HIGH-CALCIUM, HIGH-REACTIVITY LIME PUTTY

Mechanics' lime

TRADITIONAL & *sustainable*

✔ Easy Workability
- high plasticity
- Emley >400
- Sticks to trowel, sticks to wall

✔ High Purity
- 98%+ calcium
- Negligible magnesium
- All lime acts as binder

✔ High Surface Area
- 30m^2/g (BET)
- Holds water well during application
- Carbonates quickly and thoroughly

✔ Breathable
- wicks water out
- water-shedding
- healthier indoor environments

✔ Durable
- self-repairing
- cushions to accommodate movement
- expansion - not shrinkage - during carbonation maintains good bonding

HOW IS THIS PUTTY PRODUCED DIFFERENTLY? WHAT MAKES IT BETTER FOR HISTORIC HOMES, MONUMENTS and GREEN BUILDINGS?

Higher calcium content leads to quicker carbonation and a more durable mortar. Magnesium and other impurities either don't react or react slowly with CO_2. But is high-calcium lime enough to make a good lime-only mortar? No. Food-grade calcium hydrate is pure, but does not have high surface area for CO_2 reactivity. A calcium hydroxide slurry for deacidification is more likely to have high-surface area, but may not be high-calcium. Limes manufactured for Portland cement need to be "dead burned" (sintered) so the lime and Portland (hydraulic) reactions don't compete.

A "soft-burned" lime (maintained at 900°C) has a porous "coral-like" surface that is derived from firing the lime optimally to drive off CO_2 (see below). Lime for Portland-based masonry mixes continues to be fired beyond this stage until the pores close up again. This material adds plasticity to stiff and brittle Portland, but would not provide porosity or reactivity for lime-only mortar.

When a soft, self-healing, porous, and breathable surface is desired, then a high-calcium, "soft-burned" lime is ideal. Only a purpose-made architectural lime putty will have high surface area (greater than 30 m^2/g) and porosity that comes from "soft burning" and the chemical purity of a consistently high calcium content (98%+). Together these characteristics ensure all of the lime is acting as a binder (cementing the aggregate particles). If there are impurities such as magnesium, that proportion of the lime cannot be assumed to act as the cementing binder, because it will not carbonate for a very long time. It would be wiser to count the magnesium content (i.e. dolomitic limes) as part of the aggregate in order to ensure that you have the appropriate amount of calcium to bind the aggregate together into a strong and durable mortar. Architectural lime putty makes great mortar without Portland cement or pozzolans. Lime mortars are consistently compatible with historic lime-only mortars that rarely exceed 200 p.s.i. and do not impede full water and vapor movement to the exterior of a wall. Remember, the role of mortar is to cushion the masonry units and accommodate movement while eliminating point-loading.

The lime cycle is a closed loop. Calcium Carbonate [$CaCO_3$, i.e. limestone, oyster shell] is fired to drive off the CO_2, making Calcium Oxide [CaO, quicklime]. When water is introduced during the volatile process called slaking, calcium hydroxide is formed [$Ca(OH)_2$]. Lime putty is calcium hydroxide. As water leaves the lime, carbon dioxide from the air begins to take its place, once again reacting with the lime to create Calcium Carbonate again. There is an increase in mass associated with carbonation that counteracts shrinkage from water loss. The reverse is true for Portland cement mortars which lose mass and shrink with water loss.

Good quality control in manufacturing Sample A produced an optimum lime putty. The same oxide hand slaked without precise control of water and temperature created the inferior putties, C and D.

Putty Comparison

	A	C	D
10% viscosity	240	35	25
20% decantation	70 min.	10 min.	9 min.

Reactivity is created through careful control during firing and slaking. Small particles and high surface area create longer decantation times (the time necessary for a particle to settle out). Viscosity is related to surface area and plasticity. Greater plasticity and water-holding capacity mean better working properties and low shrinkage from water loss.

True lime mortars set (carbonate or "cure") by reacting with atmospheric CO_2, creating a sort of man-made limestone. Hydraulic mortars (Portland cement, bagged mortar mixes, hydraulic limes and cements) set by reacting with water. The firing of all mortar constituents drives off CO_2, but reabsorption of CO_2 by lime mortar makes it a more environmentally-responsible building choice. Lime mortars are also less fuel intensive to produce than Portland-based mortars.