[6]}, realizes grinding wheels and mill blank, thus forming end
rakeface and circumferential cutting edge rake face, as shown in Fig. 6.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig6.png}
\caption{Fig. 6 the rake face grinding simulation results}
\end{figure}

\textbf{Analysis of simulation results}

Cutter end edge shape with S arc-shaped blade is better\textsuperscript{[7]}, ensure stable cutter cut out the
workpiece in the entry, and does not generate local larger wear, improve the tool endurance; Zhou edge rake face and end rakeface can realize smooth transition, ensure good machining quality, milling cutter the cutting performance and chip removal ability; there was a narrow edge near the edge part. The blade is positive chamfering shape, can play a roll chip, chip removal effect, is beneficial to improving the penetration strength and cutting fluid cutting edge of the milling cutter. With a diameter of 10mm straight shank ball end mill as an example, when the installation angle of the grinding wheel is 1=32 degrees, 2=0 degrees of sigma, the relationship between edge width distribution and ball edge portion of the angle as shown in Table 1, shown in Fig. 8, we can see that the edge width from the ball head ends to the circumference part of a "small big small" distribution, which is near the top and the circle is very small, is almost 0 larger, central.

<table>
<thead>
<tr>
<th>Serial number</th>
<th>The ball blade angle θ</th>
<th>Edge width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.14°</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>13.47°</td>
<td>0.006</td>
</tr>
<tr>
<td>3</td>
<td>18.27°</td>
<td>0.035</td>
</tr>
<tr>
<td>4</td>
<td>22.86°</td>
<td>0.072</td>
</tr>
<tr>
<td>5</td>
<td>27.33°</td>
<td>0.115</td>
</tr>
<tr>
<td>6</td>
<td>31.75°</td>
<td>0.159</td>
</tr>
<tr>
<td>7</td>
<td>36.18°</td>
<td>0.200</td>
</tr>
<tr>
<td>8</td>
<td>40.70°</td>
<td>0.235</td>
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<tr>
<td>9</td>
<td>45.43°</td>
<td>0.261</td>
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<td>10</td>
<td>50.53°</td>
<td>0.272</td>
</tr>
<tr>
<td>11</td>
<td>56.29°</td>
<td>0.260</td>
</tr>
</tbody>
</table>

Fig. 8 angle - edge width distribution map

**Conclusion**

Machining simulation system is established in this paper to simulate the straight shank ball end cutter rake face grinding process, verified the relationship between milling cutter grinding motion, to predict the cutting edge curve of actual processed, provides a theoretical basis for optimizing grinding parameters for later edge. Through the simulation found that the end edge has a good "S" shaped curve, smooth connection end edge and the circumferential cutting edge, on the end edge with a narrow blade. This system can simulate many kinds of cutting tool in cutting process is true, accurate and complex shape parts, can avoid the site several times to try cutting time and material brings on the waste, shorten the design cycle.
References


