DOUCIL® 4A is a zeolite of the first generation optimized for use as a builder, liquid carrier and/or processing aid in laundry detergent products, helping manufacturers to produce detergents with excellent physical properties and cleaning performance.

Benefits of DOUCIL® 4A zeolite for detergents

- crystalline material of very high purity
- effective water softening
- high liquid carrying capacity
- very consistent quality enabling customers to minimize process adjustments
- non toxic, environmentally safe
Structure and Composition

Doucil® 4A zeolite is a crystalline material, with a zeolite A-type structure. It is produced by precipitation and crystallization from pure sodium aluminate and sodium silicate solutions to yield a product with the following composition:

\[ \text{Na}_2\text{O} \cdot 2\text{SiO}_2 \cdot \text{Al}_2\text{O}_3 \cdot 4.5\text{H}_2\text{O} \]

Doucil® 4A has a silicon: aluminum ratio of 1 (the maximum attainable aluminum content). 29Si and 27Al NMR spectra indicate an ordered distribution of tetra-hedrally coordinated atoms with no extra framework aluminum species. The maximum aluminum content leads to the highest negative charge on the framework and hence to the highest theoretically achievable calcium ion exchange capacity. This is important for detergents, since it allows maximum water softening.

Particle Size and Morphology

Doucil® 4A zeolite is supplied as a powder, with an average particle size of approximately 3 microns. The narrow particle size distribution (figure 1) ensures minimal incrustation of zeolite particles on fabrics. Doucil® 4A zeolite is a highly crystalline material of cubic form with rounded edges (figure 2), thus protecting fibers against damage.
**Ion Exchange Capacity**

Doucil® 4A zeolite exchanges the sodium ions in its pores for the calcium ions in the wash water (figures 3 and 4). The high crystallinity of Doucil® 4A zeolite improves the accessibility to the pores, leading to effective softening of the water and enhanced cleaning performance.

Ion exchange will also take place with heavy metal ions e.g. Cu, Mn, Fe, Pb and Zn, which are commonly introduced via tap water or soil. Removal of these ions is beneficial, as these can have negative effects on the bleaching process.

**Processability**

Detergent powders contain both solid and liquid components. In order to maintain a free flowing detergent powder, the solid components need to absorb the liquids, such as surfactants. Detergent formulators are often forced to use excessive amounts of solid builders or fillers, simply to be able to include sufficient liquid actives in their formulations.

The high liquid carrying capacity of Doucil® 4A zeolite (figure 5) allows non-tower processing routes to be used in the production of detergent powders, thus saving on capital investment and energy costs.

Doucil® 4A zeolite is also an effective anti-caking aid, improving flow properties.

![Figure 3 Calcium Binding Capacity](image)

![Figure 4 Ca - Na Ion Exchange Isotherm](image)

![Figure 5 Liquid Carrying Capacity](image)

Doucil 4A is also available as an aqueous suspension (4AS) which may be advantageous in some detergent slurry applications.

**Product Properties**

<table>
<thead>
<tr>
<th></th>
<th>Doucil 4A</th>
<th>Doucil 4AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>D50 µm</td>
<td>2.0-5.0</td>
<td>2.0-5.0</td>
</tr>
<tr>
<td>CBC</td>
<td>&gt;155</td>
<td>&gt;155</td>
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<tr>
<td>LCC</td>
<td>38</td>
<td></td>
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<tr>
<td>Ca-uptake rate sec</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>% loss on ignition</td>
<td>18-22</td>
<td>51.5-53.5</td>
</tr>
<tr>
<td>Viscosity (Din cup, sec)</td>
<td>20 max</td>
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</tr>
</tbody>
</table>
Packaging

Doucil zeolites are available in bulk, big bags or small bags, fitted with a PE inner layer.

Storage and handling

Doucil zeolites are not particularly hygroscopic, but to preserve their properties it is recommended that they are stored in dry conditions.

Zeolites: Safe for human and environment

It has long been known that detergents can have a considerable impact on the environment. In the 1970’s issues regarding eutrophication of surface water, with excessive formation of algae and subsequent oxygen deficiency led to a search for detergent phosphate substitutes. In the 1980’s zeolite found worldwide acceptance as an environmentally friendly builder for use in “zero P” formulations and has replaced sodiumtripolyphosphate (STPP) in many countries in Europe, America and Asia. With the ongoing concern for water quality this trend still continues.

Tests by independent consumer organizations have demonstrated excellent performance for the zeolite based formulations compared with the phosphate containing products.

The introduction of zeolites in detergents allowed detergent formulators to make more concentrated formulations. Introduction of these so-called “compact” and “supercompact” products, in combination with new dosage instructions to consumers, has significantly reduced the load of detergent chemicals on the environment.

Detergent zeolites have undergone extensive toxicological studies and have been shown to be nontoxic in living organisms.

Health and Safety

Material Safety Data Sheets providing detailed toxicological and handling information on PQ Corporation zeolites for detergent applications are available upon request.