facts

GLUCOSET – Alternative set retarders for gypsum spray plaster

Part 2: Performance of blend products GLUCOSET ST300 and GT60

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Introduction

It is well known that tartaric acid is a very efficient set retarder for gypsum spray plaster[1]. However, only the L-form exhibits the high performance that is required to enhance the workability of the plaster. The high cost and dramatic price fluctuations associated with tartaric acid mean that there is great interest within the gypsum industry in alternative, economical, but proven, set retarder solutions.

The objective of the following study was to find an alternative to existing retarders – natural tartaric acid – that offers a significant cost advantage.

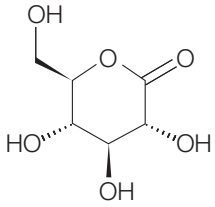
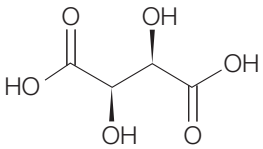
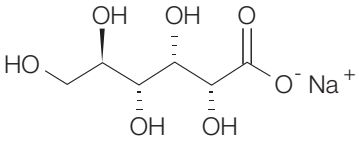
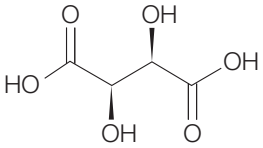
Experimental program

Raw materials

The following set retarders were used in part 2 of the study:

- (L)-Tartaric acid
- GLUCOSET S60 based on sodium gluconate
- GLUCOSET S300 based on sodium gluconate
- GLUCOSET G60 based on glucono-delta-lactone

Table 1: Additives used as set retarders[2]

Additive	Structural formula	Composition
GLUCOSET GT60 micronised (< 63 µm)		75–79%
		21–25%
GLUCOSET ST300 powder (< 300 µm)		77–81%
		19–23%

The basic gypsum spray plaster formulation was derived from a commercial spray plaster product from which the retarder component was removed (table 2).

Table 2: Basic gypsum spray plaster formulation

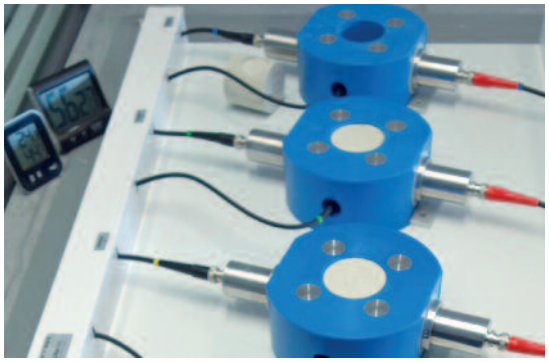
#	Compound	Concentration (w/w)
1	Hemihydrate gypsum	30–40
2	Multiphase gypsum	30–40
3	Lime hydrate	1–5
4	Crushed limestone 0–1 mm	10–20
5	Perlite 0–1 mm (lightweight)	2–5
6	Air-entraining agent	0.02–0.05
7	Set retarder	Variable (0.10–0.20%)
8	Starch ether	0.01–0.05
9	Methylcellulose	0.2–0.5
	Total	**100%**

Experimental procedure

Methods

A. Ultrasonic velocity measurement[3]

The ultrasonic velocity (longitudinal) was measured using the ultrasonic tester IP-8 developed by UltraTest GmbH, Germany.



Sample preparation:
300 g gypsum plaster + 186 g deionised water; l/s = 0.62, 60 seconds mixing, plaster poured into test cell, compacting 20 seconds at amplitude of 1.00.

B. Vicat-Dettki method[4]

The Vicat conus method according to EN13279-2 was used to determine when the gypsum plaster sample began to harden and when it stopped hardening (internal test method). The test interval was every 30 minutes after sample preparation.

Sample preparation:
300 g gypsum plaster + 186 g deionised water; l/s = 0.62.
Gypsum plaster was mixed with water for 60 seconds using a hand mixing device (Level 2). The mixture was poured into a cup and compacted by gentle stamping.

C. Application tests[5]
90 kg of the plaster was poured into a mortar mixer according to DIN EN 1015-2. The retarder combination was added to the plaster material and then mixed for 10 minutes.

A plaster machine was used to mix the gypsum plaster with water and to apply it to the test wall. A hollow brick surface (absorbent surface) was used for testing (approx. 4 m^2).

The application of the gypsum plaster followed in five steps:

1. Application
2. Levelling out
3. Flattening
4. Sponging
5. Smoothening

The time was recorded before application of the spray plaster to the wall. The quality of each process step was rated on a scale of one to five, where 1 = excellent, 2 = good, 3 = satisfactory, 4 = adequate, 5 = serious deficiencies.

Test regime
Reference:
a) Tartaric acid was used in a concentration of 0.10% for the laboratory methods.
b) Tartaric acid was used in a concentration of 0.13% for the wall tests.

Trial of the GLUCOSET retarders
GLUCOSET ST300 and GLUCOSET GT60 were used in calculated concentrations
(gluconate concentration × efficiency factor + tartaric acid concentration)

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Results and discussion

Lab results of ultrasonic velocity measurements for blends of tartaric acid and GLUCOSET S300/G60

We compared different blend compositions of GLUCOSET S60 and increasing concentrations of tartaric acid with a standard retarder formulation containing 0.10% tartaric acid.

Table 3: Composition of blend products based on GLUCOSET S60 and tartaric acid

# Sample	Tartaric acid		GLUCOSET S60 (calculated)	
	TA conc.	TA of total	(Ref. conc. – TA conc.) × overdosage factor	S60 conc.
Reference	0.10%	100%		
GLUCOSET S60			0.10% × 1.6	0.16%
# Blend 1 (TA/S60)	0.03%	21%	(0.10% – 0.03%) × 1.6	0.11%
# Blend 2 (TA/S60)	0.04%	30%	(0.10% – 0.04%) × 1.6	0.095%
# Blend 3 (TA/S60)	0.05%	38%	(0.10% – 0.05%) × 1.6	0.080%
# Blend 4 (TA/S60)	0.06%	48%	(0.10% – 0.06%) × 1.6	0.065%

Figure 1: Ultrasonic velocity measurement for TA vs. blends of TA with GLUCOSET S60

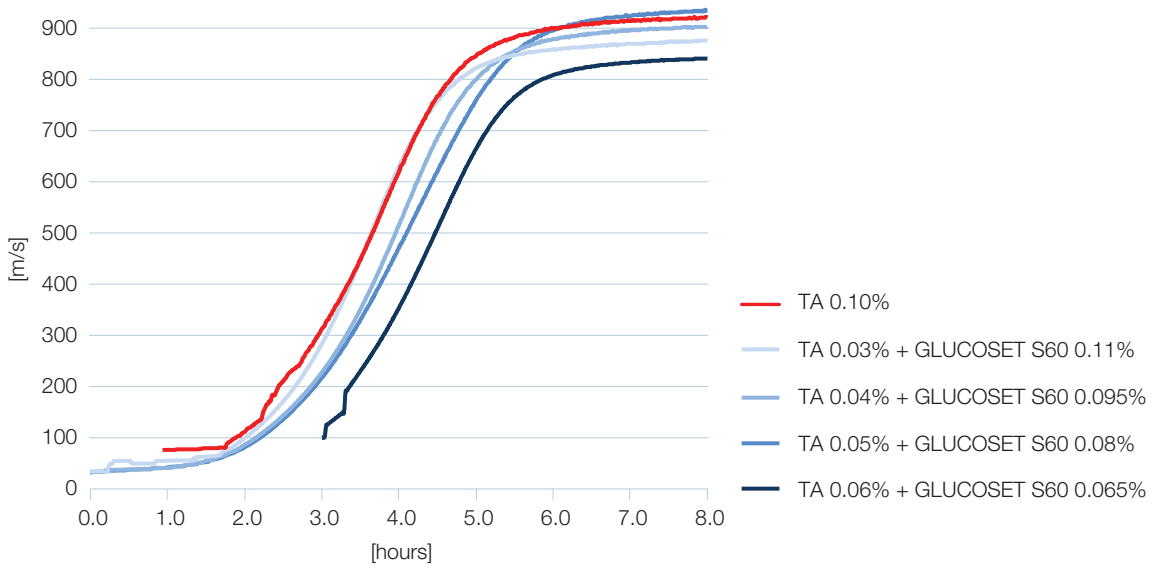

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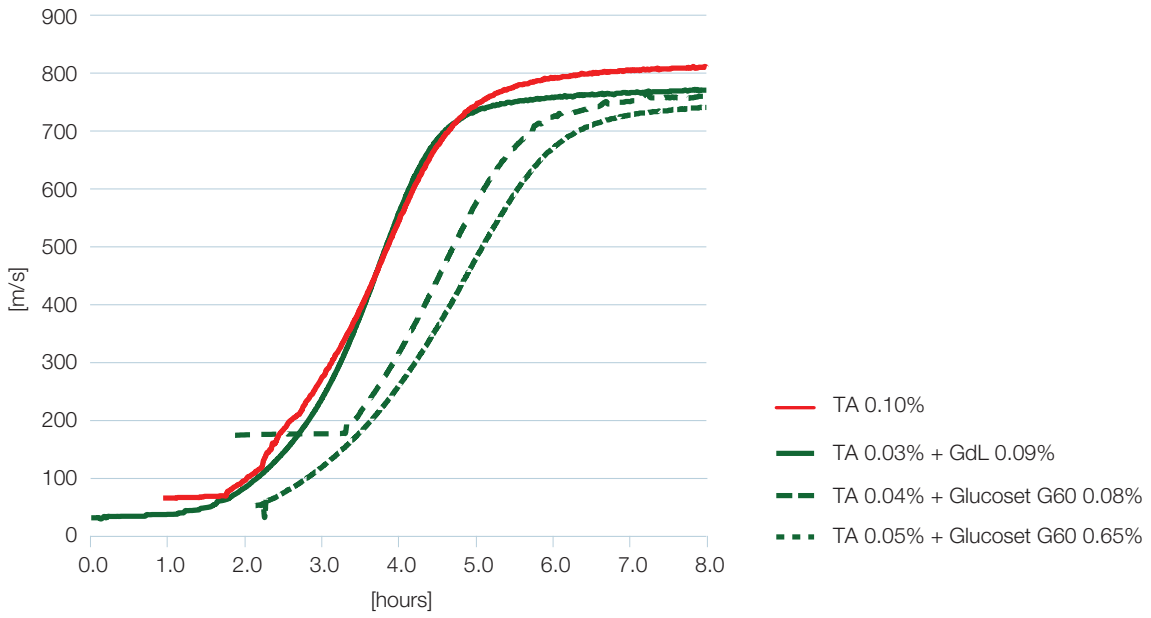
Table 4: Composition of blend products based on GLUCOSET G60 and tartaric acid

# Sample	Tartaric acid		GLUCOSET G60 (calculated)	
	TA conc.	TA of total	(Ref. conc. – TA conc.) × overdosage factor	G60 conc.
Reference	0.10%	100%		
GLUCOSET G60			0.10% × 1.4	0.14%
# Blend 4 (TA/G60)	0.03%	23%	(0.10% – 0.03%) × 1.4	0.10%
# Blend 5 (TA/G60)	0.04%	33%	(0.10% – 0.04%) × 1.4	0.08%
# Blend 6 (TA/G60)	0.05%	42%	(0.10% – 0.05%) × 1.4	0.07%

The retardation curves for the blend products with calculated concentrations were expected to exactly match the standard retardation curve (in red).

However, the results indicate that the blends – starting from a tartaric acid concentration of 0.04% – produced a stronger retardation than expected.

Figure 2: Ultrasonic velocity measurement for TA vs. blends of TA with GLUCOSET G60



The analogue experiment was carried out for the blends of tartaric acid and glucono-delta-lactone (figure 2). Starting from tartaric acid concentrations of 0.04%, the retardation curve was shifted to the right, indicating a stronger retardation effect for the blends containing 30% or more tartaric acid.

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Lab results of the Vicat-Dettki tests for GLUCOSET ST300/GT60

The reference retarder concentration of tartaric acid for a machine plaster with our reference formulations was 0.13%. This concentration of tartaric acid was required in order to ensure proper retardation of the gypsum plaster in the wall tests.

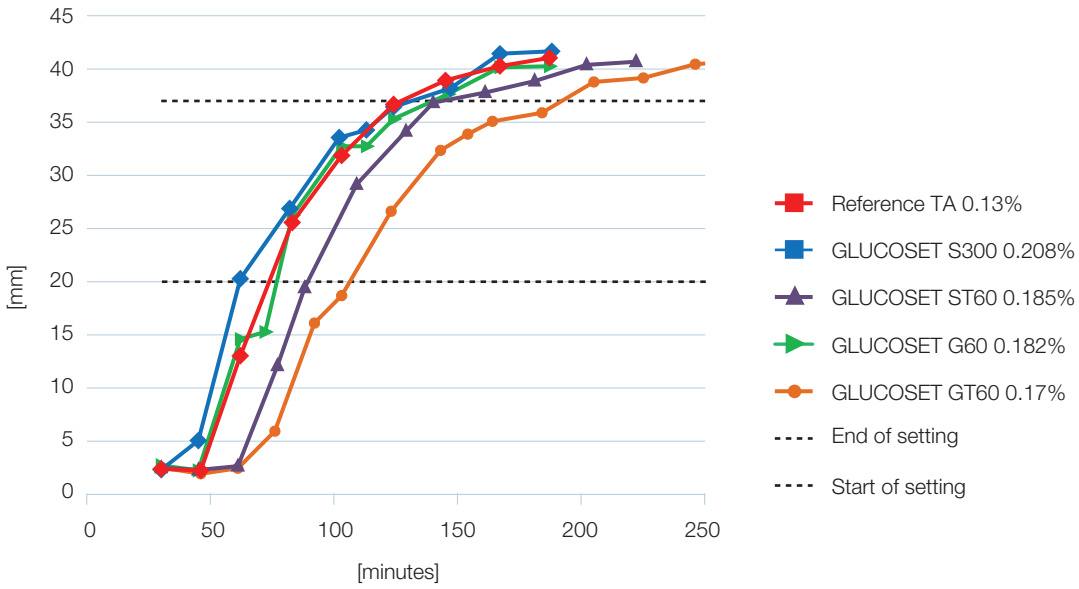
For the blend GLUCOSET products, the overdosage factor of 1.6 was applied for GLUCOSET ST300 (based on sodium gluconate) and 1.4 for GLUCOSET GT60 (based on glucono-delta-lactone)[6]. By applying these factors, we expect the same performance from all retarder products during application and in the Vicat-Dettki test.

Table 5: Composition and concentration of blend products

	Tartaric acid		Sodium Gluconate (calculated)		Glucono-delta-Lactone (calculated)		Total
Reference	0.13%	100%					0.130%
GLUCOSET G60					0.13% × 1.4	0.182%	0.182%
GLUCOSET GT60	0.04%	23%			(0.13% – 0.04%) × 1.4	0.13%	0.170%
GLUCOSET S300			0.13% × 1.6	0.208%			0.208%
GLUCOSET ST300	0.04%	21%	(0.13% – 0.04%) × 1.6	0.144%			0.185%

It emerged that the spray plaster composition with a concentration of 0.19% GLUCOSET ST300 and 0.17% GLUCOSET GT60 produced a stronger retardation compared with the reference (tartaric acid 0.13%). This is surprising and means that the concentration of the retarder blend can be reduced while achieving the same retardation effect as the reference.

Figure 3: Vicat-Dettki analysis of GLUCOSET retarders vs. tartaric acid (0.13%)



We can conclude from these results that the retarders GLUCOSET ST300 and GT60 offer an additional benefit over the gluconate-based GLUCOSET S300 or G60 retarders, which do not contain tartaric acid.

We used the same retarders in the subsequent wall test.

Results of application tests (wall tests) for GLUCOSET ST300/GT60:

GLUCOSET ST300 and GLUCOSET GT60 were used for wall application tests and compared with the pure retarders GLUCOSET S300 and G60. The reference concentration of tartaric acid was 0.13%, so as to ensure a realistic application process.

The application tests were carried out on the same day using the same basic plaster formulation as specified in table 2. The application process followed the five step methodology set out in the Experimental Procedure Section C.

For each test formulation, a subjective rating was assigned to each application step by a skilled artisan. Secondly, the moment in time each application step was started was recorded. Of special importance for the evaluation are the final three steps, as this is when the subtle differences between the individual retardants should come into play.

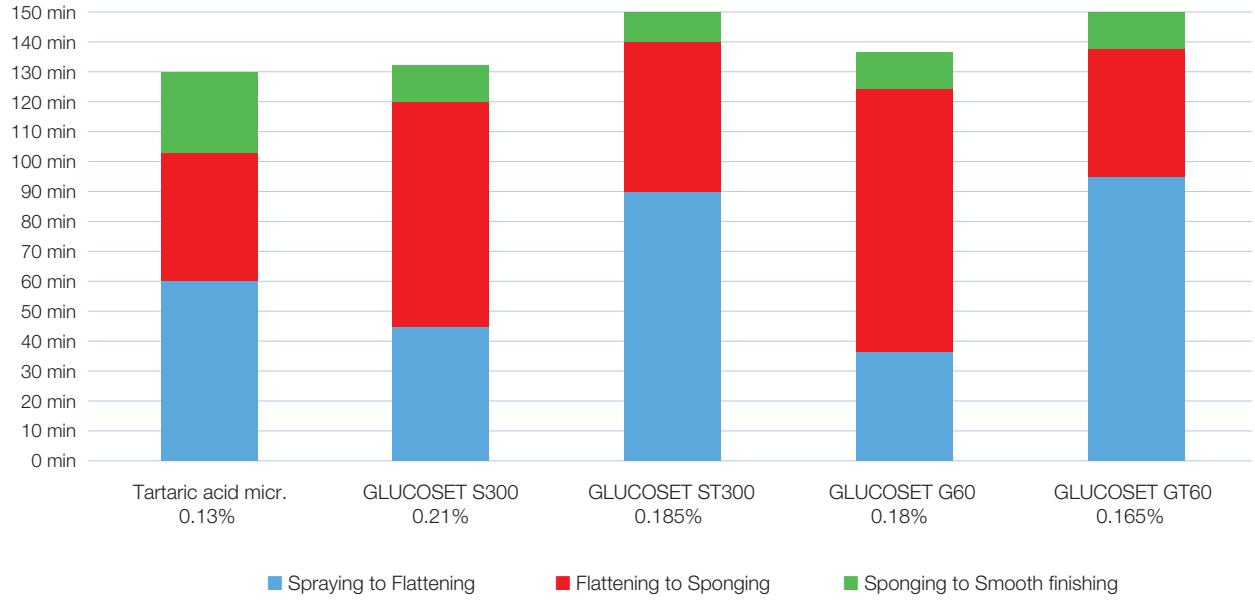
The qualitative results are summarised in figure 4. Surprisingly, GLUCOSET G60 and ST300 received a superior rating compared with GLUCOSET G60 and S300 as well as tartaric acid. This was especially true for the final, smoothening step. Both GLUCOSET GT60 and ST300 were awarded the best rating: 2.0 (= good) compared with 3.5 for GLUCOSET G60 and S300, and 3.0 for tartaric acid.

Figure 4: Subjective rating of wall application steps for gypsum spray plaster using GLUCOSET S300, GLUCOSET ST300, GLUCOSET G60 and GLUCOSET GT60 vs. tartaric acid (rating: 1 = excellent and 5 = serious deficiencies)

The duration of the last three application steps for each formulation is shown in figure 5. The spray plaster compositions containing the blend retarder GLUCOSET GT60 and ST300 exhibited a very similar behaviour: the flattening step as well as the sponging step were started significantly later than with the straight retarders GLUCOSET G60 and S300, and tartaric acid.

The total duration of the application process for the spray plasters containing GLUCOSET GT60 and ST300 was slightly longer than for the plaster products containing the standard GLUCOSET retarders or the reference tartaric acid.

Figure 5: Duration of key application steps of the gypsum spray plaster onto the wall



Conclusions

GLUCOSET ST60 and GLUCOSET GT60, two ready-to-use retarder blends based on tartaric acid and sodium gluconate or glucono-delta-lactone, respectively, were added to a standard gypsum spray plaster formulation. The performance of these plaster products was compared with that of plasters containing tartaric acid or GLUCOSET S300 or G60 in a comparable concentration.

The standard lab tests – ultrasonic velocity and Vicat-Dettki methods – demonstrated that blends of GLUCOSET G60 or S300 with tartaric acid deliver a stronger retarder performance than the single retarders.

In wall application tests, spray plaster compositions with GLUCOSET ST300 and GLUCOSET GT60 (70% of the tartaric acid replaced with gluconate-based retarders) received a superior performance rating and featured an overall longer duration of the application process than the benchmark (100% tartaric acid).

The GLUCOSET blend retarders GLUCOSET GT60 and ST300 delivered an excellent performance and present a significant cost saving – of up to 35% – over the benchmark.

References

[1] Nyvlt, J.; Ulrich, J. Admixtures in Crystallization, Weinheim, VCH, 1995.
Fischer, H.-B.; Werner, M.; Hydratationsverhalten von Gipsmischungen, Stuck-Putz-Trockenbau, 9 (1994), 16–22.

[2] Tartaric acid was purchased in micronised form with anti-caking agent from Randi SpA (Italy; natural source). Glucono-delta-lactone and sodium gluconate were supplied by Jungbunzlauer S.A. (France), and then micronised (max. 1% > 63 µm).

[3] Internal test method Bauhaus University Weimar.

[4] EN 13279-2 Gypsum binders and gypsum plasters, Part 2: Test methods.

[5] Hecker, A.; Baumann, R; Dow Chemical Company, “Controlling the setting profile of Gypsum plaster”, TECHLINE for the Construction Industry.

[6] D. Lenz, W. Knoerr, S. Koelbig, Facts Article Jungbunzlauer Int AG, “GLUCOSET – Alternative set retarder for gypsum spray plaster”, Part 1, July 2015.

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GLUCOSET is a new range of set retarder products specifically tailored for the gypsum industry and part of the Jungbunzlauer Gluconates product group. Jungbunzlauer Gluconates are multifunctional ingredients for food, personal care, pharmaceutical and technical applications. Naturally occurring in fruits, wine, honey and produced by fermentation of renewable carbohydrates in the EU, they are sustainable, readily biodegradable and safe products.

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