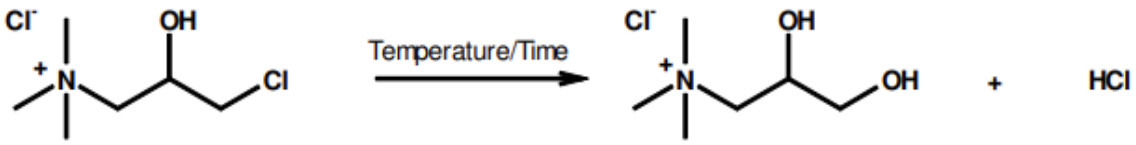
Stability of Quab 188

The storage stability of Quab 188 over a long period of time can be a concern, but this document is provided to answer any questions regarding the quality of Quab 188.

We are quite confident that the product can still be used for a longer period, and we do not see negative effects on the cationization reaction. We would like to discuss that issue in more detail in this letter and give the explanation for our statement above.

The major question that comes up is about the stability of the Quab 188 (chlorohydrin reagent). What happens with the reagent during storage, what happens to the reagent, what parameters have an effect on the stability, and what can be the consequences for the cationization reaction?

During storage, the chlorohydrin group of the Quab 188 will hydrolyze and HCl will be released. The reaction product from this hydrolysis is the Quab glycol and hydrochloric acid.



As a result, the pH of the Quab 188 will decrease over time. However, the reaction rate and the speed of this hydrolysis reaction depends on the storage temperature. The higher the storage temperature, the higher the reaction rate and the more HCl is formed and thus the lower the pH will be. As a consequence, some chlorohydrin will be lost leading to a lower active matter content.

However, one should not expect that the hydrolysis reaction is a significant reaction and will lead to a huge loss of activity over time, at least under normal use conditions at starch plants. Experiments in our laboratory have shown, that over a two year period, product that is stored between 20-25°C, the pH dropped from 5.5 to almost 3. The loss of active matter was less than 0.1% activity.

We also performed experiments at higher temperatures in order to get a better picture on what happens under more severe conditions. Therefore, a sample was stored at 100°C for 7 days and the pH and chlorohydrin content of the solution was measured. We received the following results:

Time	pH	Chlorohydrin Content
Initial	5.2	69.5%
3 hours	3.9	69.5%
7 hours	1.8	69.5%
1 day	1.0	69.2%
4 days	0.4	68.0%

We also used these samples and performed a cationization test and measured the final reaction efficiencies. As a result of these trials, we almost got the same reaction efficiencies with all samples after we had corrected the recipe with the actual chlorohydrin content.

In a similar experiment at 40°C and storage period of 2 months, the pH dropped to 2.5 but again we were not able to detect a significant loss in the chlorohydrin content.

Just to summarize the above:

- During storage, hydrolysis of the chlorohydrin group will take place and glycol and HCl will be formed. The hydrolysis rate depends on the storage conditions.
- As a result of the HCl formation, the pH of the Quab 188 will decrease over time and eventually become lower than the specification value of 3. However, a significant loss in activity cannot be detected.
- If the pH of the Quab 188 is around 1 or above, no significant activity losses can be detected, and no negative effects are expected on the cationization reaction and its efficiency.
- Even at a pH below 1, the product can be used without problems, but the recipe should be corrected with the actual chlorohydrin content. Also, a slightly higher quantity of NaOH may be needed to bring up the pH of the slurry to its required value.
- A product that was artificially altered by storage at 100°C showed a pH of around 0.5. However, the chlorohydrin activity loss was only 1.5% (absolute).
- A low pH could be problematic if the product is stored in stainless steel tanks as the low pH together with the chloride content of the Quab 188 enhances the corrosion properties. However, other viable solutions include using plastic totes and drums to avoid corrosion issues.