STUDY OF THE TECHNICAL VARIABLES IN COLOURING PORCELAIN TILE WITH SOLUBLE SALTS

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1. INTRODUCTION

In view of the growing interest in the porcelain tile production process, the purpose of this study has been to examine the main variables in the unglazed porcelain tile manufacturing process and their impact on porcelain tile decoration with soluble salts. Soluble salt solutions are of particular interest for the decoration of polished unglazed porcelain tile due to the different aesthetic effects that can be obtained. In this study, we have used industrial samples of three soluble salts and two light-coloured industrial spray-dried bodies. After their physical and chemical characterisation, the materials were used in decoration simulations to study the decorative effect as a function of the following process variables: peak firing temperature, mixtures of solutions of different soluble salts, use of different screen printing screens, drying rate, porcelain tile compaction pressure, and water-spraying condition (before or after the soluble salt application).

2. RESULTS

To evaluate the results, the chromatic coordinates (L*, a*, b*) in the CIELab system were characterised, before and after the test pieces were polished. Image analysis was performed with a stereomicroscope to quantify the total surface area coloured by the action of the soluble salt.

Variation of the peak firing temperature (1160ºC, 1180°C, 1190°C, and 1210°C) displayed no significant influence on salt penetrability, or on the percentage of the total pigmented area. A variation did occur, however: the colour shade decreased with the rise in peak firing temperature, which evidenced the poor stability of the studied salts at higher temperatures.

After the application of the soluble salt, the drying rate was controlled to obtain the expected levels of penetration. In that stage, immediately after the application, some pieces were placed in an oven at 100°C for rapid drying, while others remained for two hours at a room temperature of 29°C before being subjected to drying in the oven. The pieces placed in the oven soon after the application, evaluated after firing and before polishing, tended to display increased colour intensity with greater body compaction: that is, they had a soluble salt concentration at the surface of the piece, probably because of the reduction in the size of the capillaries, hindering the diffusion of the solution. In addition, rapid drying also prevented penetration to deeper levels.

Water can be sprayed before the salt is applied, with a view to facilitating penetration, or after the salt is applied, in order to foster penetration by transporting the salt inwards into the ceramic body. Four different water-spraying conditions were studied: (C1) water was only sprayed before the application of the salt solution, (C2) spraying was performed before and after the application, (C3) there was no spraying, and (C4) spraying was only performed after the application. The water-

spraying condition had a notable influence on the decorative effects of the salts. Figure 1 shows the difference produced in the decoration. The application of water was particularly critical for salt 2, since without spraying (C3) there was practically no penetration and the colour was largely removed in the first polishing stages.

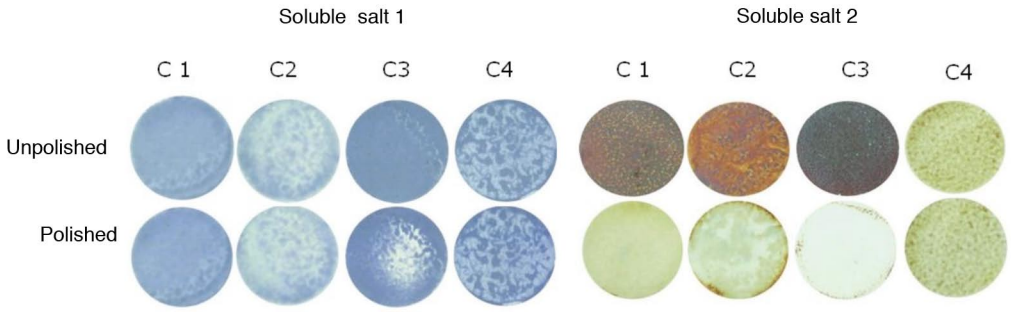

Figure 1. Images of test pieces coloured with two different soluble salts under the four water-spraying conditions, before and after polishing.

The mineral nature of the unfired materials making up the body demonstrated the power to determine the colour generated by the decorating solutions. Figure 2 shows two examples of variation in colour when a soluble salt was applied under the same conditions but with different bodies.

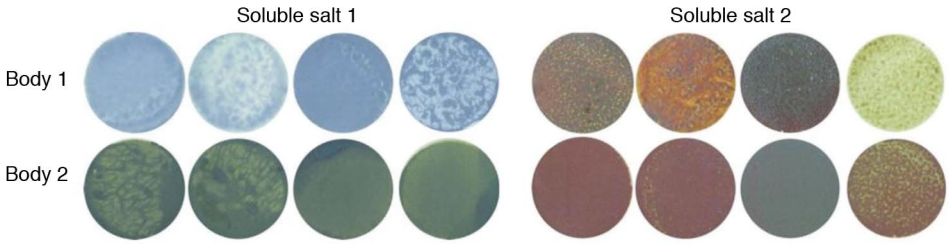

Figure 2. Images comparing the colour development of soluble salts applied to bodies of different mineral compositions.

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