Enhanced Performance
Through Applied Innovation

ELEMENTIS
A global specialty chemicals company

Personal Care

BENTONE HYDROCLAY ™

and the effect of pH and Salt

Introduction

All smectite clays create a network due to a balance of charges on and around the clay platelet. This creates an equilibrium between electrostatic repulsion and van der Waals attraction forces. Ingredients that can alter the charge density and distribution on smectite clays can affect the network and either strengthen or weaken it and ultimately potentially destroy it.

Influence of pH

Figure 1 shows the viscosity of the different BENTONE HYDROCLAY™ products over a pH range from pH 3-12.

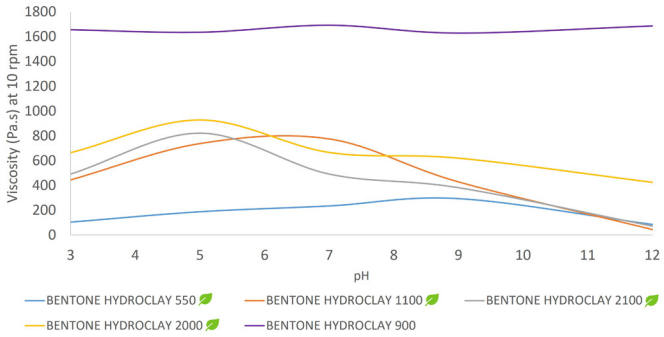

Figure 1. BENTONE HYDROCLAY™ and the influence of pH on viscosity

The pH curve can be quite deceptive for smectite clays. For the pure hectorite clay the highest viscosity is achieved at pH 5, but this is not the entire story. Smectite clays are generally happiest and most stable at pH 7-11 and form the structure shown in Figure 2, where they have edge to edge interaction.

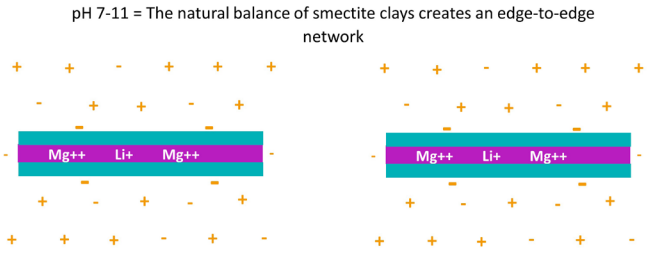

Figure 2. Typical smectite clay network at pH 7-11

However, Personal Care formulations are often targeting a range of pH 5-7. This pH range causes the edges of the platelets to become positively charged, and an edge to surface attraction occurs as shown in Figure 3.

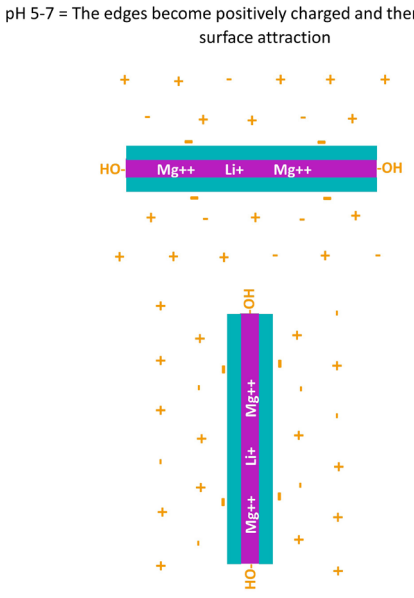

Figure 3. Smectite clay network at pH 5-7

This type of network takes up less volume but can create a viscosity boost. However, the long-term structure is weaker than at pH 7-11, which may lead to phase separation over time. This phase separation can be overcome by either increasing the concentration of clay, increasing the emulsifier concentration to create a stronger system, or utilizing the synergies of clays with other thickeners like xanthan gum. The synergy of hectorite and hydroxethylcellulose in BENTONE HYDROCLAY™ 900 also helps to overcome challenges in a wider range of pH systems.

It is not recommended to formulate with pure smectite clays below pH 5 and above pH 11.

Below pH 5 the negative surface charge becomes saturated, while above pH 11 the negative charges become stronger, and the forces of repulsion holding the clay network together become more dominant, which in both cases significantly impacts the structure stability.

Influence of Salt

Salt can affect the charge balance around clay platelets, affecting the clay network. Figure 4 shows the influence of salt concentrations from 0-5% on the viscosity of dispersions of the BENTONE HYDROCLAY™ series in water.

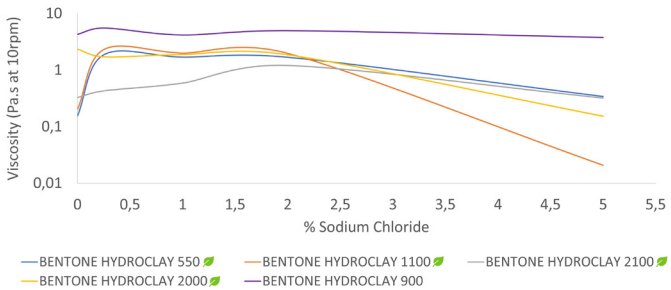

Figure 4. BENTONE HYDROCLAY™ and the influence of salt on viscosity

In the presence of salts, e.g. sodium chloride, the sodium ion neutralizes some of the electrons, so the surfaces repulse less against each other. The platelets in turn come closer together, forming a stronger attraction. This makes the gel structure more stable as more energy is needed to separate the platelets and leads to an increase in viscosity. With too much salt, all the electrons around the platelet are neutralized. The lack of surface repulsion causes the platelets to stack closely on top of each other, leading to an irreversible breakdown in the viscosity as depicted in Figure 5.

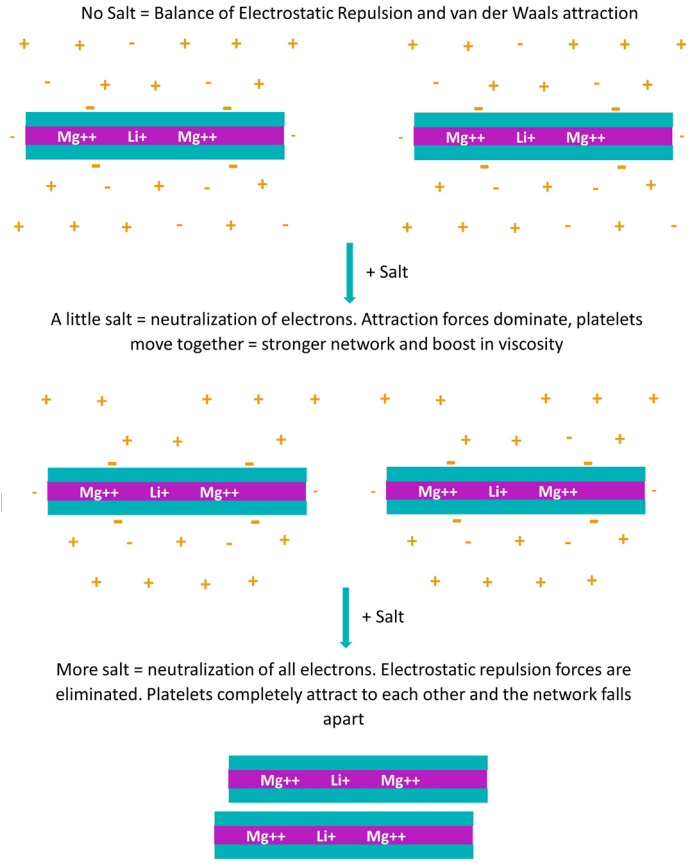

Figure 5. The influence of salt on the clay network

Conclusion

Clays can be sensitive to ingredients that affect the charge density on platelets. This is not necessarily limited to pH and salt, but also other ingredients like surfactants may interfere with the structure built up by clays. There are several methods to overcome these hurdles and formulating towards an optimal system. BENTONE HYDROCLAY™ 900, a combination of Hectorite and Hydroxyethylcellulose for instance, utilizes the synergy with a different thickener to improve the pH and salt stability of Hectorite. A simliar effect can also be achieved e.g. with other hydrocolloids or emulsifiers.

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