

**LTL**

**Linde Type L**

**Si(76), Al(24)**

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**Type Material**  $K_9[Al_9Si_{27}O_{72}] : wH_2O$  ( $w = 0$  to 36)

**Method** J. P. Verduijn [1]

**Batch Composition** 2.35  $K_2O$  :  $Al_2O_3$  : 10  $SiO_2$  : 160  $H_2O$  : trace  $MgO$  <sup>a</sup>

#### **Source Materials**

deionized water

potassium hydroxide (Baker 0222 pellets, 86.8% KOH)

alumina (Baker 0005, 92.6%  $Al(OH)_3$ )

silica sol (Dupont Ludox HS-40, 40%  $SiO_2$ )

magnesium nitrate (Baker,  $Mg(NO_3)_2 \cdot 6 H_2O$ )

#### **Batch Preparation** (for 59 g product)

- (1) [50.00 g water + 30.39 g potassium hydroxide + 15.82 g alumina], heat to boiling until clear. Cool to room temperature and correct water loss due to boiling
- (2) [150.24 g silica sol + 99.0 g water + 14.5 g  $Mg(NO_3)_2$  solution],<sup>b</sup> mix until homogeneous (~3 minutes)
- (3) [(1) + (2) + 25.00 g water (rinse)],<sup>c</sup> mix until thickening starts (~ 3 minutes)<sup>d</sup>

#### **Crystallization**

Vessel: 300 mL stainless steel autoclave <sup>e</sup>

Temperature: 175°C

Time: 48 hours <sup>f</sup>

Agitation: none

#### **Product Recovery**

- (1) Cool to room temperature
- (2) Filter and wash (5 times) with 650 mL water. The pH of the last wash water should be ~10
- (3) Dry at 150°C for 16 hours
- (4) Yield: After drying at 150°C, ~ 15.3 wt% based on the weight of synthesis gel in the autoclave (nearly 100% on  $Al_2O_3$ )

#### **Product Characterization**

XRD: LTL (only crystalline product). Competing phases: MER (without  $MgO$ )

Elemental Analysis: 6.2  $SiO_2/Al_2O_3$ , 1.0  $K_2O/Al_2O_3$

Crystal Size and Habit: cylindrical, 0.2 to 0.4  $\mu m$  diameter, 0.4 to 0.7  $\mu m$  long (L/D ~ 2)

#### **Reference**

- [1] J. P. Verduijn, US Patent 5 242 675 (1993)

**Notes**

- a. The synthesis mixture contains 9 wt ppm of added  $Mg^{2+}$  species (based on the weight of the synthesis mixture).
- b.  $Mg(NO_3)_2$  solution: dissolve 2.5645 g magnesium nitrate ( $Mg(NO_3)_2 \cdot 6 H_2O$ ) in 997.4 g water.  
This solution contains 0.24 mg  $Mg^{2+}$ /g solution. The function of the  $Mg^{2+}$  species is to avoid the formation of byproducts such as MER, and to control the particle size of the LTL product.
- c. This water is used to quantitatively transfer the aluminate solution.
- d. After 3 minutes mixing, the gel is still pourable. Longer mixing is permitted, but the gel then tends to stiffen and is difficult to transfer to the autoclave.
- e. No Teflon liner was used.
- f. Crystallization time is not critical (24 to 72 hours).