

Phosphorus-Free Laponite® Sols

Abstract: Sodium and Ammonium Polyacrylates have been used to reduce the viscosity of aqueous dispersions of synthetic layered silicates; Laponite®, to provide phosphate-free sols that allow the user to incorporate Laponite® in liquid form into a formulation.

Laponite® products are available either as gelling or sol grades,¹ to impart thixotropic rheology in a wide range of water-based formulated systems. Examples of application areas where this technology has been shown to be effective in controlling rheological properties include; coatings, ceramics, personal care, household cleaning, oilfield, agricultural and others. The sol grades contain phosphate-based additives as peptising agents, to enable dispersions containing high solids to be prepared that are stable liquids, for up to 2 years in some cases. These allow flexible incorporation into formulations, for example, by post-addition or as a process aid.

The combination of sodium or ammonium polyacrylates with Laponite® has been shown to produce a peptising affect, allowing the preparation of phosphorus-free sols that are more environmentally acceptable or chemically compatible in certain applications. In particular, low molecular weight (M_w) ammonium polyacrylate has been found to produce the most stable sols with Laponite®. One example is Dispex® A40.²

Laponite® sols that are stable for more than 5 months can be produced when combined with 5 - 115 % w/w of polyacrylate (based on Laponite® weight). Several experiments were carried out to determine the optimum level of polyacrylate for maximum sol stability. This was found to be 50 % w/w of Dispex® A40 (based on Laponite® weight). An example of a typical dispersion is shown in Table 1 and to calculate the correct amount of polyacrylate based on the amount of Laponite®, the general calculation in Figure 1 should be used.

Table 1 - Guideline formulation

<i>Example Dispersion Containing 8 % w/w Laponite® with Ammonium Polyacrylate</i>			
Ingredient	Alternative Name	Weight to add, as received (g)	Percentage Active of Total (%)
Aqua (DI)	Water	88	90.4
Dispex® A40	Ammonium Polyacrylate	4	1.6
<i>Mix together for ~ 30 s at 700 rpm.</i>			
Laponite® RD or SH	Hydrous Sodium Lithium Magnesium Silicate	8	8
<i>Mix together for 1 h at 700 rpm.</i>			
Total		100	100

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Rockwood Additives Limited
Moorfield Road Widnes
Cheshire UK WA8 3AA
Tel: +44 (0)151 495 2222 Fax: +44 (0)151 420 4401

Rockwood Clay Additives GmbH
Stadtwaldstr. 44
85368 Moosburg, Germany
Tel: +49 (0) 8761 72 150-0 Fax: +49 (0) 8761 72 150-334

Rockwood Specialties (Singapore) Pte. Limited
171 Chin Swee Road
Unit No: #10-08 San Centre Singapore 169877
Tel: +65 6532 0676 Fax: +65 6532 0502

Figure 1 - Polyacrylate Calculation

$$\text{Weight of Dispex}^{\text{®}} \text{ A40} = \frac{\text{Weight of Laponite}^{\text{®}}}{2}$$

Note: Weights are 'as received'

The sol stability is affected by the amount of Laponite[®] present in the dispersion. For example, with the maximum 8 % w/w Laponite[®] solids, a dispersion will be stable for < 24 h before gelling occurs. If the Laponite[®] solids are reduced to 5 % w/w, the stability is increased to more than 5 months. To illustrate this effect, the viscosity data measured over time for dispersions containing 5-10 % w/w Laponite[®] in combination with 50 % w/w Dispex[®] A40, (based on Laponite[®] weight) are presented in Table 2. The time taken to gel is also recorded. The viscosity measurements were made using a Brookfield LV viscometer (Brookfield Engineering Laboratories, Inc.), using the UL adapter for the low viscosity samples, and the Helipath T-bar spindle F for the higher viscosity gels. As a rough guide, a viscosity below 1000 cP indicates the dispersion is a liquid and flows, above this the dispersion is a gel.

Table 2 - Effect of Laponite[®] Solids Content on Sol Stability

Laponite [®] Conc ⁿ as received (%)	Viscosity/cP						Time to Gel
	1 h	24 h	2 weeks	3 weeks	6 weeks	10 weeks	
5	17	8	18	12	18	18	> 5 months
6	18	14	16	18	18	28	> 5 months
7	26	38	78	104	1940	gel	6 weeks
8	167	762	gel	gel	gel	gel	2-3 days
9	786	53950	gel	gel	gel	gel	<24 h
10	1311	215500	gel	gel	gel	gel	<24 h

Conclusion:

A polyacrylate-based, phosphorus-free peptising agent has been developed for use with Laponite[®] synthetic layered silicates, to form low viscosity sols that can allow the user to incorporate Laponite[®] in liquid form into a wide range of formulations. Depending on the Laponite[®] solids level, the sols are stable for more than 5 months.

References:

- 1) Laponite[®] is a synthetic layered silicate available from Rockwood Additives Ltd, Widnes, UK.
- 2) Dispex[®] A40 is a 40 % w/w solution of Ammonium Polyacrylate, with an average molecular weight of ~4000 gmol⁻¹; available from Ciba UK plc., Macclesfield, UK. INCI Name is AMMONIUM POLYACRYLATE.

Formulation provided by Rockwood Additives Ltd.

For more information- contact the Laponite team on help@laponite.com

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