Choice of Concrete Quality for Slurry Systems for Acidified Slurry

Up to 2002, Staring Maskinfabrik* A/S developed a method for limitation of the ammonia evaporation from slurry. The system is based on an „acidification“ of the slurry, by addition of sulphuric acid lowering the pH value of the slurry to about 5.5 (in the unprocessed slurry, the pH value is about 7).

**) The activities in agriculture and environment were in 2004 spun off from Staring Maskinfabrik A/S and carried on in the company of Infarm A/S.*

Acid and concrete do make the alarm bells ring. So, to establish whether this method would have negative consequences to the resistance of the concrete in the slurry systems, in a cooperation between Landbrugets Rådgivningscenter, Staring Maskinfabrik, and Aalborg Portland, a test series was run on various concrete samples stored in acidified as well as unprocessed slurry.

As mentioned above, concrete does not have good resistance to acid but a lowering to a pH of 5.5 is considered not to entail any significant reduction in its resistance, particularly since no surface wear occurs at the same time.

Part of the sulphuric acid is neutralized by the slurry so in relation to the PH value some sulphuric acid is added which will, among other things, increase the sulphate content in the slurry to a relatively high level (4,000 – 6,000 mg/l, as against about 200 mg/l in unprocessed slurry).

Denmark has seen but few examples of damage caused by sulphate impact but the risk of damage due to the high sulphate content is actually thought to be higher than the risk of damage due to the lowered pH value.

These tests were run over nearly two years without any sign of damage whatsoever.

Below, we have made an evaluation of this risk. The basis for our evaluation is one of previous experience (as gained by us and other parties) with sulphate attack in general, and also of the test results to hand.

In Denmark, consulting on concrete in sulphated environments has been conducted based on a Cembureau Recommendation, in 2004 incorporated in the rules of the common European DS/EN 206 standard.

Classifying in said standard sulphate impact in the manner tabled below:

DS/EN 206 Environment Class	**XA1**	**XA2**	**XA3**
SO^4 content mg/l	**200 – 600**	**600 - 3000**	**3000 – 6000 content of SO**
Cement sulphate resistance requirements	**Any moderate sulphate resistance**	**Moderate sulphate resistance**	**High sulphate resistance**
W/C ratio requirement	**$\leq$ 0.55**	**$\leq$ 0.50**	**$\leq$ 0.45**

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Definition of Environment Classes as well as Steps to be taken to counteract sulphate impact.

The risk of sulphate attack may thus be counteracted by an appropriate choice of cement type, as well as concrete quality. In addition to the cement sulphate resistance and the concrete w/c ratio (density), fly ash and micro-silica have a positive effect on concrete resistance in a sulphated environment.

The effect of fly ash and micro-silica is due to increased concrete density but in addition to that the fly ash content of aluminate and ferrite phase has a positive effect (limiting) on the equilibrium conditions for the potential decomposition mechanisms. In many cases, adding fly ash may well prove to be the solution.

Our recommendations are hereby issued to the concrete industry and agriculture for the choice of concrete quality and cement type/powder combination for concrete in connection with acidified slurry. For other conditions and applications of concrete in agriculture, our recommendations for concrete quality remain unchanged.

As mentioned previously, our recommendations are based on our current knowledge. We shall keep the concrete industry and agriculture currently informed, should any future studies/experience change our recommendations.

For further information, CtO may be contacted on telephone + 45 9933 7754, or by Email CtO@aalborg-portland.dk

Yours Sincerely,
AALBORG PORTLAND A/S
CtO • Cementfabrikkernes tekniske Oplysningskontor

Brian Dürr Pedersen
CtO Manager

Thorkild Rasmussen
CtO Consultant

Recommendations for choice of concrete quality for new slurry systems for acidified slurry

For new slurry systems, acidifying the slurry by adding sulphuric acid*, over a 25-year period history we do not expect any durability problems for the combinations of concrete quality and cement type** referred to below.

For bottoms and channel walls in slurry channels (indoor structures) as well as for bottoms of slurry tanks (mostly frost free), a concrete quality equivalent to moderate environment class (to DS 411 / DS 481) may be used, subject to using the cement types / cement agent combinations listed below.

Low alkaline sulphate resistant cement (possibly with fly ash and micro-silica)
White cement (Aalborg White) (possibly with fly ash and micro-silica)
Rapid cement with addition of min. 15% fly ash (possibly with micro-silica)
Basis cement with addition of min. 15% fly ash (possibly with micro-silica)

For slurry tank sides (facing the slurry), a concrete quality equivalent to moderate environment class (to DS 411 / DS 481) with a stricter requirement on the w/c ratio $\leq$ 0,45 may be used, subject to using the cement types / binder combinations listed below.

Low alkaline sulphate resistant cement (possibly with fly ash and micro-silica)
White cement (Aalborg White) (possibly with fly ash and micro-silica)
Rapid cement with addition of min 15% fly ash (possibly with micro-silica)
Basis cement with addition of min. 15% fly ash (possibly with micro-silica)

Recommendations for evaluation of the concrete quality in existing slurry systems, with a view to re-building to acidified slurry

In relation to new systems, a slightly higher risk may have to be run in order not to renounce the possibilities of applying the acidification principle.

For existing slurry systems for which the slurry is required to be acidified by adding sulphuric acid, the same combinations of concrete quality and cement types as for new systems may, of course, be regarded as “safe”.

Further, the same concrete qualities evaluated with the RAPID and BASIS cement types but without addition of fly ash are thought to pose a limited risk viewed over a period history of 20 – 25 years.

For sides in slurry tanks made with pure BASIS cement, there will, however, be a somewhat higher risk.

*) Addition of sulphuric acid equivalent to SO^{4-} content in slurry $\leq$ 6,000 mg/l, and a pH value of the slurry of $\geq$ 5.5.

**) These recommendations relate to cement from Aalborg Portland; no other cements were evaluated.