EFFECTS OF CLAY AND FELDSPARS WITH VARIOUS VITRIFICATION PROPERTIES ON VITRIFICATION COMPOSITIONS OF CERAMIC FLOOR TILES

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1. INTRODUCTION

In the ceramic industry, clays are characterized by their plastic properties. Clays enable forming the desired shapes with appropriate strength to resist any stress to be encountered by the products during the production process.

Ceramic products are subjected to high firing temperatures to achieve the final product properties. After the vitrification reactions that take place during firing, various physical and chemical changes are obtained. The most favourable physical properties gained on firing are the firing shrinkage and water absorption properties. According to ISO-10545, the composition of the ceramic product should be formed largely of clay and feldspar, if the firing shrinkage and water absorption rates of the ceramic products are to be confined within 3 per cent

In this paper, the investigation of the effects of the raw material properties on the vitrification composition of ceramic floor tiles is summarized.

2. LABORATORY TESTS

2.1. MATERIAL AND METHOD

In this paper, two different types of clay and four different types of feldspar, each having different properties, were utilized. The chemical analysis and firing specifications of the material used are given in Table-1 below:

CHEMICAL ANALYSES		FELD. SBP-8	FELD. HBT-1	FELD. HBT-11	POTASH FELD.	CLAY-1	CLAY -11
K.Z		1.60	0.46	0.50	0.35	8.11	7.5
SiO_2		70.86	77.50	69.40	69.50	59.3	60.76
Al_2O_3		15.31	12.60	18.35	17.00	24.88	23.75
TiO_2		0.25	0.11	0.30	0.04	1.18	1.16
Fe_2O_3		1.29	0.23	0.10	0.10	2.85	2.83
MgO		0.21	0.07	0.30	0.15	0.73	0.59
CaO		0.70	0.60	0.40	0.20	0.28	0.14
Na_2O		3.43	2.67	7.50	2.90	0.41	0.44
K_2O		5.91	5.51	3.0	11.50	0.21	2.25
FIRING PROPER. (1180 °C)	Shrinkage (%)	10.40	4.20	2.50	1.00	7.30	6.80
	Water abs. (%)	0.30	14.60	18.00	15.10	2.40	5.50
MINERAL ANALYSIS (%)	Na-Feldspar	29.02	24.00	63.46	24.53	3.46	3.73
	K-Feldspar	34.93	32.00	17.73	67.96	12.40	13.30
	Kaolin	8.28	4.00	6.99	-	55.52	52.16
	Free Quartz	24.44	38.00	6.08	6.64	23.10	25.38
	Total	96.68	98.00	94.26	9.13	94.48	94.56

Table 1: Chemical analysis and firing specifications of the raw materials used.

Care was observed in selecting the raw materials having different vitrification properties, which were utilized during the investigation. Observing the firing shrinkage and the water absorption properties listed in the table above, it was found that Clay-1 featured inferior vitrification than Clay-2. Again, different results were obtained for the feldspars as well. The investigation was based on various different compositions prepared by clay and feldspar mixtures. They were then subjected to the firing operation under temperatures of 1160, 1180, 1200 and 1220 °C. On the other hand, the feldspar materials with the same properties were mixed with clay materials having different vitrification behaviour to form the equivalent compositions, after which they were subjected to firing under the same temperatures and their firing shrinkage and the water absorption properties were measured. Type SBP-8 and type HBT-1 feldspars came from Troas, Çanakkale, while type HBT-11 feldspar came from the surrounding of Aydin (Turkey). Potassium Feldspar was brought from India.

2.2. TEST RESULTS

In this investigation, the various different compositions prepared with the feldspars referenced HBT-1, HBT-11, and Potash Feldspar with less then 30% Clay-1 presented

lower vitrification behaviour fired under temperatures of 1200 °C. But the vitrification degree increased at temperatures over 1200 °C. In case of the clay content higher than 30%, any differences in the vitrification properties were diminished and more stable results were obtained. As a result, the shrinkage and water absorption behaviour was diminished. The feldspar having different impurity contents, SBP-8 feldspar, had good vitrification properties under firing temperatures of 1200 °C. Therefore, care should be observed to enhance the vitrification behaviour by preparing suitable material compositions having good vitrification properties.

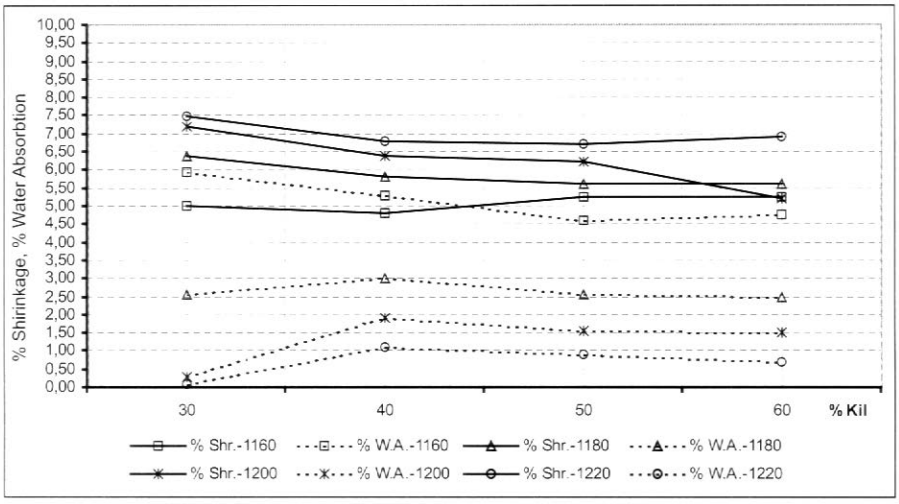

Figure 1: Shrinkage and Absorption of the Compositions Formed by Clay-2 and SBP-8 and HBT-1 Feldspars.

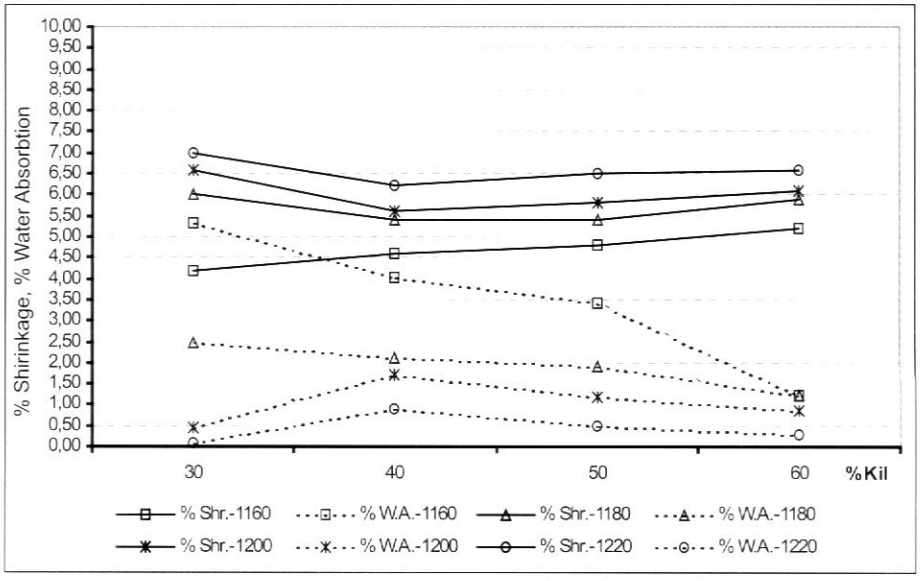

Figure 2: Shrinkage and Absorption of the Compositions Formed by Clay-1 and SBP-8 and HBT-1 Feldspars.

Figure 1 and 2 show the results of the firing of ceramic floor tile compositions formed by two different clays together with SBP-8 and HBT-1 feldspars. The compositions were formed by addition of feldspar mixtures having different properties in proportions of 50% SBP-8 and 50% HBT-1. The same compositions were included with Clay-1 and Clay-2. The results revealed that the clays had more effect on the vitrification properties than the feldspars did. In addition, when more clay was added to the composition, better shrinkage and water absorption was obtained. Since Clay-1 featured a higher vitrification property than Clay-2, this meant that appropriate vitrification results could be obtained under low firing temperatures. In effect, it was found that the use of especially 50-60% of clay yielded the optimum firing shrinkage and water absorption properties.

3. CONCLUSION

The following conclusions can be drawn from the investigation performed:

- Different vitrification behaviour was observed for the ceramic compositions formed by the raw materials having different vitrification properties. Therefore, the selection of the raw material should consider the differing behaviour in this regard.

- The feldspar having different impurity rates, as in the case for SBP-8 feldspar above, yields inferior vitrification properties under firing temperatures of 1200 °C. Therefore, care should be observed to enhance the vitrification behaviour by preparing suitable material compositions having good vitrification properties.

- In addition to their high degree of vitrification properties, the plasticity properties of clays in ceramic compositions at 1200 °C are more dominant than feldspars.

- The use of 50-60% clay is extremely important for achieving optimum firing shrinkage and water absorption properties.