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Discussion About the Article «Discussion on Detecting Technology of Chaser for Graphite Electrode Machining» in Carbon Techniques No. 4, 2015

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Abstract: Up to now, in the carbon industry, there is no uniform standard for the detection of chaser. In order to set up this standard the different method from each carbon company should be studied and then find out the commonalities. In the magazine CARBON TECHNIQUES No. 4, 2015, article «Discussion on detecting technology of chaser for graphite electrode machining» Zhang Baoyi of Jilin Carbon Co., Ltd. has made a detailed description of the conventional testing methods for chaser which is used in graphite electrode processing. However, due to the difference between the detection methods and parameters of the chaser in the carbon enterprises, this paper based on Kaifeng carbon company's current test specification and discussed the difference part from the original paper. This paper through analyzed the differences of two method which used in Kaifeng Carbon Co., and in the original paper, combined with the mathematical tools to discuss of the geometric meaning of measuring parameters, finally found that most parameters in both methods are same and the rest have the same geometric meaning, for another word the parameters as the representative item and other parameters can be obtained by calculations. But which are the most representative parameters are considered different from carbon companies in carbon industry.

Keywords: Chaser, Detection, Universal Tool Maker's Microscope

1. Introduction

In the article 《Discussion on detecting technology of chaser for graphite electrode machining》 in CARBON TECHNIQUES No. 4, 2015 (the original paper), Zhang Baoyi of Jilin Carbon Co., Ltd. has made a detailed description of the conventional testing methods for chaser which is used in graphite electrode processing. In the article explained how to check the technical parameters of the chaser with universal tool maker's microscope (microscope). However, due to the difference between the detection methods and parameters of the chaser in the carbon enterprises, this paper based on Kaifeng carbon company's current test specification and discussed the difference part from the original paper. In conjunction with geometric tools, define the actual meaning represented by the detection parameters.

In the process of writing this article, the special measurement expert, Zhu Keming from Shanghai YongHua Alloy Tool Co., Ltd., has provided detailed business guidance. In the geometric calculation part of this article, Mr. Rolf, engineer of German DECOM company, Mr. Kamada Shiaki, minister of Pinghu Kuroda Seiko Co., and Jiang Jianrong, minister of Minjiang precision cutting Tool Co., Ltd. of Chengdu, all of them have offered selfless help. Special thanks for them all.

2. Method

2.1. Evaluation Method of Chaser Hardness

In the original paper, Mr. Zhang Baoyi has described the effect of the material and hardness of the knife on the quality of the electrode. This article only supplements the influence of the form of the chaser on the hardness of the chaser and its influence on the quality of the electrode.

The existing form of chaser can be divided into two types: cemented carbide chaser and mosaic carbide chaser according to the proportion of carbide part of chaser.

(1) The cemented carbide chaser is made by cemented carbide, which has the advantages of uniform material, strong structure, good processing and thermal stability, but its disadvantage is that the price is expensive. This kind of chaser is represented by Kenna Germany in Shanghai.
(2) The mosaic carbide chaser are connected by metal welding and riveting combination to combine the mosaic carbide parts with the steel parts as the carrier. The advantage is low price, which is about 1/4 of the price of cemented carbide chaser. Because of difference of physical properties between different material parts, the disadvantage of this kind of chaser is it could be easily to expand and uneven after stress, which leads to the bending deformation of the chaser and affecting the machining accuracy. This kind of chaser is much more popular in Chinese carbon companies. This kind of chaser is represented by Chengdu Minjiang precision cutter Co., Ltd.

According to personal experience, the full thickness of the chaser is about 18mm. According to the difference of the using frequency, the detection parameters of the chaser are fluctuated after 7~8 times of grinding. After 10~14 times the grinding, the chaser should be considered can be used again or not. At this time the thickness of the chaser is about 13 ~ 14mm and some chaser can be used to 12mm or thinner. Therefore, it is not conducive to the cost control of enterprises to adopt the cemented carbide chaser, but it plays a positive role in processing stability.

In the original paper, Mr. Zhang also referred to the hardness tester which is used to detect the hardness of the chaser to predict the service life of the chaser, but the result is not completely accurate according to the result of the technical communication between the author and the producer. Since the service life of chaser depend not only on the material hardness, so the simplest and most intuitive way to judge the service life of the chaser is to count the quantity of the products produced by the chaser and establish the data base of each supplier, which can be used to evaluate the quality of the chaser from different suppliers and annual longitudinal comparison.

2.2. Geometric Parameters of Chaser and Measuring Method

In the original paper, Mr. Zhang mentioned the main parameters during chaser examination are as shown:

(1) tooth angle,
(2) tooth height,
(3) upper and lower half tooth height of the middle line position,
(4) full tooth pitch,
(5) the left and right half teeth pitch of the middle line position,
(6) single tooth pitch,
(7) the positioning size of the chaser,
(8) other dimensions of the chaser.

Among them, the parameters which Mr. Zhang mentioned the testing methods are as shown:

(1) tooth height,
(2) tooth angle,
(3) taper of thread,
(4) upper and lower half tooth height of the middle line position,
(5) full tooth pitch.

As a comparison, the parameters involved in this paper are as shown:

(1) tooth top / tooth bottom straightness error,
(2) half angle of the tooth,
(3) tooth height,
(4) single tooth pitch,
(5) accumulative pitch in one inch,
(6) full teeth pitch within 200mm,
(7) width in tooth bottom

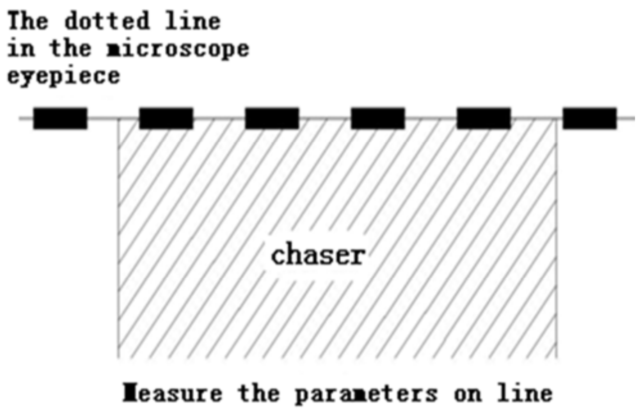
In addition, some parameters that not commonly tested are as shown.

(1) radius of tooth top,
(2) angle of chaser tooth,
(3) flatness of the upper and lower surface of chaser.

2.2.1. Principle of Microscopes Using

Before measuring, we should emphasize several measurement principles of the microscope.

(1) "Abbe measurement principle", that is, in the length measurement, the standard length (standard line) should be placed on the extension line of the measured length (measured line).
(2) The angle of microscopes measuring eyepiece should be controlled within 0.5'.
(3) The parameters on line are measured with the dotted line of the microscope eyepiece, and the angle parameters are measured with the solid line, as shown in Figure 1.



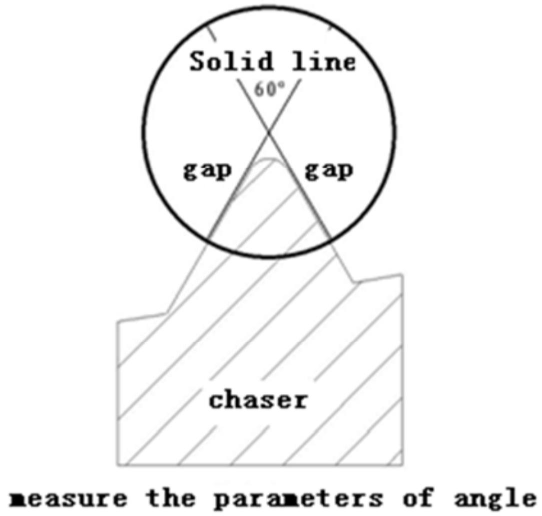


Figure 1. Schematic diagram of principle (3).

For principle (3), in my opinion is that when using the microscope auxiliary line to measure object, dotted line should be used to measure the linear edge of the measured object in order to judge how about the overlap between the auxiliary line and the edge of the object being measured ; when we measure the angle or the intersection of two lines, we should use two solid lines with the method of gradual approach to make the gap between the auxiliary line and the corresponding projection of measured object, and so to ensure the accuracy of the measurement.

2.2.2. Testing Standards and Principles

In the original paper, Mr. Zhang mentioned that all the testing of the chaser should be based on the drawings. For this article is based on the 45 teeth chaser made by the KENNAMETAL German which is used for 700mm (28 inch) T4L electrode and the testing parameters are shown in Figure 2.

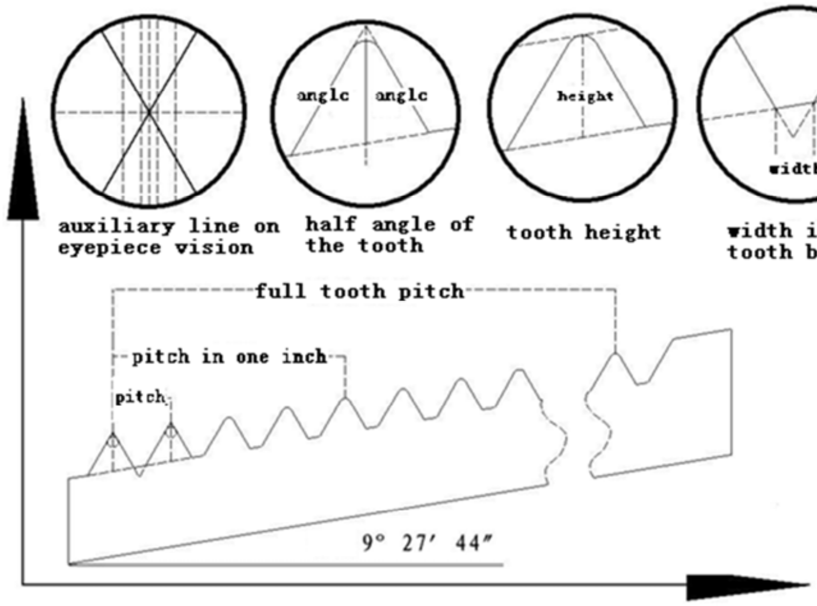


Figure 2. Schematic diagram of the detection parameters of the chaser.

According to figure 2, all the testing should based on the 9° 27 '44' which is the thread angle, and the parameters should be corrected by the same angle. At the same time, according to the “Abbe measurement principle”, the standard length (standard line) should be placed on the extended line of the measured length (the measured line). Therefore, the measured object should be rotated for the corresponding angle so that the direction of the pitch and the height parameters of the tooth is consistent with the direction of the X and Y axis.

In the original paper, the parameters and drawings are based on the horizontal placement, the taper of the thread is judged by the angle between the tooth border and the Y axis. The two things above I think should be not advisable.

2.2.3. Detection Methods and Steps

(i) Tooth top / tooth bottom straightness error

When the chaser is evaluated, the straightness error of the tooth top / tooth bottom can directly reflect the quality of the chaser. At the same time, because the straightness of the chaser directly affects the straightness of the thread which is processed. So this parameter of straightness error must be detected first.

The straightness error of the tooth top / tooth bottom is the connection of all top / the corresponding point of the bottom of each tooth. It is independent of the angle of the thread. Therefore, the chaser could be placed horizontally and then measure & record the coordinates of each point, then evaluate the straightness error by different methods.

According to the relevant literature, there are generally three ways to evaluate straightness error: [1]:

(1) The connection of two end point method;

(2) Least mean square approximation method;

(3) Minimum region method.

According to the characteristics of chaser, the connection of two end point method is recommended in this paper. The measuring methods and operation procedures on microscope are as follows:

(1) Place the chaser on the loading platform and adjust the focal length of the microscope objective lens to make the edge of the chaser clear.
(2) Take the microscope eyepiece to 0 degrees, adjust the field of view, make sure that the auxiliary line can be clearly discernible.
(3) By using the method shown in Figure 3 to measure Y axis coordinates of the first and last tooth of the chaser and then adjust the platform to make the two points Y axis coordinate as same as possible.
(4) Using the method shown as Figure 3 to measure all the top of teeth and record all the Y axis coordinate Ytop.
(5) Using the method shown as Figure 4 to measure all the bottom of teeth and record all the Y axis coordinate Ybottom.
(6) Tooth top / tooth bottom straightness error can be calculated as follow: Tooth top straightness error $=Y_{top,max}-Y_{top,min}$ tooth bottom straightness error $=Y_{bottom,max}-Y_{bottom,min}$

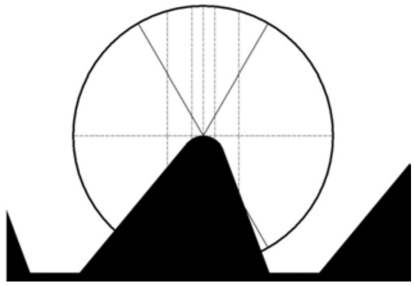


Figure 3. *Sketch of step 3.*

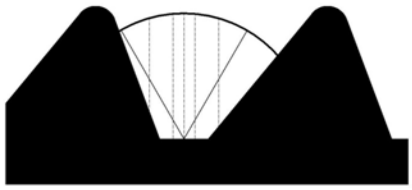


Figure 4. *Sketch of step 5.*

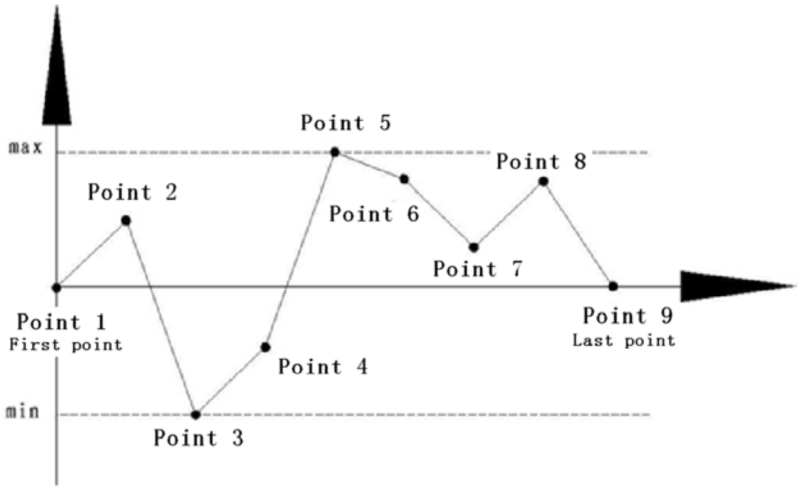


Figure 5. *The geometric meaning of straightness error measured by "the connection of two end point method".*

It should be emphasized that the tooth top line described above is not the true line of the teeth top of the chaser, but the simplified operation in the measurement [2]. The differences were shown as Figure 6.

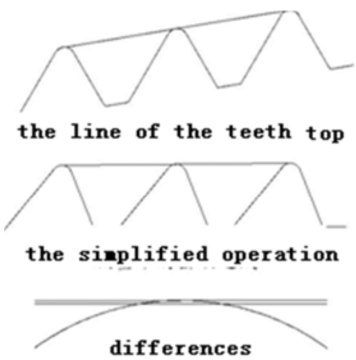


Figure 6. *The differences between theory and measuring.*

(ii) Setting up measuring coordinate system

As mentioned above the parameters are measured base on the thread angle 9°27'44", so the measuring coordinate system should be set up with the same angle [3]. The concrete methods and steps are shown as follows.

(1) Place the chaser on the loading platform and adjust the focal length of the microscope objective lens to make the edge of the chaser clear.
(2) Take the microscope eyepiece to 0 degrees, adjust the field of view, make sure that the auxiliary line can be clearly discernible.
(3) By using the method shown in Figure 7 to measure X/Y axis coordinates of the first and last tooth of the chaser(X1, Y1).
(4) By using the method shown in Figure 7 to measure X/Y axis coordinates of the last tooth of the chaser(X2, Y2).

(5) Calculate the angle of the chaser by the equation (1).

$$TAN(angle) = \frac{Y_2 - Y_1}{X_2 - X_1} \quad (1)$$

(6) Repeat step 3-5 to make the angle turn to be 9° 27'44".

(7) Fixed the platform and then the measuring coordinate system is set up.

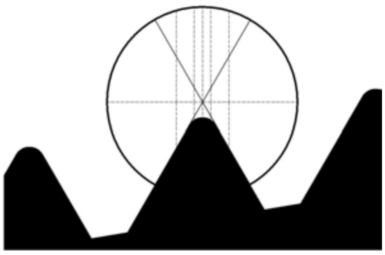


Figure 7. *Sketch of step 3.*

It is necessary to emphasize that the following parameters should be detected in this measuring coordinate system.

(iii) Half angle of the tooth

The geometric meaning of half angle of the tooth is shown in Figure 2, and its measuring methods are as follows.

(1) Adjust the angle of the microscope eyepiece to 0 degrees.
(2) By using the method shown in the left of Figure 8 to let both of the solid line with the angle of 60 degrees in the eyepiece of the microscope is tangent to the top circle of the tooth.
(3) By using the method shown in the right of Figure 8 to rotate the eyepiece to make the left solid line coincide or parallel with the tooth left edge.
(4) Record the eyepiece angle of the microscope as the deviation value of the left half angle of this tooth: α_i (i=1, 2, 3……).
(5) By using the method shown as step 3 to record the right half angle of this tooth as β_i(i=1, 2, 3……).
(6) Repeat step 3-5 to measure the left and right deviation value of all the teeth.
(7) All the deviation value above should be within the specified error range, as shown in formula 2.

$$|\alpha_i| or |\beta_i| \ngtr specified\ error\ range\ (i = 1, 2, 3 \ldots\ldots) \quad (2)$$

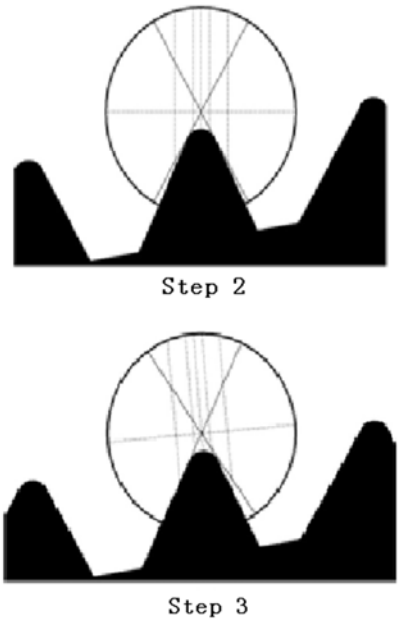


Figure 8. *Sketch of step 2 & step 3.*

(iv) Tooth height

The geometric meaning of tooth height is shown in Figure 2, and its measuring methods are as follows.

(1) Adjust the angle of the microscope eyepiece to 0 degrees.
(2) By using the method shown in the left of Figure 8 to let both of the solid line with the angle of 60 degrees in the eyepiece of the microscope is tangent to the top circle of the tooth.
(3) Keep the X axis of the microscope no moving, take the horizontal dotted line in the microscope eyepiece along the direction of the Y axis to be tangent to the top circle of the tooth, and then record the Y axis coordinate as: Y tooth height 1.
(4) Keep the X axis of the microscope no moving, by using the method shown in the Figure 9 to take the horizontal dotted line in the microscope eyepiece along the direction of the Y axis to coincide to the both bottom line of tooth, At this point, the angle of the microscope eyepiece should be between 9 ° 27 '30' to 9 °28', and then record the Y axis coordinate as: Y tooth height 2.
(5) The tooth height can be calculated as shown in Formula 3.

$$tooth\ height_i = Y_{tooth\ height\ 1} - Y_{tooth\ height\ 2}\ (i = 1, 2, 3 \ldots\ldots) \quad (3)$$

(6) Repeat step 2-5, record all the tooth height and comparing with the standard value by formula (4).

$$|tooth\ heigh_i - standard| \ngtr specified\ error\ range\ (i = 1, 2, 3 \ldots\ldots) \quad (4)$$

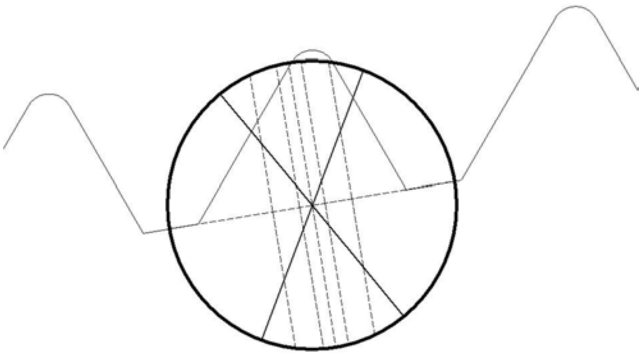


Figure 9. *Sketch of step 4.*

(v) Single tooth pitch, accumulative pitch in one inch, full teeth pitch within 200mm

The geometric meaning of parameters of pitch is shown in Figure 2, and its measuring methods are as follows.

(1) Adjust the angle of the microscope eyepiece to 0 degrees.
(2) By using the method shown in the left of Figure 8 to let both of the solid line with the angle of 60 degrees in the eyepiece of the microscope is tangent to the top circle of the tooth, and then record the X axis coordinate as: Xi(i=1, 2, 3……).
(3) Repeat step 1-2 and record all the X axis coordinate for each tooth in the measuring range as: Xi.
(4) For single tooth pitch, it should satisfy the formula (5).

$$|(X_{i+1} - X_i) - standard\ pitch| \ngtr specified\ error\ range(i = 1,2,3 \ldots\ldots) \tag{5}$$

(5) For accumulative pitch in one inch, it should satisfy the formula (6).

$$|(X_{i+4} - X_i) - standard\ pitch \times 4| \ngtr specified\ error\ range(i = 1,2,3 \ldots\ldots) \tag{6}$$

(6) For full teeth pitch within 200mm, it should satisfy the formula (7).

$$|(X_{32} - X_1) - standard\ pitch \times 31| \ngtr specified\ error\ range \tag{7}$$

It should be explained that in this paper I take the 45 teeth chaser for the example, its total length is about 300mm and for the microscope which general X axis travel is only 200mm. Therefore in the range of 200mm detection, for the maximum it can hold 32 complete teeth with 31 pitches. But for the shorter chaser this method should be adjusted accordingly [4].

(vi) Width in tooth bottom

The geometric meaning of width in tooth bottom is shown in Figure 2, However, because of the arc shaped transition at the junction between the two teeth, the accuracy of the measurement is relatively lower than other parameter [5]. Therefore, in the process of evaluating the quality of the chaser, the width in tooth bottom can be used as an auxiliary parameter to correct the tooth height [6]. The geometric relationship between the two will be introduced in the third part of this article.

The measuring methods of width in tooth bottom are shown as follow.

(1) Adjust the microscope eyepiece and platform make the solid line coincide with the left edge line of one tooth bottom, as shown in Figure 10.
(2) Adjust the microscope eyepiece and platform make the dotted line coincide with the edge line of one tooth bottom, as shown in Figure 11. At this time, the angle of the microscope eyepiece should be between 9°27 '30' to 9 °28'.
(3) Repeat step 1-2 until there is no need to move the platform, just Only rotating eyepiece can realize the coincidence shown as steps 1 and 2, and then record the X axis coordinate as: X left.
(4) By using the same method as step 1-3, we can get the intersection point that the right boundary line and the edge line of the tooth bottom, and then record the X axis coordinate as: X right.
(5) The width in tooth bottom can be calculated as formula (8).

$$width\ in\ tooth\ bottom_i = |X_{left} - Y_{right}|\ (i = 1,2,3 \ldots\ldots) \tag{8}$$

(6) Repeat step 1-5 to measure all the width parameters of tooth bottom and compare them with the standard values. The absolute value of the difference should be within the specified error range.

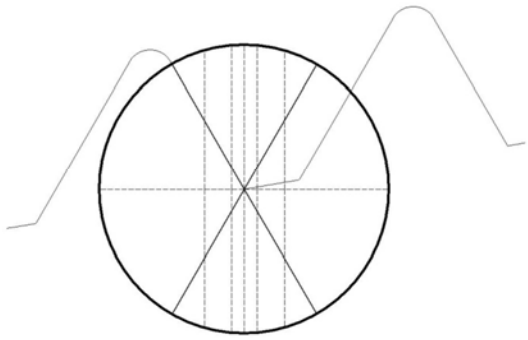


Figure 10. *Sketch of step 1.*

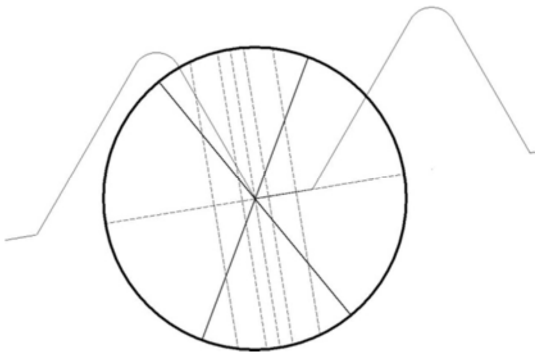


Figure 11. *Sketch of step 2.*

(vii) Radius of tooth top

Since the microscope is only suitable for measuring the parameters of line, the radius of tooth top can not be obtained by direct measurement, but the approximate data can be obtained by the geometric conversion relation as shown in Figure 12. It is important to note that this data is measured only under the condition that the tooth top should be no broken and can be considered as part of circle [7].

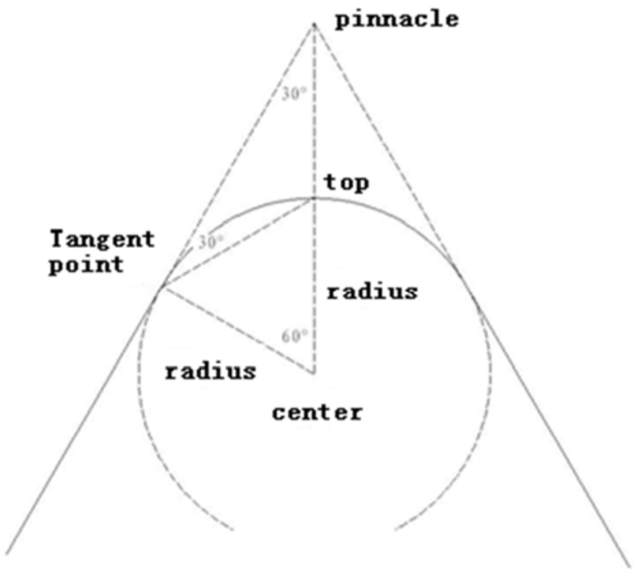


Figure 12. *Geometric conversion diagram of the circle radius of the tooth top.*

The method of measurement as follows.

(1) Adjust the angle of the microscope eyepiece to 0 degrees.

(2) By using the method shown in the left of Figure 8 to let both of the solid line with the angle of 60 degrees in the eyepiece of the microscope is tangent to the top circle of the tooth, and then record the Y axis coordinate as Y pinnacle.

(3) Keep the X axis of the microscope no moving, take the horizontal dotted line in the microscope eyepiece along the direction of the Y axis to be tangent to the top circle of the tooth, and then record the Y axis coordinate as: Y top. (same as 2.3.4 step 3)

(4) The radius of tooth top can be calculated as formula (9).

$$radius\ of\ tooth\ top_i = Y_{pinnacle} - Y_{top}\ (i = 1, 2, 3 \ldots\ldots) \quad (9)$$

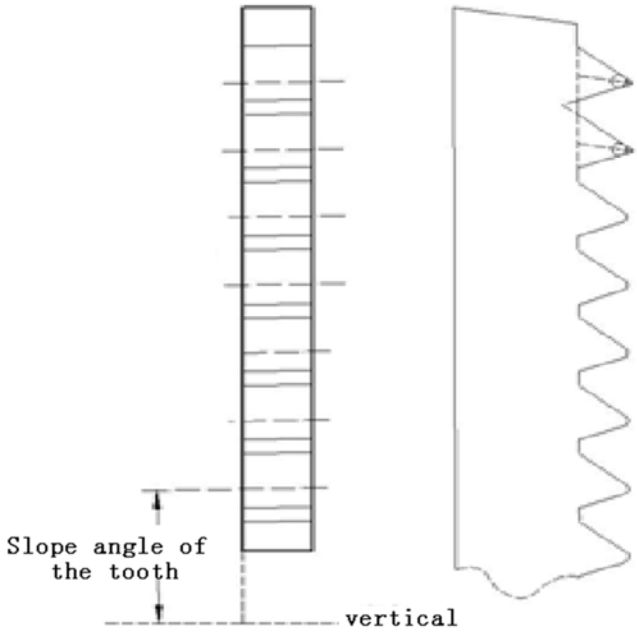


Figure 13. *The geometric meaning of slope angle of the tooth.*

(5) Repeat step 2-5 to measure all the radius parameters of tooth top.

Because the radius of the tooth top is only used to evaluate the wear degree of chaser so no need to compare with the standard value, but it can be used for judge the accuracy of the measurement of the tooth height [8].

(viii) Slope angle of the tooth

The geometric meaning of slope angle of the tooth is shown in Figure 13.

The measurement of the slope angle of the tooth can not be measured by microscope directly. It should be measured with the auxiliary lighting equipment and this parameter has no unified standard.

(ix) Flatness of the upper and lower surface of chaser

The flatness of the upper and lower surface of the chaser is used to evaluate the degree of deformation of the chaser after using. According to the author's personal experience, because of the difference between the cemented carbide section and the common steel part, the degree of deformation of the different parts is different during proceed of machining, which leads to the bending deformation of the chaser. Chaser with severe bending deformation can not be detected by microscope [9].

The flatness of the upper and lower surfaces of the chaser can be measured by the plate and dial indicator, as shown in Figure 14.

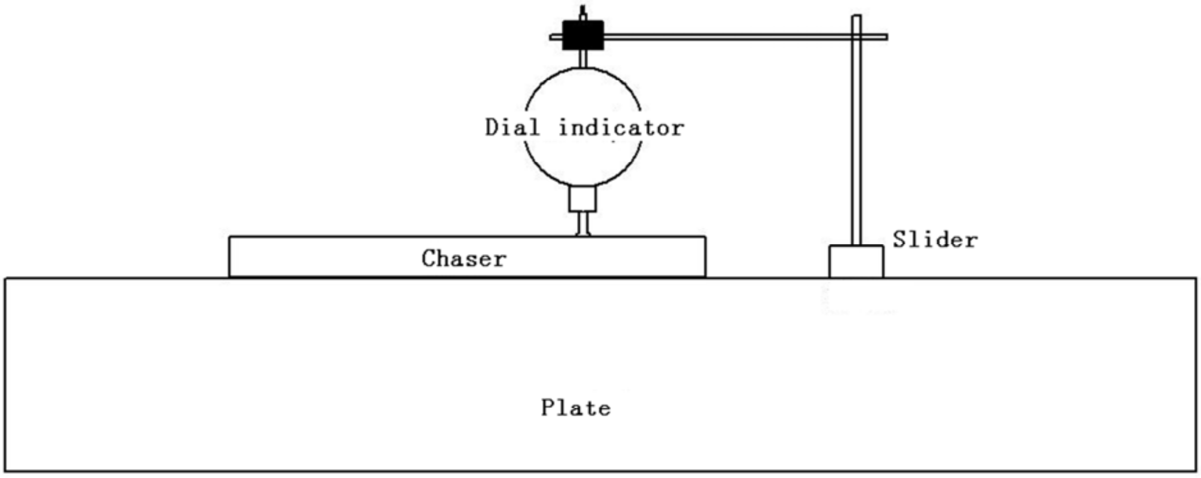


Figure 14. *Measurement of flatness of the upper and lower surface of chaser.*

3. Discussion of Geometric Meaning and Corresponding Relation

As mentioned in 2.2 above, most of the measuring parameters of the chaser are the same, only a few of them are different, but in my opinion they have the same geometric meaning. Here this paper take the parameters "the upper and lower half tooth height and the half tooth pitch in the middle height of tooth" mentioned in original paper and "half angle of the teeth" mentioned in this paper for example. The discussion is as follows.

In order to discuss the geometric meaning of the parameters, the chaser should be placed in the two-dimensional measuring coordinate system as shown in Figure 15. In this case each parameter can be transformed into angle & length and solved by mathematical method [10].

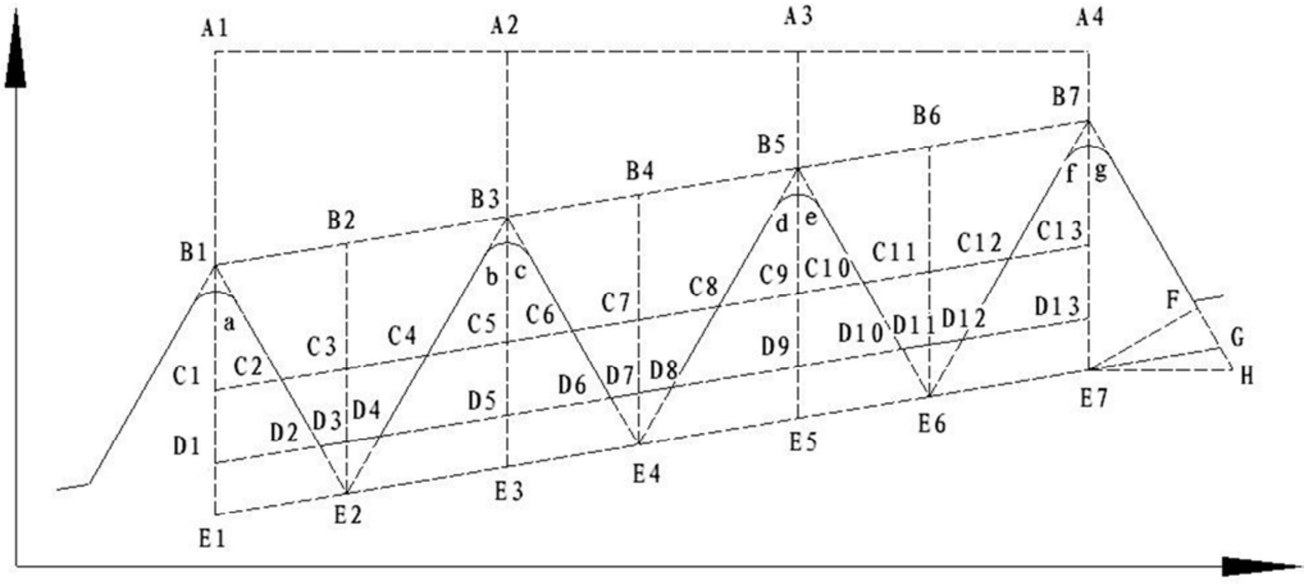


Figure 15. *Chaser in the two-dimensional measuring coordinate system.*

In a two-dimensional coordinate system, the location of a point can be described as (X, Y) and the length of a line can be calculated by projection length on X axis and Y axis. Respectively, in order to calculate the length of the line shown in Figure 15, the projection distance of each line on the X and Y axes should be measured first. Since there are relationship between measured parameters, so the most easily measured parameters as the representative item and other parameters can be obtained by calculations. But which are the most representative parameters are considered different from carbon companies.

In the original paper, Mr. Zhang introduced the measurement and evaluation method of the upper and lower half tooth height and the half tooth pitch in the middle height of tooth. This paper take half angle of the teeth for instead through geometric analysis, for another word they have the equivalent meaning. That is they are all the parameters used to evaluate the condition of the tooth of the chaser. As shown in Figure 15, the proposition can be transformed into the following analytic equation.

Prerequisites: the shape of the teeth is good, the straightness error of the teeth top & teeth bottom is 0, the chaser taper is 9 °27 '44 ".

Known: pitch A1A2, A2A3, A3A4; half angle of the teeth: a, b, c, d, e, f, g

Unknown: The half tooth pitch on the line C1C13 which is in the middle height of tooth: C4C6, C6C8, C8C10.

Solution:

According to the known, it can be considered that the straight line B1B7 is parallel to the straight line E1E7.

According to the definition, straight lines B1E1, B2E2……B7E7 parallel to each other.

Taking triangle B7E7G as an example, the following equation can be obtained by using auxiliary line E7F which is perpendicular to BB7G:

$$E_7G = \frac{B_7E_7 \times \sin(g)}{\sin(90° - g + taper)} \quad (10)$$

$$B_6B_7 = \frac{B_6E_6 \times \sin(f)}{\sin(90° - f - taper)} \quad (11)$$

$$B_5B_6 = \frac{B_6E_6 \times \sin(e)}{\sin(90° - e + taper)} \quad (12)$$

$$\frac{B_5B_6}{B_6B_7} = \frac{\sin(e) \times \sin(90° - f - taper)}{\sin(f) \times \sin(90° - e + taper)} \quad (13)$$

At the same time, the pitch should satisfies the following formula:

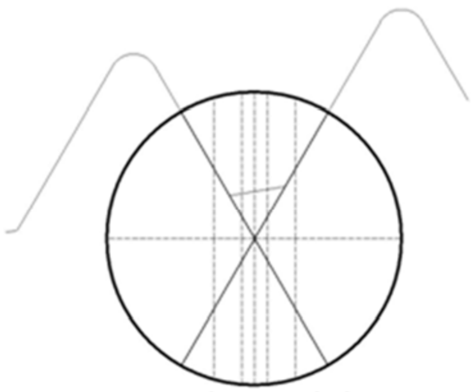
$$B_5B_6 + B_6B_7 = A_3A_4 \times \cos(taper) \quad (14)$$

From above two formulas the specific values of B5B6 & B6B7 can be calculated.

According to the definition, in the middle height of tooth, the length of lines C11C12 and C12C13 can be considered as half of B5B6 and B6B7 respectively.

By the same way the specific values of C4C5, C5C6, C6C7, C7C8, C8C9, C9C10, and C4C6, C6C8, C8C10 can be calculated at the same time.

From the above, it can be said that the half tooth pitch in the middle height of tooth and the half angle of the teeth have the same geometric meaning. However, in the actual measurement process, the view is too narrow in the eyepiece, as shown in Figure 16.



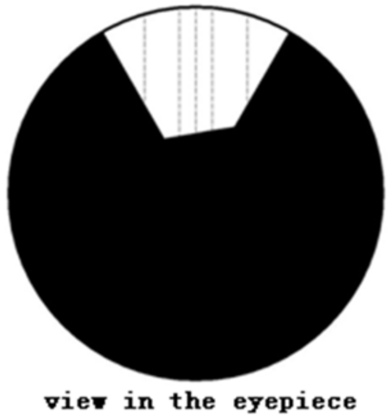


Figure 16. *Narrow view in eyepiece.*

In this paper mentioned that the Width in tooth bottom can be used to calculate the tooth height, this can be transformed into the following analytic equations by using Figure 15.

Prerequisites: the shape of the teeth is good, the straightness error of the teeth top & teeth bottom is 0.

Known: the chaser taper, tooth height: B_7D_{13}, B_5D_9, pitch: A_3A_4, half angle of the tooth: e, f.

Unknown: Width in tooth bottom: $D_{10}D_{12}$

Solution:

$$D_9D_{10} = \frac{B_5D_9 \times \sin(e)}{\sin(90° - e + taper)} \quad (15)$$

$$D_{12}D_{13} = \frac{B_7D_{13} \times \sin(f)}{\sin(90° - f - taper)} \quad (16)$$

$$D_{10}D_{12} = A_3A_4 \times \cos(taper) - D_9D_{10} - D_{12}D_{13} \quad (17)$$

It can be seen from the above that the tooth height and the width in tooth bottom are corresponding functions, that is, when the tooth width decreases, the tooth height increases, and vice versa.

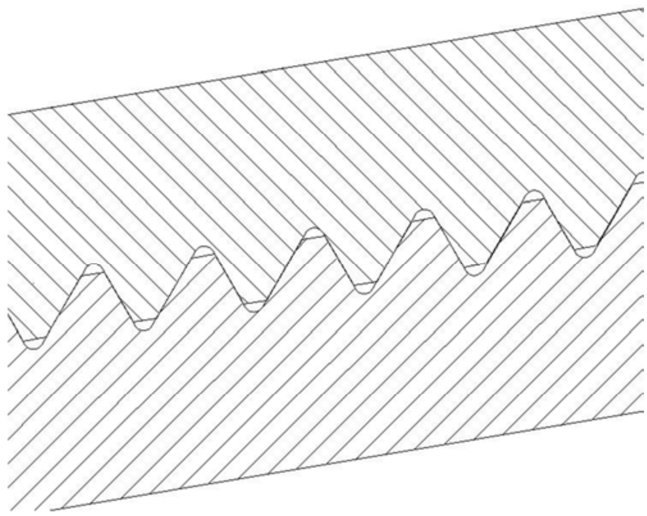


Figure 17. *The connection of the electrode and nipple.*

It is important to note that in the upper solution, the real participation in the calculation should be the height of the tooth pinnacle, the tooth height is the parameter obtained through the conversion of the radius of the tooth top circle, but because the height of the tooth pinnacle does not exist in reality, it is the virtual parameter only on the drawing, so the tooth height is generally used instead the height of the tooth pinnacle as the Y axis principal variable in the two-dimensional measurement coordinate system [11]. Also the X axis principal variable is generally recognized as tooth pitch. Although the tooth height are also affected by the radius of the top circle of the teeth shown as figure 17, but the part of the tooth top circle does not participate in the thread connection. Therefore, the change of the tooth height caused by the subtle change of the radius of the top circle does not affect the connection of the electrode and nipple. When the height of the tooth pinnacle is certain and the pitch is certain, so the tooth shape is without change.

4. Conclusion

This article is just mentioned general method of chaser detection in KFCC. It has been tested for many years and be proved that it can meet the needs of chaser quality evaluation. Compared with the original paper it can be considered that most parameters in both methods are same and the rest have the same geometric meaning.

What needs to be pointed out is that the difference mentioned in part 3 is only for reference, in this paper the calculation and verification are only personal opinions and Public discussion is required to verify its correctness.

Up to now, in the carbon industry, there is no uniform standard for the detection of chaser.

The way to set up this standard, the different method from each carbon company should be studied and find out the commonalities. Thanks again for Mr. Zhang's paper who make the first step of this work. The chaser parameters measured in his paper are universal and of great significance.

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