

On the Modeling Structure Treatment in Traditional Ceramic Technology to Avoid Firing Deformation

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Abstract. Traditional ceramic molding is the starting point and final destination of ceramic ware production. It is the junction of a long process in the technology development. It is invisible in the history of ceramic technology evolution and in the production of each ceramic product. It does not only reflect the common technological and cultural thoughts, but also reflects the realistic fulfillment of concrete actions one by one.

Introduction

From the invention of ceramics to the appearance of ceramic ware until now, the deformation of ceramic modeling is still one of the difficult problems perplexing ceramic design and production. For this reason, the main body of ceramic production can't make ceramic objects at will all the time. Even if it is carefully designed and made, there are still various reasons that can cause ceramic products to deform, damage, etc., which is contrary to the original intention of human creation.

However, it takes a process for human beings to know, understand and effectively grasp the development law of everything. Therefore, exploring ceramic technology, analyzing the modeling principle of products and preventing their deformation also need such a process. Only in this way can we return to the original intention.

Persistence for a Long Time before Success

With the improvement of ceramic craftsman's cognitive ability and mastery of ceramic manufacturing technology, ceramic technology is becoming more and more perfect and abundant: the ancients said, "the division of labor is extremely fine and requires a large amount of labor to make meticulous products." It can be seen that a successful ceramic product is not easy to obtain. In the ceramic manufacturing process, firing is one of the main processes. It is the production process of ceramic products with fixed volume and specific properties by heating the ceramic green body according to a certain thermal system so that the green body undergoes physical and chemical reactions under specific high temperature conditions. In terms of ceramic technology, there is "one firing, two earth and three production". Thus, it can be seen that materials and their technology, production (preparation of materials and molding of products) and firing are all factors that affect the success of ceramic production. All kinds of mistakes in the whole process will lead to more or less defects in ceramic products. Among them, firing is one of the important techniques for making ceramics. If firing fails, all the efforts in the previous processes will be wasted.

However, the success of firing a piece of ceramic ware does not depend entirely on the firing process. The chemical and physical properties of the ceramic material, its process, modeling process, shape of the ware and other technological and non-technological factors also have direct and indirect effects. Therefore, considering the production process from the comprehensive factors such as design and production process, strictly observing various specifications, and adopting some reasonable skills when necessary are the objective requirements for the success of ceramic production. However, some process errors are still inevitable, resulting in the occurrence of product defects. The most common defects are deformation during firing, such as distortion of caliber, irregular change of geometric shape, etc. Therefore, it is very necessary to take various effective measures to avoid defects in ceramic production and improve the rate of finished products.

Think Carefully, Act Carefully, Comfort Ingenuity

From the starting point of creation, the ceramic production process is aimed at meeting the functional needs. Therefore, ceramic craftsman of past dynasties have worked hard, scrupulously followed the creation and its technological spirit, continuously learned from the defects caused by mistakes, and turned them into successful experiences: improper kiln installation methods, such as uneven sagger bottom inclination; too high temperature of the product in the heating process of the blank during firing; the highest firing temperature exceeding the melting temperature of its basic components; long holding time, all of which will affect the finished product rate of ceramic production. In this way, ceramic craftsman of all ages have always adhered to the spirit of creation, fulfilled their duties, meticulously produced and achieved certain good results. This is the manifestation of the craftsman spirit in traditional ceramic production.

Unique Double Circular Foot Setting and Its Modeling.

Foot, or "bottom foot", is placed at the lowest part of the whole shape, which supports the whole shape, conforms to the function and gives people a comfortable visual impression. It must be able to support the whole ware to stand upright and make the ware smoothly contact the placing surface. According to the research and statistics of ancient ceramic feet by scholars at home and abroad, there are many types of feet, up to at least 130 kinds, including flat-bottomed feet, pie-shaped feet, jade-like feet, circular feet, column feet, etc.

Double circular foot is the most important form of circular foot (as shown in Fig. 1), which appeared more frequently in Jingdezhen modeling of Qing dynasty and marked the ingenuity of ceramic craftsman. Double circular foot, "one of the forms of circular



Fig. 1 Double circular foot 1

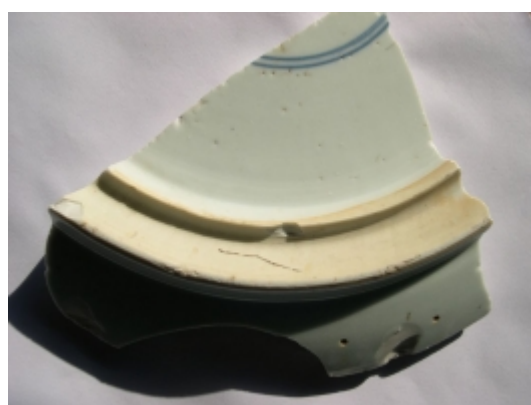


Fig. 2 Double circular foot 2

foot, which is also known as 'double bottom foot'. In early Kangxi period of Qing Dynasty, Jingdezhen kiln had a foot form of some bottles, plates and jars (as shown in Fig. 2). Because there is a groove at the bottom of the ware's circular foot, it forms a double circular foot, hence its name. The inner foot is lower than the outer one, and the outer one is in contact with the placing surface. During the Yongzheng period, there were also wares with double circular feet which came from the production experience of ceramic craftsman in past dynasties. It is the result of continuous improvement in molding process, aiming to prevent the dishes, pen washing, bottles, cans and other wares with large foot span from collapsing during high-temperature firing. Because the ceramic craftsman found that for this kind of wares with "large - span bottom foot", it is difficult for the single circular foot to support the weight of the whole ware, which is easy to cause deformation during firing, so the ceramic craftsman disposed of it at the bottom of the ware and set it into a double circular form. This is the origin of the double circular form modeling. From a mechanical point of view, the middle part of a bottom surface with the same thickness is the weakest part when it is stressed and is also where it is most likely to distort under the action of gravity due to insufficient supporting force when the blank reaches a certain temperature in a molten state. The double circular foot can increase the thickness of the inner circular foot at the bottom of the ware, which cannot only reinforce the relatively weak middle part, but also can decompose the gravity of the ware

concentrated in the middle of the circular foot to avoid foot deformation. The ingenious arrangement has been used up to now, and often appears in modern ceramic design and even becomes one of the concepts of modern ceramic design.

In modern ceramic design, designers usually adopt the form of double circular foot to strengthen the supporting force at the bottom of the ware with large diameter which is easy deformation at the bottom during firing. Specifically, the height of the inner circular foot of the ware is changed to be the same as that of the outer one, so that both the inner and outer circular feet can jointly bear the weight of the ware and effectively prevent deformation.

Well - conceived Anti - deformation Setting of Lifting Beam and Its Treatment.

In general, a practical ware is constructed around its main function, which consists of a main part and a secondary part. The secondary part assists the main part in performing its function. In ceramic wares, the lifting beam is a secondary part, i.e. one of the accessories, which is used to assist the main body of the ware to realize the preset function, and can strengthen or assist the main body to play its function (as shown in Fig. 3). In ceramic wares, the part which is similar to lifting beam includes mouth, ear, foot, knob, handle, etc. They are like the lifting beam and become the organic component of the whole ware.



Fig. 3 White Glaze Lifting Beam Pot of Liao Dynasty

In production, the lifting beam is separately made and then organically bonded with the main body, which undoubtedly increases the difficulty of the production process, and at the same time, also adds problems to firing and packaging. Therefore, when setting up the lifting beam for the ware, we should not only consider its independent modeling form, but also its organic relationship with the main body of the ware, as well as the adverse effect caused by firing errors on the whole modeling.

The lifting beam has a relatively large span and a relatively large degree of freedom of creativity. Therefore, the lifting beam can be creative and made into a large number of modeling images. On the basis of improving its practical function, the lifting beam can be as diverse in form as possible, beautiful and unique, so as to fully show its beauty. However, from a mechanical point of view, the gravity of the suspended part in the middle of the lifting beam is supported by the connecting parts between the two ends and the main body, and the closer the part is to the middle, the smaller the supporting force of the two ends will be, which makes the possibility of bending and deformation due to the influence of gravity be greater when the lifting beam is fired at high temperature, and the expected effect cannot be achieved. For this reason, it has become a major technological problem in the traditional ceramic production to properly handle the modeling structure of the ceramic lifting beam. Ceramic craftsman found that the supporting force of the two jointing points formed at the two ends of the joint between the lifting beam and the main body was crucial, so they used the anti-deformation method to carry out appropriate treatment, i.e. to make a

certain degree of bulge or concave on the basis of the original design to balance the shrinkage in possible deformation, thus eliminating the occurrence of deformation. (as shown in Fig. 4).



Fig. 4 Purple Sand Lifting Beam Pot by Li Zhongfang of Ming Dynasty

Pursue Diligently to Become Harmonious

The deformation phenomenon in ceramic production has always been an important problem in ceramic technology, and it is also a difficult problem puzzling ceramic craftsman to create at will.

However, in front of the diligent Chinese ceramic craftsman, this problem was finally solved. The ancient ceramics production paid attention to practice, found out problems from actual operation and solved them. The traditional ceramic manufacturing process is carried out by craftsman with strong professionalism. The whole process is perfect. Even if there is division of labor, it will always be operated in a cohesive manner in close coordination. Therefore, it is reasonable and scientific in terms of technology. The development and progress of ceramic production is the continuous improvement of technology, that is, the continuous improvement of production technology. It is rooted in the concrete operation of production practice and is solved in time when problems are found at any time. In this way, it initially reflects a subconscious technical behavior of ceramic craftsman. However, after many practical operations, it is finally transformed into experience and conscious thinking, even rising to an idea, which is the manifestation and transformation process of traditional craftsman spirit. "Technical thought is a rational thinking on the implementation of technology and a regular feeling and summary of metaphysical thinking mode in the process operation. In the process of creation, technological thought changes from abstract consciousness to concrete technological route, which determines the trend of creation and determines the type, characteristics and formal structure of products." Of course, what we have learned from the case of anti-deformation treatment of double circular feet and lifting beams is only a reflection of the transformation of traditional ceramic technology into an ideology and even a spirit.

Conclusion

Ceramic technology gradually tends to conform to the production process, the function of wares and even the economic value. This process cannot be separated from the whole development process of ceramic technology, the growth process of a ceramic craftsman, and the careful thinking and careful production of each ceramic craftsman. It is not only the result of ingenuity but also the embodiment of craftsman's spirit.

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