NEW MIXED FELDSPAR FOR CERAMIC FLOOR TILE AND SANITARY WARE

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1 - INTRODUCTION

In 1992, the Société des Feldspaths du Midi discovered a deposit of mixed feldspars whose main advantages, under the same formulation conditions and physical characteristics of the fired tile (basically porosity), lay in a 20°C drop in firing temperature, and 10° C rise in mechanical strength.

2 - ORIGIN - GEOLOGY - EXTENSION

The deposit involved lies in the South of France, in a granitic region, whose origins goes back to the secondary era.

The estimated reserves of the principal three qualities, according to drilling surveys, amount to around 5 million tons.

3 - PRODUCT

The product may be defined as an albitized episenite having the following composition:

- Albite	55%	- Sericite	12%
- Anorthite	5%	- Quartz	2%
- Microcline	25%	- Secondary minerals	1% (Epimonzonite, Epidote, Zolzite)

The product contains two very different phases: coarse crystals of around 8 mm, made up of closely mixed microcline and albite, and a layer surrounding the crystals, which comprises the remaining compositional constituents and albite.

4- BEHAVIOUR

4.1 - General features

During the drilling surveys of the deposit, the firing controls and chemical analyses had suggested that the product might be non-typical compared with common feldspars.

Initial tests with clays carried out at the head laboratory of the Groupe Minéral Harwanne, to which the Société des Feldspaths du Midi belongs, confirmed this fact. The Society therefore decided to study the raw material's behaviour, comparing it with other feldspars, in particular with the ones used in Spain, for geographical reasons, since the deposit lies in the South of France. AICE/ITC in Castellón were commissioned to conduct the study.

Table No. 1 : Characteristics of Feldspar T66/13

T	Firing shrinkage	Porosity	Chromatic coordinates		
			L*	a*	b*
1100°C	1	23.5	84.9	3.8	17.8
1120°C	3.5	11.5	79.3	4.5	18.8
1140°C	10	0.5	60.2	5.0	19.0
1160°C	9.5	0	57.1	3.8	18.5
1180°C	10	0	57.5	3.9	18.8
1200°C	10	0	57.5	3.7	18.6
1230°C	12.5	0	62.1	2.8	18.5
1260°C	12.5	0	62.8	1.8	17.1

4.2 - Formulations - Sample preparation

The typical problems relating to manufacture in the Castellón region were taken into account in the tested formulations, especially with regard to the choice of clays, which led to using Teruel clays together with English clays to provide the necessary cohesion in the unfired body.

Sample preparation conditions were the usual ones for such materials at AICE/ITC; milling in acetone, oversize at 60 microns: around 3%, pressing pressure of the test specimens 250 kg/cm^2, fast firing at different temperatures with a 6 min soak.

Table No. 2 : Formulation and characteristics of the unfired mixes.

Composition no.	Teruel clay	English clay	Feldspar CS	Standard Turkish feldspar	Feldspar T66/13	Oversize at 60 microns	Dry bulk density
1	63	7	15	15	-	3.1	1.986
2	63	7	-	30	-	3.3	2.001
3	63	7	-	-	30	3.6	1.961

4.3 - Results

4.3.1 - Firing behaviour

Table No. 3 : Firing behaviour

Firing	Composition no.	Loss on ignition	Firing shrinkage	Water absorption	Bulk density	Chromatic coordinates		
						L*	a*	b*
1140°C	1	4.80	4.3	7.3	2.158	74.6	3.7	16.0
	2	4.88	3.8	8.0	2.134	73.7	3.7	14.8
	3	5.03	5.6	6.1	2.206	74.8	4.1	17.1
1160°C	1	«	4.9	5.4	2.215	71.1	3.2	15.4
	2	«	4.4	6.4	2.186	73.7	3.1	14.8
	3	«	6.2	4.2	2.265	69.3	3.8	15.7
1180°C	1	«	5.5	4.4	2.248	68.9	2.8	14.8
	2	«	5.0	5.1	2.228	71.1	2.8	14.3
	3	«	6.7	3.2	2.305	66.7	3.2	15.7
1200°C	1	«	6.2	2.4	2.318	64.8	2.0	13.2
	2	«	5.8	3.0	2.296	67.2	2.1	14.0
	3	«	7.2	1.8	2.356	63.4	2.2	13.9
1220°C	1	«	6.9	1.3	2.368	61.4	1.1	11.6
	2	«	6.5	1.8	2.349	63.3	1.2	12.1
	3	«	7.7	1.0	2.389	61	1.3	12.4

It can be observed that the composition containing feldspar T66/13 starts sintering faster than the other two, reaching a 3% porosity more quickly and less sharply, with less variation in firing shrinkage.

This is consistent with the data obtained on the product taken by itself, i.e. sintering start at a relatively low temperature, good firing interval.

An important point: It can be observed that when the feldspar is fired on its own, it turns a relatively dark colour. However, this does not entail any significant change in tile body colour, compared with the other two feldspars that were a much lighter colour (see L*, a* and b* in Tables 1 and 3).

4.3.2 - Comparison of tile characteristics with 3% porosity

The current standard sets the porosity requirement of glazed stoneware at 3%. The firing characteristics and mechanical strength data were examined for each tested body at 3% porosity.

Table No. 4 : Fired tile characteristics at 3% porosity.

	Temperature °C	Fired mechanical strength	L*	a*	b*
1	1195	485	66.0	2.3	13.7
2	1202	431	66.3	2.0	13.7
3	1180	473	66.8	3.2	15.8

Feldspar T66/13 is observed to lower firing temperature by 20° and raise mechanical strength of the fired body by 10° C.

5 - CONCLUSIONS

* Sintering starts at a relatively low temperature.

  The crystals within which albite and microcline are closely bonded, form an almost eutectic composition and allow a glassy flow to arise rapidly.

* Firing time

  The microcline/albite eutectic composition undergoes no sudden melting, and the low anorthite content slows down the fusion of albite in the surrounding layer, while sericite breaks down at the same time yielding mullite, which limits glassy flow.
  This set of phenomena encourages a long firing interval.

* Enhanced mechanical strength after firing.

  The presence of sericite, which decomposes as indicated above, yields mullite, which in turn «structures» the glassy part of the body and raises its mechanical strength.

* Colour

  The position of iron in the lattice, mostly in the sericite, and subsequently in the mullite, impedes it from «entering» the glassy flow, so that it has no effect upon the colour of the body.