TESTS and RESEARCH - Mineralogy and Chemistry of Raw Materials & Products

St Astier Natural Hydraulic Limes (NHL)

Chemistry and mineralogy of the raw material

Manufacturing and finished products chemical and mineralogical data.

St. Astier Natural Hydraulic Limes (NHL) are produced from the burning and slaking of a pure chalky limestone with siliceous content. No additions are made. They strictly conform to the French Norm NFP 15.311 and the European Norm EN 459 classifying NHL.

The limestone in the St. Astier basin (approx. 40 Km^2) derives from crustacean deposits (chalky limestone) infiltrated by silica but untouched by clay. Exploited for thousands of years, industrial production begun in 1851. The quarries, owned by the same group from the industrial beginning, extend for 30 hectares. Tests conducted by the French government show a unique uniformity in the composition of the deposits (up to 100 m. depth).

<table>
<tr><td colspan="3">Chemical and mineralogical analysis of the deposit.</td></tr>
<tr><td>Chemical Analysis</td><td>%</td><td rowspan="11">The absence of clay infiltration and the consequent minimal presence of Al_2O_3, sulphates and alkalis ensures the production of hydraulic limes based almost totally on the combination of Calcium Oxide and reactive silica.</td></tr>
<tr><td>Loss at ignition</td><td>40</td></tr>
<tr><td>CaO</td><td>44</td></tr>
<tr><td>SiO_2</td><td>13</td></tr>
<tr><td>MgO</td><td>0.6</td></tr>
<tr><td>Al_2O_3**</td><td>1.1</td></tr>
<tr><td>Fe_2O_3**</td><td>0.32</td></tr>
<tr><td>SO_3 **</td><td>0</td></tr>
<tr><td>Na_2O **</td><td>0.04</td></tr>
<tr><td>K_2O **</td><td>0.1</td></tr>
<tr><td>Others**</td><td>0.84</td></tr>
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Corresponding mineralogical composition			
H_2O (moisture content)	8		*The soluble silica, available to be combined with the CaO produced in the burning of the* $CaCO_3$) *determines the hydraulicity of the finished products.*
$CaCO_3$	75		
SiO_2 (soluble)	11	reactive/combinable	
SiO_2 (insoluble)	2	inert/un-combinable	
$MgCO_3$	1		
Others (derivatives from items marked ** above)	3		

The production of different types of Natural Hydraulic Limes from the same raw material deposits proves that hydraulicity depends on the amount of silica combined and not on the total amount present. The theory that hydraulicity depends on the total amount of "clay (or silica)" in the raw material is fundamentally flawed.

The production method is essentially unchanged from the one used since ancient times: limestone burned and slaked. It is therefore correct to say that St. Astier NHL products are amongst the very few traditionally produced limes. The scientific knowledge of the manufacturer and modern quality control have, however, the favourable effect of producing reliable materials with constant performance.

The burning process: Its methods and the energy used are the determining factors in the quantity of silica that combines with Calcium Oxide (CaO) to form Calcium Silicates (CS) which produce the hydraulic performance of the finished products. Burning takes place in vertical kilns at temperatures not above 1,000ºC. The fuel is anthracite coal, imported from Wales due to its purity, as it produces the least residuals.

Continuous checks are made to measure the efficiency of the burning (CO_2 tests) which are essential to regulate the hydration that follows.

Hydration (slaking): The controlled hydration process is so precise that virtually no quick lime (<1%) will be present at the end. The efficiency of the slaking process is such that only a small percentage of the slaked material has to be milled to achieve the desired granulometry (0.09mm). As shown below, the amount of potentially damaging components produced is so minute that adverse reactions, leading to materials deterioration, are not possible.

Composition	CHEMICAL (%)			MINERALOGICAL (%)			
	NHL5	NHL3.5	NHL2		NHL5	NHL3.5	NHL2
Loss @ Ignition	16	18	20				
Calcimetry (CaO_2)	10	11	6				
Insoluble	5.6	9.6	8		5.6	9.6	8
CaO	59	56	63	Free lime $Ca(OH)_2$	22	25	58
Calcium Carbonate $CaCO_3$ UNBURNT					23	25	13
SiO_2	15	12	6	Calcium Silicate			
Combined				C_2S	43	35	17
				C_3A	0.7	0.5	0.4
Al_2O_3	1.92	1.66	1.3	C_2AS	1.3	1.0	0.8
Fe_2O_3	0.57	0.49	0.4	C_4AF	0.7	0.5	0.4
SO_3**	0.41	0.45	0.31	$CaSO_4$	0.7	0.8	0.5
				Others			
MgO	1.01	0.98	0.75				
MnO	0.02	0.01	>0.01				
TiO_2	0.18	0.16	0.12	The quantities of these components are so small that their mineralogical presence is too minute to be relevant. Very significant for the alkalis (K_2O/Na_2O) which, even in small quantities (1.5/2% as in ordinary cement) can produce ALKALI-SILICA reactions.			
K_2O	0.21	0.16	0.12				
Na_2O	0.07	0.06	0.04				

**** The presence of SO_3, absent in the raw material, is induced by the coal used in burning. The small level of it, however, is harmless. Higher gypsum ($CaSO_4$) levels due to additions as in the case of ordinary cement or some other hydraulic binders can cause damage.**

C_3S can occur due to "high spots" in the furnace and also due to autectic reactions caused by the presence of alkalis which lowers the fusion point.

For further Guidance, contact your St Astier Distributor.