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Innovation Technology of Shiwan Ceramic Art Murals

JunHan Li[1] Thawascha Dechsubha[2]

Abstract

The purposes of this research were: Shiwan is the largest ceramic production base and trade market in China. It is one of the most advanced ceramic production bases in China. With a large number of strong ceramic manufacturers and well-known ceramic brands, it has a good prospect of development. Shiwan ceramics has a long history. Since the mid-1980s, when Shiwan purchased China's first foreign production line for architectural ceramics from Italy, China's architectural ceramics industry has entered the stage of scale and industrialization. After nearly 40 years of development, Chinese ceramics have profoundly impacted the world in terms of quality, ceramic machine and equipment, design, research and development, and most of the ceramic equipment has been domestically produced. With the rapid growth of architectural ceramic technology, Shiwan traditional ceramic murals have also begun to change from hand-made to fully mechanical production. The perfect combination of high technology and art has created a unique form of innovative ceramic murals in Shiwan.

Keywords: Innovation Technology, Shiwan Ceramic Art Murals, trade market in China

Introduction

As China's economy develops and urbanization accelerates, the demand for infrastructure is increasing, and there are more and more large-scale municipal projects. High-speed rail, subway, airport, and other large projects are growing, requiring large murals to decorate and advertise. The durability, corrosion resistance and other advantages of ceramic murals make them applied in many new high-speed rail, subway and other large-scale projects.

Due to the production of raw materials and the process method's limitations, the traditional ceramic mural is not flat and small, the toughness is not enough, and

[1] Ph.D, Candidate, Semiotics and Arts Cultural studies, School of Liberal Arts, Shinawatra University
E-Mail: junhanli123@gmail.com
[2] Assoc. Prof, Dr, School of Liberal Arts, Shinawatra University

it is very easy to be damaged and broken, which increasing the difficulty of installation. Traditional ceramic murals are hand-carved or hand-rolled (Figure 1 and Figure 2) and installed with cement or marble viscose. Compared with Shiwan's innovative ceramic murals, traditional ceramic mural relatively troublesome to install, and it is easy to fall off, and it is not easy to install a large area at high altitude.



Figure 1 Traditional ceramic murals



Figure 2 Traditional ceramic mural porcelain plate pressing

Shiwan relies on a solid production process of architectural ceramics and constantly improves the flatness of the porcelain plate. On June 19, 2019, the first 36000 ton press (HT36000) independently developed by Henglitai, a ceramic machinery and equipment enterprise in Shiwan, was successfully installed, debugged, and tested in the Xiqiao production base of Monalisa Group. The 36000-ton press is not only the largest ceramic plate molding press in China but also the largest traditional mold molding press in the global ceramic tile field (Figure 3).



Figure 3 36000 ton porcelain plate pressing machine (HT36000)

For China's ceramic industry, it is a landmark technological innovation, the most significant technological breakthrough in the history of China's ceramic equipment development and an essential embodiment of China's ceramic plate production and manufacturing strength. It means that China already possessed the production technology of ceramic plates with independent intellectual property rights in the production and manufacturing of ceramic plates. It has opened up a new road for the deep development of China's ceramic plate manufacturing. The application of a 36000t large press makes the flatness of the ceramic plate embryo of Shiwan ceramic innovative mural excellent, which is more conducive to the installation of ceramic murals.

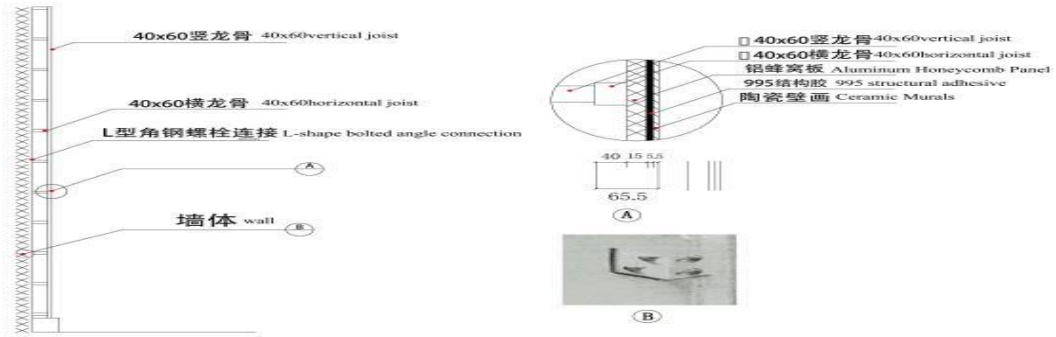


Figure 4 Installation of innovative fresco of Shiwan Ceramics

Due to the flatness and thinness of Shiwan ceramic innovative mural porcelain plate, the installation of keel, light aluminum plate, glue and other materials, different from the traditional ceramic mural installation methods. The traditional ceramic use

with cement, mortar installation, long time use will be easy to fall off, and the new installation is more stable and safe (Figure 4, Figure 5).



Figure 5 Schematic diagram of Shiwan ceramic innovation mural installation

Compared to traditional ceramic murals, Shiwan ceramic innovation mural is lighter and thinner, more in line with environmental requirements

With the continuous development of China's comprehensive strength, people's lives are improving, and the requirements for environmental protection are getting higher and higher. China has issued stricter rules and regulations for environmental protection. The ceramic industry is a high-energy consumption and pollution industry, which consumes a lot of mineral resources and energy in the production process. The ceramic industry now is facing severe resource, energy, and environmental challenges. With the excessive consumption of ceramic resources, energy shortage, environmental pollution, etc., ceramic enterprises' production costs and environmental pressure are increasing. Developing environment-friendly ceramic products has become an inevitable choice for the sustainable development of the ceramic industry.

Thin and reduced production of ceramics is an important way to save resources, energy conservation in the architectural ceramics industry. It is also the future development direction of the architectural ceramics industry.

The domestic energy saving and emission reduction task is arduous, Shiwan ceramics as the main traditional industry pillar industry, industrial structure adjustment and optimization is the long-term strategy for Shiwan ceramic enterprises to survive. How to use resources reasonably, reduce energy consumption and reduce environmental pollution while obtaining maximum economic benefits is an urgent problem to be solved for the sustainable development of China's ceramic industry.

The old concept of "pollution before treatment" is no longer suitable for the current expansion, and economic interests cannot become an excuse for ceramic enterprises to pollute the environment. In order to promote the development of green process of ceramic enterprises, the transformation and upgrading of enterprises become the focus. Thin ceramic technology is the best solution to reduce energy consumption, material consumption and logistics cost.

With the introduction of ceramic plates, Shiwan started to produce ceramic plates in about 2007. The thickness of traditional ceramic murals is about 12 mm. In contrast, the thickness of Shiwan ceramic innovative murals is only 3 mm (Figure 6)

It greatly reduces mineral resources, saves electricity and fuel, reduces emissions of sulfur dioxide and carbon dioxide, and saves the entire cycle logistics cost.



Figure 6 3mm Shiwan ceramic innovative murals

According to the calculation results, the ceramic tile thickness is reduced by 3mm on the original basis, saving a lot of resources and energy every year. The average reduction in fuel consumption was about 1.49 kgce/m2, a 29% reduction year-on-year, and the average reduction in electricity consumption was about 1.52 kw.h/m2, a 28% reduction year-on-year.It can be seen that there is excellent potential for thin ceramic tiles to save energy. One ton of raw materials can produce 23~25 square meters of ordinary ceramic frescoes, if the same amount of raw materials is used to produce innovative ceramic frescoes, the output can reach about 83 square meters. Therefore, compared with the traditional ceramic fresco, Shiwan ceramic innovation fresco raw materials can save 50%, comprehensive energy consumption savings of more than 50%, soot emissions can also be reduced by more than 64%.

In fact, in the 1980s, Japan came up with the concept of ceramic plates. By 2004, Spanish ceramic plates were on the market. By 2007, more than 70% of European ceramic brands owned ceramic plates. By 2009, ceramic plates had taken a large share

of the market. In addition, the prevalence of the global concept of "low carbon" in 2009, especially the convening of the World Climate Conference in Copenhagen, has made people pay more attention to low carbon and environmental protection. China did not put ceramic sheets on the market until 2008. Due to the lack of social and economic development and market economy at that time, thin ceramic plate did not have enough survival basis and failed to rise. In recent years, with the increasing maturity of ceramic industry, thin ceramic plate has really entered people's vision. Not long ago, at Boloni World Ceramic Sanitary Ware Exhibition in Italy, the products of the whole present an ultra-thin trend. The thickness of ceramic plate is 3mm, the maximum thickness is 6mm and the specification is 1m×3m. Some people wonder if there is a safety factor when the tiles get thinner. In fact, they have passed various tests,the breaking strength, and physicochemical properties of ceramic plate are no less than those of traditional tiles. There is an additional indicator that the ceramic plate is getting thinner, it also has a certain amount of elasticity, which is a real low-carbon building material.

Compared with traditional ceramic murals, Shiwan ceramic innovative murals are made in large size with beautiful and simple appearance

The progress of equipment in the Shiwan ceramic industry has promoted the production of large-sized ceramic plates. Traditional ceramic murals are generally 100×100mm, 150×150mm, 200×200mm, 2000×1000mm (Figure 7).In 2016, Foshan Mona Lisa Ceramics Company took the lead in launching 2400×1200mm large-size ceramic plates, while proposing the general direction of development of large sintered stone. By 2019, with the invention and application of the 36,000-ton ceramic press, Foshan Shiwan Mona Lisa Ceramics Company has launched another large-size ceramic plate of 3200 × 1600 mm. By 2021, the largest ceramic plate can be sized up to 9000×1900mm (Figure 8 and Figure 9).The improvement of the kiln also makes it possible to fire these large-sized ceramic plates.

Compared with traditional ceramic kilns, the structure of large-sized ceramic plate kilns has been greatly improved, which is mainly reflected in intelligence, process improvement of the quenching section, and temperature optimization of the slow cooling section. Intelligence of the improved kilns is mainly reflected in the automation of temperature control, energy consumption and output display automation, in addition to the extra brick track check, abnormal alarm system, etc., making the control process more convenient and more efficient. In 2020, Foshan issued the "Work Program For Foshan City Architectural Ceramics Industry Clean Energy Transformation". The program requires Foshan ceramic enterprises to complete the transformation of

the kiln using natural gas as well as the transformation of the large plate kiln. It has promoted the technical progress of the kiln. The change in industrial technology from traditional kiln to machine-control kiln has brought energy-saving technology to a higher level. The development of intelligence has led to significant achievements in architectural ceramic kiln technology, which has also provided the necessary conditions for the development of innovative ceramic murals in Shiwan.



Figure 7 Traditional ceramic murals

From the world of ceramic tile trends, ceramic plates have become the day's trend. Whether thin or thick, ceramic plates have become a hot topic of research and development for various companies.

The thickness of the ceramic plate can cover 3 ~ 30mm, the size of up to 1600 mm × 4800 mm. The corresponding ceramic plate-forming technology and equipment have also become the technical highlights of the industry. In December 2015, Henglitai independently developed Asia's first "10,000-ton" YP10000 brick press, which can produce 1200 mm × 2400 mm large-size dry-pressed ceramic plates, was officially launched into the market. In December 2016, a "giant" brick press, YP16800, which is nearly 9 meters high and weighs more than 500 tons, was assembled in Henglitai's workshop. At the same time, Keda company also introduced the KD16008 press. YP16800 and KD16008 press into production, meaning that domestic equipment can also do 1400 mm × 2800 mm specifications of the board so that the public can see the maturity of the technical route of production and manufacture of ceramic plate. Shiwan ceramic enterprises using domestic equipment to produce large-size ceramic plate has become a reality.

Ultra-wide kiln technology

In 2016, the 3.85 m wide ultra-wide kiln was officially introduced to the market. China's Keda Clean Energy, China Kiln, and Modena have all launched 3.85 m wide kilns. 3.85 m wide kilns will play a leading role in the introduction of new kiln equipment and environmental protection and energy saving for the whole industry.

The ultra-wide kiln has the advantages of higher output, higher efficiency, more space-saving, and labor cost-saving. In addition, the ultra-wide kiln has a more energy-saving role. The kiln in the ceramic industry fuel costs account for more than 25% of the total production costs, so the key to energy saving and consumption reduction is the kiln. And making the kiln body wider has the obvious advantage of reducing energy consumption.

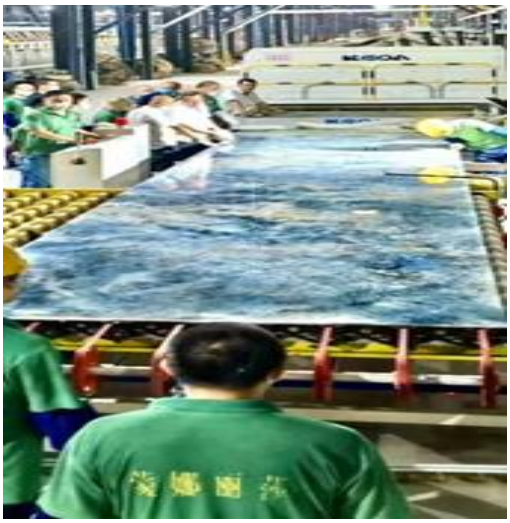


Figure 8 Large size 9000X1800mm Shiwan ceramic murals



Figure 9 Large size Shiwan ceramic murals

Compared to traditional ceramic murals, Shiwan ceramic innovative murals introduce high technology to achieve batch production

The introduction of ceramic digital printing technology for the production of super-large Shiwan ceramic mural technology provides a guarantee. Ceramic digital printing technology is known as the third reform of China's industrial ceramic printing technology, but also, gradually, many domestic ceramic enterprises look forward to it. Compared with the traditional glazing method of the inkjet printer phase, this technology has many advantages.

Different from the traditional ceramic mural manual glazing, Shiwan ceramic innovation mural uses ceramic digital printing technology. In the process, mass

production has a qualitative leap. The traditional manual glazing way slow, and the glaze color and firing after the glaze color is very different. The effect after firing when glazing depends mainly on experience (Figure 10 and Figure 11).



Figure 10 Traditional ceramic murals not fired after glazing



Figure 11 Traditional ceramic murals fired after glazing

Shiwan ceramic innovation mural using digital printing technology, the effect when glazed and the effect when fired is basically the same. This technique is easier to control the finished effect (Figure 12).

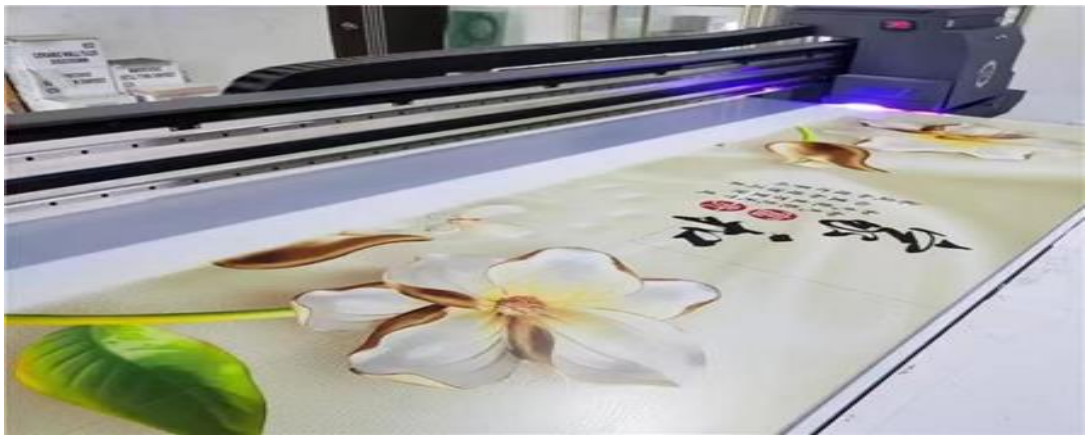


Figure 12 Innovative murals of unfired Shiwan ceramics with ink-jet glazing

Shiwan ceramic innovation mural glazes color digital printing technology can achieve personalized requirements in a very short period of time, more suitable for today's ceramic murals personalized, small batch, and a variety of color development tendencies. The fineness of inkjet products is not much different from high-definition

pictures, and the products of traditional technology will be restricted by the specifications, while inkjet technology, in theory, has no specification restrictions.

Some high-end varieties, such as imitation bark, imitation wood, and other decorative glaze tile surface, have uneven three-dimensional surfaces; inkjet printing can also be fully applied with this. The technology can not only restore the texture and effect of natural materials more realistically but also the bumpy surface to achieve printing.

In addition, manual labor is reduced due to the high automation performance and convenient operation of digital printing equipment. Compared with the painting process of traditional handmade ceramic murals, Shiwan ceramic innovative murals have a shorter construction period, minor color differences, and lower production costs. The digital printing technology of continuous copying and printing enables the mass production of ceramic art murals.

Inkjet printing technology integrates many advanced technologies such as electronic control, ink use, mechanical synthesis pattern design, and numerical control operation. Applying this technology in ceramic murals can increase the product resolution from 72 dpi to 360 dpi and handle orders of different batches and varieties flexibly. Digital inkjet printer does not need to change ink or clean ink path, which saves production costs such as trial version and so on. The technology shortens the production cycle, reduces product inventory, and reduces warehouse area. It also eliminates the damage and defects caused by contact with the spray base material and can print on uneven surfaces, significantly reducing the cost of printing equipment. Also, manual labor was reduced due to the high automation performance and convenient operation of inkjet equipment. From the design point of view, the emergence of inkjet technology provides rich and colorful design elements for ceramic design, from which various natural ingredients such as flowers, plants, birds, animals, mountains, and rivers appear bright. The landscape of nature has become an inexhaustible design element for designers. The texture of stone, wood, exterior wallpaper, cloth, etc., is best represented by inkjet technology. In addition, inkjet printing has changed the contact feature between traditional printing technology and tiles. The printing effect is printed from the top to the bottom of the nozzle, and the tiles are no longer in direct contact with the printing tools, thus enabling multi-angle, high-density glazing and fully showing the stereo design effect of tiles. Inkjet printing is the first to achieve one-time printing on the three-dimensional surface of tiles, especially for vivid texture printing on various concave-convex floating tiles and beveled faces. The difference between concave-convex stereo faces can be up to 4mm, which enables the concave-convex faces to be uniformly colored, and makes

the connection between the accessories of various unique shapes and the main brick more natural. For all these reasons, inkjet printing technology in ceramic innovative mural decoration ushered in the spring of development.

In 2000, the world's first industrial ceramic decorative inkjet printer was launched; Spain's Kerajet Company was the first enterprise in the world to have a patent for inkjet equipment technology, while the United States'FERRO Company was the first enterprise in the world to have a patent for inkjet ink. Because inkjet printers developed by Kerajet are patented, other companies around the world can only develop them internally. After the patent was opened in 2008, other companies that developed inkjet printers internally began selling them to the outside world. Therefore, inkjet printers are put into use late in China.

In 2008, Shiwan developed and developed the first inkjet printer for ceramic tile decoration in China. Gold Asia Company launched the first 3D digital inkjet stereo tile in China on March 30, 2010, becoming one of the first companies to launch inkjet printing products in Shiwan. In recent years, the number of inkjet machinery used in ceramic tiles has been increasing globally. Statistics show that nearly 400 inkjet printers were in use worldwide by April 2011, double the number of devices in 2009. Among them, there are about 40 inkjet printers in our country, which accounts for 10% of the total inkjet printers in the world. Shiwan Ceramic Company, which has been involved in the inkjet industry, has nearly 20 companies. The world's ceramic tile production has entered the era of inkjet printing. As the largest country in the world in ceramic production, China must become one of the most potential markets for the application of this technology. (Figure 13, Figure 14)



Figure 13 Ceramic Digital Printer



Figure 14 Ceramic Digital Printer

The application of pneumatic sand blasting technology, with fine relief

Sandblasting technology is both new and old technology, which originated in the 1980s and is a technology that uses jet material to act on the surface of parts. After many years of development, sandblasting technology on the market has been continuously improved, and a complete set of supporting equipment application devices has been formed.

Pneumatic sandblasting uses an air compressor as the power source and compressed air as a medium to realize energy transfer and control. The material needed is sprayed onto the surface of the object at a certain speed to achieve the desired state.

At present, sandblasting technology has become mature, and its role is increasing. Its application has already expanded to all fields of modern technical engineering, from the shaping and surface strengthening of precision parts in the aeronautical field to the hair treatment of welded feet of applied electronic product components. From the cleaning, coarsening, and spraying of glass and stone materials to the grinding of garment fabrics, various fields continue to innovate and expand.

The reliefs of traditional ceramic murals are usually carved by hand. The construction period is relatively long, and the labor cost is also high. The innovative mural of Shiwan Ceramics adopts the pneumatic sandblasting carving process. First, the computer makes the sample plate, designs the pattern and characters, and then engraves them on the sandblasting protective film through the computer lettering machine; Then, it pastes the protective film of the carved content on the surface of the ceramic plate, removes the protective film of the part that needs to be carved, and protect the part that does not need to be carved with the protective film; Finally, use the pneumatic sandblasting gun to sandblast the parts with the protective film removed until the processing depth meets the requirements of the pattern. The application of pneumatic sandblasting technology has greatly improved the carving production efficiency of artistic murals. Computer graphics also make the relief patterns vivid and skillful (Figure 15, Figure 16, Figure 17).



Figure 15 pneumatic sandblasting machine

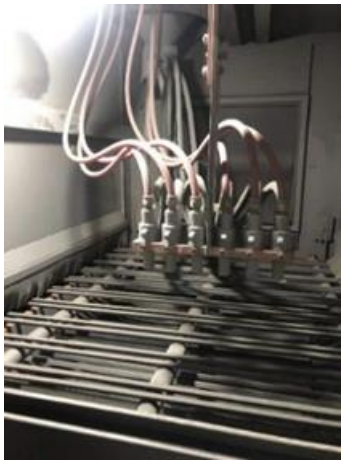


Figure 16 pneumatic sandblasting interior



Figure 17 pneumatic sandblasting relief effect

The application of new ceramic materials and technologies presents a variety of artistic effects.

Traditional ceramic murals are mainly traditional mud and glaze, which are relatively single in form. Shiwan Ceramic Innovative murals show a diversified development of artistic effects with the continuous development of new materials and new technologies in Shiwan architectural ceramics.

In recent years, the main new materials are metal enamel, sunken enamel, glowing enamel, anion enamel, peeling enamel, etc. Their application makes the artistic effect of the New Shiwan ceramic art mural more likely. The metal glaze is a special artistic glaze in the glaze of the ceramic industry. The surface of the enamel plate applied with metal glaze shows a metallic gloss and can present various colors, such as red, yellow, silver, blue, black, etc. (Figure 18, Figure 19).

Sinking glaze has better liquid flow and excellent permeability than ordinary glaze. Ordinary glaze, in the process of product surface printing, often simply attaches the product color texture to the low glaze surface by means of glaze and then burns the product with ordinary glaze printing; its surface texture and pre-printed texture basically do not change much. The process of printing with sunken glaze on the surface of the product is different because the sunken glaze has very good liquid fluidity and excellent permeability. When printing with sunken glaze on the surface of a non-burnt bottom glaze, the superfluous fluidity and permeability of the sunken glaze itself will enter the low glaze layer, thus achieving a good mutual solubility effect. By firing at high temperatures, the mutually soluble subsided glaze reacts strongly with the low glaze layer, resulting in a clear pattern with a convex and concave texture. The pattern

of the product burned with the sunken glaze is random. Sinking enamel ink greatly enhances the performance of product color texture and also greatly improves the visual effect of product decoration and application.

Luminescent ceramic is a kind of high-purity, high-tech, and cutting-edge material which is made of rare earth material by high temperature and high-pressure excitation. It can absorb sunlight or other scattered light and absorb and store light energy to activate and emit strong light later. The luminescent time is more than 12 hours, and the luminescent performance can be reproduced repeatedly, maintaining the luminescent effect for up to 15 years.

The application of various new materials and new technologies makes Shiwan ceramic innovative murals more abundant and more expressive.



Figure 18 Metal glaze porcelain plate



Figure 19 metal glaze porcelain plate

The Future Development of Shiwan Ceramic Mural Art Innovation

2023 since the beginning of the year, due to the epidemic is basically over, as of March the entire domestic ceramics production area pottery enterprises have started back to production, some of the media reported that the kiln rate in Guangdong is less than 40%. Domestic production capacity and production line ranked ahead of the large head of ceramic enterprises such as new pearl, Marco Polo, Dongpeng Holdings and other enterprises can all production lines open up the color glaze market this year has a profound impact. Guangdong production area this year, the most obvious feature is the ignition time late, ignition production line less. Guangxi production area in Fuji County and ceramic industrial park, to Hongyu, Xiejin, Ou Shennuo, Mona Lisa as the representative of a number of ceramic enterprises have

basically ignited out of the brick. In Hubei, Hunan production area, most of the local ceramic enterprises have been ignited to resume production, production capacity is gradually released. From the performance of Quanzhou pottery enterprises after the start, the number of kiln ignition is also higher than the same period last year, the kiln rate of about 80%. Shandong ignition pottery enterprises to eighty percent, but the effective capacity has not been fully utilized. Jiangxi Gao'an, Shanggao, Fengcheng and other places in the basic full production of ceramic enterprises. According to clip Jiang County, Western Porcelain Ceramics Association news, as early as February 3, Sichuan clip Jiang, large and medium-sized ceramic enterprises basic production, enterprise sales department back to work rate of more than 90%, the production line back to work rate of more than 75%. Overall, the end of the epidemic after the first year of ceramic start-up resumption of production is currently considered normal, the entire industrial chain is also full of expectations for 2023.

Summary of main conclusions

Guided by Lotman's cultural semiotics theory, this study analyzes the innovative ceramic art murals in Shiwan, summarizes the technological and artistic characteristics of Shiwan's innovative ceramic art murals, examines the innovative development of Shiwan's ceramic art murals, and analyzes the future development of Shiwan's ceramic art innovation murals. Through the analysis of the innovative ceramic art murals in Shiwan in the previous chapter, three research questions raised by researchers can be answered. Match the three research questions with the three research objectives. The three research questions are as follows. 1. What are the main technical and artistic characteristics of innovative murals in Shiwan ceramic art? 2. What challenges are facing the development of innovative murals in Shiwan ceramic art? 3. How will the future development of Shiwan ceramic art mural innovation face? The researchers used three research methods, namely interview, text analysis, comparison, and observation. Based on the three questions in this study, there are a total of the three main findings mentioned above. In response to the problems in this study, the researchers have made the following suggestions.

Suggestions

We should strengthen capacity growth, expand capacity scale, and reduce costs, so that more industries, venues, and multiple fields can accept and apply this process technology, and better promote the development of the industry. Further enhance the convenience of use and installation. Improve the softness of the material, making it more flexible for use. In terms of coloring process, it can be further improved,

as coloring is relatively thin compared to conventional ceramics, reducing the texture of ceramic colored glaze. The excellent performance of ceramic materials, with the characteristics of being "hard" and "brittle", makes it difficult to cold work. The requirements for material mechanical properties in use and processing are an inherent contradiction. We should promote strengths and avoid weaknesses, change our concepts, and innovate our thinking: production is aimed at meeting application needs, and we should explore and promote standardized and customized production; Strengthen the research and development of technology and equipment for online cutting and processing of billets, promote the "design forward and quantity cutting of billets", reduce the amount of cold processing of burned products, and produce products that are free from processing and less processed; Design formulas and thicknesses based on the mechanical properties of products for different purposes, predict product strength, meet usage requirements, and optimize the process technology of ceramic art murals with design and technology leadership.

Shiwan innovative ceramic art murals belong to new technologies, new products, and low public awareness. Restrict the development of this product. In addition, controlling costs to make it more acceptable to more consumers.

Green environmental protection is one of the necessary factors for long-term development. The ceramic industry belongs to a heavily polluting industry, with high energy consumption and high pollution. It is a key industry for air pollution prevention and control in China. Therefore, developing green and environmentally friendly products is the direction of development. The future should start with the use of materials, product design, product quality, and functional integration. It is not only necessary to improve its service life, but also to improve product functionality and find ways to save resources and energy.

Limitations and Expectations

This study uses Lotman's cultural semiotics theory as the theoretical framework to analyze the innovative ceramic art murals in Shiwan, and ultimately draws some main conclusions. However, this study is still far from perfect, and there will be some discoveries in future research.

Firstly, the literature referenced by researchers is limited and carries a certain degree of subjectivity. Shiwan innovative ceramic art murals are an emerging product, and there are not many researchers involved in the research, so there is little literature available. In terms of artistic characteristics, it is a characteristic summarized by the researcher themselves, with subjectivity. Furthermore, as Lotman comes from Russia, researchers can only read translated Chinese versions of his works, which inevitably

leads to some misunderstandings about his theory. Therefore, research will be subject to certain influences and limitations.

I hope that Shiwan's innovative ceramic art murals will be widely applied and more people will understand and accept them. I hope this emerging product will have greater technological improvement and be applied in more fields.

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