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THE EFFECT OF IRON CHLORIDE ON THE CERAMIC SURFACE

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Abstract:

The purpose of this research is to study the effect of iron chloride on the surface of ceramics, as well as the use of iron chloride to obtain multiple colours, taking advantage of the difference and colour variation resulting from different proportions of iron chloride and saving effort, time and money for the potter to obtain the best chromatic results for glass coloured with iron chloride.The researchers adopted the (experimental approach) because it is an approach based on scientific experience to achieve the goal of the study in an accurate scientific manner. The researchers adopted the method of spraying the solution on the ceramic piece after the exploratory experiments. The researcher reached the best result for obtaining the best pottery body that is resistant to thermal shock and easy to form. The clay was prepared using kaolin (60%), glass sand (20%) and pottery powder by (20%)We concluded that alumina is not the only cause of glass adhesion to the pottery body, but oxides of copper, iron and zinc, which have proven successful in improving the adhesion strength without the need to increase the percentage of alumina. It is possible to use high percentages of additives to obtain special effects in artwork, especially in pottery sculpture. Color effects vary with different temperatures, the amount of additive.

Introduction:

The beginning of glassmaking in Mesopotamia Since ancient times, humans learned to make glass through some key reasons or ideas, thus bringing humans into the mystery of handicrafts. Before being pushed into industrial glass, humans already knew natural glass, specifically obsidian glass. The color or brown is similar to ordinary glass in shape and performance, but the chemical composition is different. Glass is generally considered a solid and transparent material that is not affected by natural conditions and consists of a homogeneous mixture of pure sand or lime with a small amount of oxides and some minerals According to the data, in order to preserve the materials used in everyday life, the Mesopotamians began to use utensils and various materials (such as leather, wood, and stone) that were not allowed to be filtered. The manufacturing process is not easy. It is limited to the period before the appearance of glass (i.e., the Stone Age)

Research problem:

Ceramics included elements of construction and composition and was subject to the requirements and necessity of the material and the reciprocal relations between the visual effect and the taste that control the production of the artistic image. Therefore, the arts formed an important presence in the history of human knowledge, and it was an important tool for expressing human need and interests in all directions.

Ceramics is one of the manifestations of development and sophistication in human societies. We did not find over the ages that ceramics have developed and excelled in the abundance of production in different societies or the environment, but ceramics accompanied with the development of civilization and subjected to technical treatments as a basic tool in determining the artistic image produced.

The treatment of technology is included in the formulation of the artistic style and also determines the technical nature adopted by the artist, through which the artwork can be classified under one of the artistic currents.

There are multiple techniques of ceramics in showing the ceramic surface in multiple colors with overlapping spectra with the aesthetic values of the ceramic achievement. Chemical reactions and physical changes are among the distinguishing characteristics of ceramics over other arts, which contributed to the discovery of multiple techniques throughout history, which resulted in scientific production methods, as It begins with the selection of raw natural materials, with the determination of the weight ratios of their compositions, how to heat treatment, and the preparation of control and control means. And this diversity in the nature of the ceramic surface, which corresponds to the spirit of experimentation and experimentation in the art of ceramics, prompted the potter to invent different methods of techniques, and one of these techniques is the use of iron chloride in the effect of color.

Here the question is asked: Is it possible to produce ceramics using iron chloride?

Research objective:

- Use iron chloride to get multiple colors.

- Take advantage of the difference and color variation resulting from the difference in iron chloride ratios.
- Saving effort, time and money for the potter to get the best color results for iron chloride stained glass.

Research border:

1- Objectivity border:

- **clays**
  - kaolin
  - sand glass
  - Pottery powder
- **glass**
  - clear alkaline glass
  - white glass
- **colorants**
  - yellow dye (Sphene)
  - red dye (Gamet)
  - blue dye (Zircon)
- **oxide used**
  - Iron Chloride Fecl3
- **Temperatures**
  - Pride temperature 1200 ℃
  - Glass temperature 950 ℃
- **Ovens**
  - Electric oven for pride
  - Fuel (liquid gas) furnace for glass

2- Time border:

- The academic year 2020-2021

3- spatial border:

- Laboratories of the College of Fine Arts, Department of Fine Arts, Ceramic Branch.
- The potter's operator.

Theoretical framework:

Clays:

Clay is known as one of the minerals of sedimentary rocks and is characterized by the presence of small crystals that are invisible to the naked eye. Its composition is called hydrated aluminum silicate and its chemical composition is Al2O3.SiO2.2H2O, and it belongs to a structural group called kaolin.(1)The process of weathering and sedimentation is beneficial to man because it confines man to the soil, which is the only source of human wealth. Clay is defined physically as a natural soil product with a particle size of fewer than 2 microns that has the properties of elasticity and layer compatibility and has the ability to obtain hardness and hardness at high temperatures (the term clay material is usually used to refer to any natural earth material (H2O) consisting of silicon oxide (SiO_2), aluminium oxide (Al_2O_3), water, iron oxide (FeO, Fe_2O_3), alkali metals (K_2O, Na_2O, Li_2O) and alkaline earth metals (CaO), MgO, BaO. Clay is mainly the result of water decomposition on the falling bits of feldspar rock. Although affected by local chemical changes, it is usually found in pure form as minerals [2]

Kaolin:

Kaolin is a general designation for pure clay with a ratio of (98%) (2h2o,2sio2,al2o3) and a molecular weight of (285).It is considered one of the primary clays, and it has many colors, including white, and it is found in many regions of the world [3].In Anbar Governorate, there are deposits of these clays from the Akashat phosphate mine within the lower governorate (Al-Ka'ra). They can withstand high temperatures, which reach (1500 °C) and this is what distinguishes these clays [4].

Red clays:

It is one of the most common types of clay in nature, so it can be obtained in large quantities, and it is considered a traditional pottery material locally, and its material has become an expert in terms of quality and the applicability of ceramics. This clay is characterized by a high degree of plasticity due to its soft particles, which is why a certain percentage of non-plastic materials such as sand or ceramic powder are added to reduce plasticity, so red clay is called a high percentage of iron oxide, which makes different colors, including brown or Red or green-gray or yellow-brown [5]

Sometimes it is mixed with high-temperature clay to increase its temperature, and potters in private workshops use this clay extensively in the implementation of projects and works of art, and it is prepared and washed in a basin of water to get rid of salt and impurities [6].It also contains high alkali content, high alkaline earth content (MgO-CaO), iron oxide (Fe_2O_3) and organic matter, so it is very porous after combustion. There is a strong relationship between the melting point of red clay, porosity and product hardness, and this can be explained by the graph ,which shows the course of porosity and accompanied by the strength to reach the best porosity and hardness [7].

Spherical clays:

Sedimentary clays were named by this name because they were first discovered in the form of balls in one of the English mines, and spherical clays like kaolin are from granite-type rocks and are similar in chemical composition to their common origin. It has high plasticity, very viscous when saturated with water, and has a high shrinkage degree during drying and burning, and its burning temperature is (1260-1300)℃.

Stand glaze:

It is pure white sandy rock, which contains a large amount of silica, and mainly consists of quartz-specific granules, and also contains a small number of heavy metals and impurities. As for the term glass sand, the term silica sand, which has several chemical and physical specifications suitable for with the manufacture of glass, such as granules whose size ranges between (100-500) microns, as well as iron oxides (Fe_2o_3), the proportion of which is less than (0.05%).Glass sand is characterized as fine-grained, white in color, a weak welding material, and mineral glass sand is composed of iron oxides, kaolin, quartz, and the ore itself is characterized by the appropriate volumetric gradation for the glass industry according to international standards.

Type of glass in terms of transparency and opacity:

Clear glazed glass is a glass that contains very little non-fusible substances (plankton), so it can allow light to pass unimpeded, and when you add colored oxides, it will cause these oxides to completely dissolve in the vitreous liquid, so because the light from the glass The opaque is reflected from the surface of the glass-ceramic layer, and the glass becomes opaque, and the materials it contains with a large amount of (alumina) will not melt, while other materials are melted. These suspended materials impede the diffusion and diffusion of light, which leads to partial reflection of light and the addition of colored oxides to the glass, and opaque colored oxides accumulate on the surface of the glass. Because these suspended materials are non-fusible materials, these suspended particles have a stable color and are characterized by heat resistance, so the effect of colored oxides in opaque glass is more stable than that of transparent glass [8].

Classification of glass (raw - Fritt):

Raw Glaze takes longer to melt between browning and maturing to achieve a uniform, flat surface. The reaction is not limited to glass compounds, but also includes oxides and colored pigments in its composition. Therefore, the solubility of oxides in raw glass is affected by many variables. For ready-made glass (Fritt Glaze), through reaction and pre-melting, thermal leveling is based on the melting of the glaze on the surface of the ceramic body in a shorter time, and over time the melting of oxides or colored pigments in the molten glass occurs faster, and color stability is preferred industrial.

Glass Overlay:

The tinting technique can be used to color one layer with different coloring agents by superimposing different glazes. One coat in artist-made ceramic glaze mix. As for the other layer, the porcelain can add ready-made coloring pigments to it, and this is exactly the possibility of creating a new color product that the porcelain did not reveal or was not known before, because the technique of layering glazes is used and different colors are used, and they are colored according to the coloring agent that is, the mixed properties (oxide and pigment) are sufficient to create a new color list.

Fusibility:

The main component of porcelain glass is silica (sio_2) in addition to alkaline oxides, earth bases and intermediate oxides such as alumina (Al_2o_3) in addition to other components of glass are boric oxide (B_2o_3) and phosphorous pentoxide (p_2o_5) and the addition of other materials always leads to a lower melting point as a rate In most systems, the oxides are collected below their melting point and are in a separate state [9].

It was found that there are some variables that lead to lowering the melting point

1- The silica mesh is replaced with a boric mesh into glass in two cases
- The dissociation of the oxide and the decomposition of silica glass in the absence of bases

- The boric oxide turns from tertiary to tetrahedral in the presence of bases and reduces the surface expansion coefficient

2- Oxygen ratio silica (SIO_2: O_2) In the presence of earth bases, alkaline oxides and mineral oxides, the oxygen ratios are increased and lead to a reduction in the strength of the bonds and this leads to a lower melting point and thus the network disintegrates replacing the silica with a tetravalent oxide with a lower takaful such as aluminum with a tertiary takafu leads to a decrease in the temperature.

3- Replacing the silica (SIO_2) to form a weak network, so the hardness will be low because the hardness depends on the strength of the bonds to each other. Silica is replaced with materials that are not capable of forming the mesh, such as alumina (Al_2o_3) and titanium dioxide (Tio_2), and thus the melting point decreases.

4- Influence of chemical and physical properties on the mesh:

- The size of the ion: the liquidity rises, the smaller the size of the ion, the lower the viscosity of the glass
- Replacement of oxides: Replacing one of the oxides with one or more oxides leads to a reduction in melting and gives a mixture with a wide range. Among these oxides is potassium oxide(10).

Research methodology and field procedures:

Research Methodology:

The researchers adopted the (experimental approach) because it is an approach based on scientific experience to achieve the goal of the study in an accurate scientific manner.

Preparing the materials used in the construction of pottery models:

clay body pottery

Kaolin clay was chosen because of the low level of shrinkage and shrinkage, and it is modified through additives because the research depends on clays that withstand thermal shock.

Pottery Powder Grog:

Ground and sifted local pottery powder was used

Stand glaze:

Local glass sand was used within the body mixture due to the low thermal inversion value of silica glass.

Colorants:

- yellow dye (Sphene)$3sio_2 3cao.al_2o_3$
- red dye (Gamet) $Zr.sio_4$
- blue dye (Zircon) $Ca.Tio.Sio_4$
- fragment dye

Clay preparation:

After the exploratory experiments, the researcher reached the best result for obtaining the best pottery body that is resistant to thermal shock and easy to form. The clay was prepared using kaolin (60%), glass sand (20%) and pottery powder (20%) as show in the table 1.

Table(1) shows the proportion of clay preparation

No.	kaolin	pottery powder	Stand glaze
1	75	15	10
2	75	10	15
3	70	15	15
4	60	20	20

Preparing clay mixtures for pottery models:

The clay was prepared by the plastic method by placing the mixture in a basin with water and leaving it for (48) hours until all the components of the mixture completely dissolved. Times until the disposal of salts and soluble organic materials, and then mixed and sifted with a fine sieve and then brushed on a piece of cloth for the purpose of getting rid of the excess water until the clay becomes moldable.

Forming models:

After the process of preparing the clays, forming the models by working on a plank of wood and then dividing and weighing the clay by 1 kg and forming the models by moulding with plastic clay using a gypsum mould made by the researcher as show in the figure 1.

Fig.1 shows gypsum mould.

Drying models:

The models were left after forming and blocking for (8) hours after being left covered with a piece of cloth for (24) hours and then left to dry without the presence of any air current to preserve them from excessive shrinkage when drying, which leads to twisting of the body and then left to dry completely.

Burning models:

The large electric furnace (120 x 80 x 60) as show in the figure (2) was prepared with a cable thermometer and a digital scale at a rate of (100) models in one burn. Then the models were placed in layers inside the oven and the burning process lasted (6) days and the oven was operated according to as show in the table (2).

Operating time	Extinguishing time	time	Temperature
10sec	90 sec	24 hour	100℃
10 sec	80 sec	24 hour	200℃
10 sec	70 sec	24hour	300℃
15 sec	50 sec	24hour	500℃
30 sec	30 sec	24hour	700℃
4 hour	---------	4hour	1200℃
1 hour	--------	1hour soakingtime	1200℃

Fig.2 shows the oven during pottery

Preparing glass mixtures:

The temperature was determined in the current research to produce vitrified experiments and measure its color effects resulting from the temperature and that the temperature is (950 °C) white glass and transparent glass was used as color pigments are added to the alkaline glass at a rate of (5%) for all pigments and both separately.

Preparation of iron chloride solution:

After the exploratory experiments carried out by the researcher in the current research, iron chloride was added at a ratio (1-2-3-4-5-6-7-8-9-10 grams) per 1 litre.

Experiment type:

For the purpose of studying the color variables of iron chloride on the ceramic surface and the different application mechanism, (4) methods have been developed

- first method/method of immersion in iron chloride solution, which is to immerse the entire ceramic piece for one time and take it out
- second method/method of immersion in iron chloride solution, which is to immerse and remove the ceramic piece continuously several times
- Third method/method of placing the ceramic piece immediately after it comes out of the oven in iron chloride solution until it cools as show in the figure (3).
- Fourth method/method of spraying the solution on the ceramic piecethe researcher relied on the fourth method because it is the most correct method among the methods and because it gives the best results. The researcher used a hand pump to spray the ceramic piece with iron chloride, taking into account the amount of chloride, which is (200) ml for each piece.

Fig.3 show the sample immersion in iron chloride solution

Burning models:

The models were placed inside the oven at a rate of five models per burn and at a temperature of (950 °C). These models represent the use of five percentages of iron chloride for each model relative to the single color used and the use of the gas oven in the burning process with dimensions (45 × 45 × 75) The method was adopted Burning to reach the degree of (950 °C) in a time of (3) hours with a quarter of an hour maturity period Soaking time.

Experimental work :

The ceramic piece is taken out of the oven immediately after maturity without separating the heat source. The piece is taken out of the oven at a temperature of (950 °C) and sprayed with the solution at (750 °C).
using forceps, the piece is placed on a rotating cylinder (manual cylinder) and then the piece is sprayed with iron chloride solution by a manual spray pump with the piece moving continuously to reach the solution all over the piece and this process continues for 90 seconds at a rate of (200) millilitres of chloride per piece and both on single.

Results of the physical properties of the pottery models:

Longitudinal contraction of clay and pottery bodies:

Table (3) shows the percentage of shrinkage after drying and after burning.

longitudinal contraction after dehydration	Longitudinal contraction after burning	The percentage of total shrinkage
10.52 %	2.15 %	12.67 %

Tests of the apparent porosity, water absorption and volumetric density of the clay body.
Table (4) shows the results of apparent porosity water absorption and density.

body type	Porosity	Water Absorption	Density g/cm^3
pottery body	34.409%	37.673%	1.741%

Discuss the results of the physical properties of the pottery models:

The results show in Table (3) that there is a contraction as a result of shrinkage due to the evaporation of water from the models before the flaking, but after burning the entire percentage of water comes out at a temperature of (200°C) and at a temperature of (600°C) the chemical water begins to evaporate in addition To the decomposition of some compounds into other compounds that repel some gases such as (CO_2) and (SO_2), so these models shrink and shrink, so the total contraction is (12.67%).
When observing the table (4), we note that there is a value for the apparent porosity and its reason is the decomposition of some organic compounds that decompose after burning and turn into other gas-repelling compounds, as well as the presence of some sulfate and carbonate compounds that decompose into oxides and gases, the reason that gives the formation of gaps in the body Pottery thus the appearance of virtual porosity.
As for water absorption, its percentage is higher than the apparent porosity, because water fills these gaps, and therefore water also penetrates between the layers of the compounds that enter the pottery body.

Conclusions:

- We concluded that alumina is not the only cause of glass adhesion to the pottery body, but rather the oxides of copper, iron and zinc, which have proven successful in improving the adhesion strength without the need to increase the percentage of alumina.
- It is possible to use high percentages of additives to obtain special effects in artwork, especially in pottery sculpture.
- The color effects vary according to the temperature, the amount of the additive and the burning atmosphere.
- Glass additives interact and give them different colors in the way of diffusion and oxidation of metal ions
- It is possible to add other metal filings to the glass mixtures and form a coherent and adherent surface on the surface of the pottery object.
- Metal filings can be used to produce ceramic works and give them aesthetic colors with a mosaic character and a gradual texture in the roughness.
- The resulting glass is suitable for ceramic works with different surfaces (horizontal, vertical), giving them aesthetic values with different textures.

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