CHARACTERISATION OF FELDSPARS FOR PORCELAIN TILE MANUFACTURE

Bozdogan, I.(*); Ginés, F.(**), Orenga, A. (**)

(*) Esan Eczacibasi Co.; (**) Guzmán M, S.A.

1. INTRODUCTION

Alkaline feldspars (mainly sodium and sodium-potassium feldspars) are the feldspars normally used for porcelain tile manufacture.

Two of the most important characteristics to be taken into account on selecting these materials are the meltability and impurities that they contribute to the ceramic composition. For this reason, the present study proposes some simple, reliable, relatively inexpensive techniques for characterising feldspars.

2. PROCEDURES USED FOR CHARACTERISING FELDSPARS

Table I details the techniques currently used to characterise these raw materials.

	MEASURED PARAMETER	TECHNIQUE
METABILITY	Dimensional changes	• Hot-stage microscope • Melting cone or cylinder
	Alkaline oxide content (Na_2O, K_2O)	• Chemical analysis
IMPURITIES	Firing colour	• Visual or colometric observation of the melting cone or cylinder
	Colouring oxides (Fe_2O_3, TiO_2)	• Chemical analysis

Table 1.*Techniques for characterising feldspars.*

As the table shows, chemical analysis and the melting cones or cylinders allow assessing feldspar fusibility as well as impurities content.

Meltability is related to feldspar mineral content (albite and orthoclase), and hence to the alkaline oxide content. In general, the higher this oxide content (mainly of Na_2O) the greater will feldspar meltability be. On the other hand, the iron and titanium mineral content, which are undesirable impurities as they affect the whiteness of the product, can be evaluated by measuring the respective oxides.

In the case of melting cones or cylinders, the fluxing behaviour is related to the dimensional changes the cones or cylinders undergo during firing: the greater the change, the more fluxing is the material. On the other hand, the test specimens made enable the impurities content to be assessed both qualitatively, by examining various attributes such as colour, surface appearance and the presence of point impurities in the fired specimens, and quantitatively, by determining the chromatic coordinates or the whiteness or yellowness index (colorimetry).

Finally, the hot-stage microscope allows the dimensional changes the material undergoes with temperature to be determined continuously. Though this method is more expensive than the forgoing, it allows more accurate assessment of feldspar meltability.

3. DRAWBACKS TO THE CURRENT PROCEDURES

As indicated above, knowing the chemical composition enables feldspar behaviour in the ceramic composition to be predicted with relative accuracy. However, chemical analysis requires expensive equipment and / complicated test techniques not within every laboratory's reach.

For this reason, feldspar characterisation by means of melting cones or cylinders has traditionally been one of the most widely used techniques, as relatively inexpensive equipment is required and the tests are easy to perform. However, to ensure that the results obtained are correct, the following points need to be kept in mind:

- The characterisation study always needs to be conducted with feldspar milled to the same particle size.

- The reduction that the feldspar cylinder diameter undergoes on raising firing temperature depends more on melting starting temperature than on the quantity of arising glassy phase. Linear shrinkage is therefore not a good parameter for assessing the meltability that a feldspar contributes to a ceramic composition.

- The colour of the fired feldspar basically depends on the arising glassy phase. Thus, in feldspars with a high alkali content, which therefore develop an important quantity of glassy phase, the presence of iron (dark colour) and titanium (yellow colour) impurities is appreciated to a greater extent than in feldspars with smaller proportions of these oxides. However, this fact should not affect the colour of the fired ceramic composition.

4. PROPOSED PROCEDURE

Having commented the drawbacks to current techniques, a test method is proposed for characterising feldspars based on the preparation of melting cones and cylinders.

As already indicated, the linear shrinkage measurement of feldspar cylinders is not recommendable for assessing feldspar meltability. However, meltability can be evaluated quite closely by measuring the height of conical test specimens fired at 1250°C. This parameter is plotted in Figure 1 for different feldspars versus their alkali content. It can be observed that the correlation is quite good. Logically, the fit is no better because at the same alkaline oxides, some feldspars are more fluxing than others owing to their mineral composition, crystalline structure, impurities, etc.

On the other hand, the iron and titanium impurities contained in the feldspar can be quantitatively assessed by measuring the chromatic coordinates L* (white-black) and b*(yellow-blue). This is done by preparing cylindrical test specimens that are fired at different temperatures, subsequently determining their chromatic coordinates and fired density. In order to have end results that are independent of the arising glassy phase, values are to be chosen at which maximum densification has just been attained. Figures 2 and 3 plot the L* and b* coordinates of different feldspars versus their respective iron and titanium contents. Good correlation between these parameters and the impurities content can be observed in both cases.

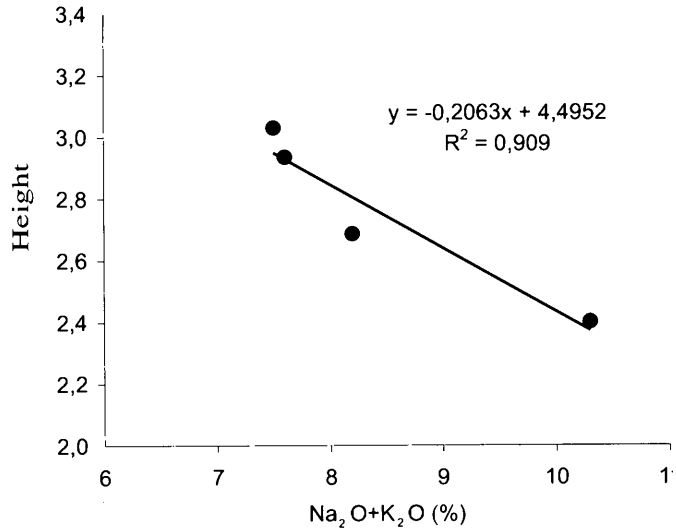

Figure 1. Relation between the height of feldspar cones fired at 1250°C and alkaline oxide content.

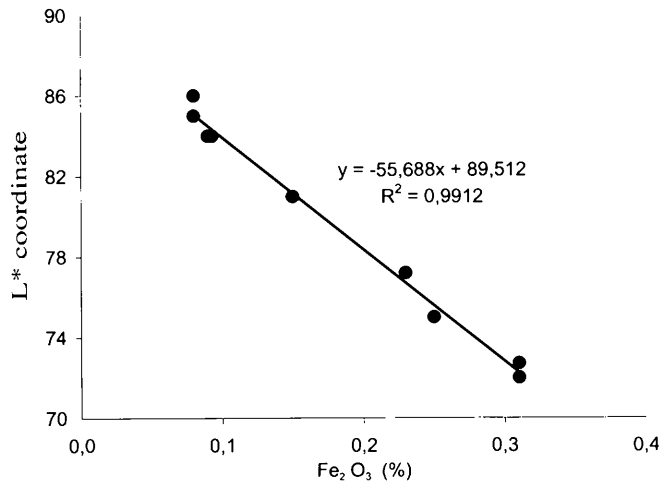

Figure 2. Relation between the L chromatic coordinate and iron oxide content.*

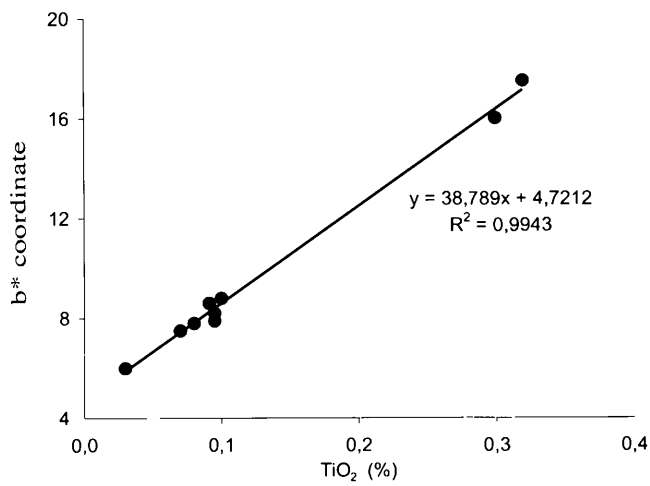

Figure 3. Relation between the b chromatic coordinate and titanium oxide content.*

5. CONCLUSIONS

In the present study, after describing and commenting the advantages and disadvantages of certain methods that are used at present, some simple reliable, relatively inexpensive tests are proposed for characterising feldspars.

These techniques were tested with a series of sodium and sodium-potassium feldspars with very different physico-chemical characteristics, which are currently used in porcelain tile manufacture, and their validity was confirmed.