facts

GLUCOSET – Alternative set retarders for gypsum spray plaster

Part 1: Performance GLUCOSET S300 and GLUCOSET G60

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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 in the gypsum industry in alternative, economical but proven set retarder solutions.

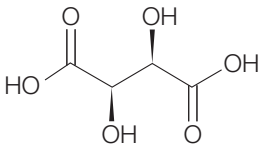
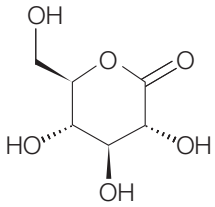
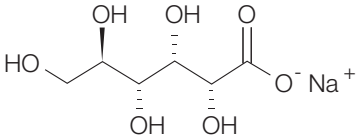
The objective of the following study was to find an alternative to the existing retarders – natural tartaric acid – that offers a significant cost advantage.

Experimental program

Raw materials

The following retarders were used in the study: tartaric acid, glucono-delta-lactone, and sodium gluconate.

Table 1: Additives used as set retarders[2]

Additive	Structural formula	Composition
(L)-Tartaric acid (TA), micronised (< 63 µm)		$C_4H_6O_6$ 150.08 g mol^{-1} pKa_1 = 2.98; pKa_2 = 4.34
GLUCOSET G60 Granulation: micronised (< 63 µm)		$C_6H_{10}O_6$ 178.14 g mol^{-1}
GLUCOSET S300 powder (< 300 µm)		$C_6H_{11}NaO_7$ 218.14 g mol^{-1}

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

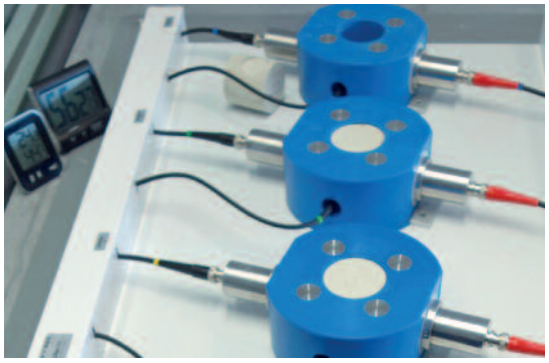
Table 2: Basic gypsum spray plaster formulation

#	Compound	Concentration
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 from UltraTest GmbH, Germany.



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

B. Vicat-Dettki method[4]
The Vicat conus method according to EN13279-2 was used to determine the beginning and end (internal test method) of the hardening of the gypsum plaster sample. The test interval was every 30 min from the sample preparation.

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

C. Application tests[5]

90 kg of the plaster was filled into a mortar mixer according to DIN EN 1015-2. The retarder combination was added to the plaster material and then mixed for 10 min.

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 the process step was rated on a scale out of five, where 1 = excellent, 2 = good, 3 = satisfactory, 4 = adequate, 5 = serious deficiencies.

Test regime

a) In order to establish a “standard” retarder concentration of tartaric acid, different concentrations of tartaric acid were used in the basic gypsum spray plaster formulation.
The retardation profiles of the different plasters were studied using the ultrasonic velocity measurement method.
The resulting concentration of 0.1% tartaric acid was used as reference for all further studies except for experiments under c).

b) GLUCOSET S300, GLUCOSET G60 were added in different concentrations to the basic gypsum spray plaster formulation in order to monitor the retardation profile by ultrasonic velocity measurement.
The target was to achieve the same retardation profile for the gluconate retarder as for the reference. The specific efficacy of each gluconate retarder versus tartaric acid was determined.

c) GLUCOSET S300, GLUCOSET G60 were tested in comparison to tartaric acid in application tests on the wall.

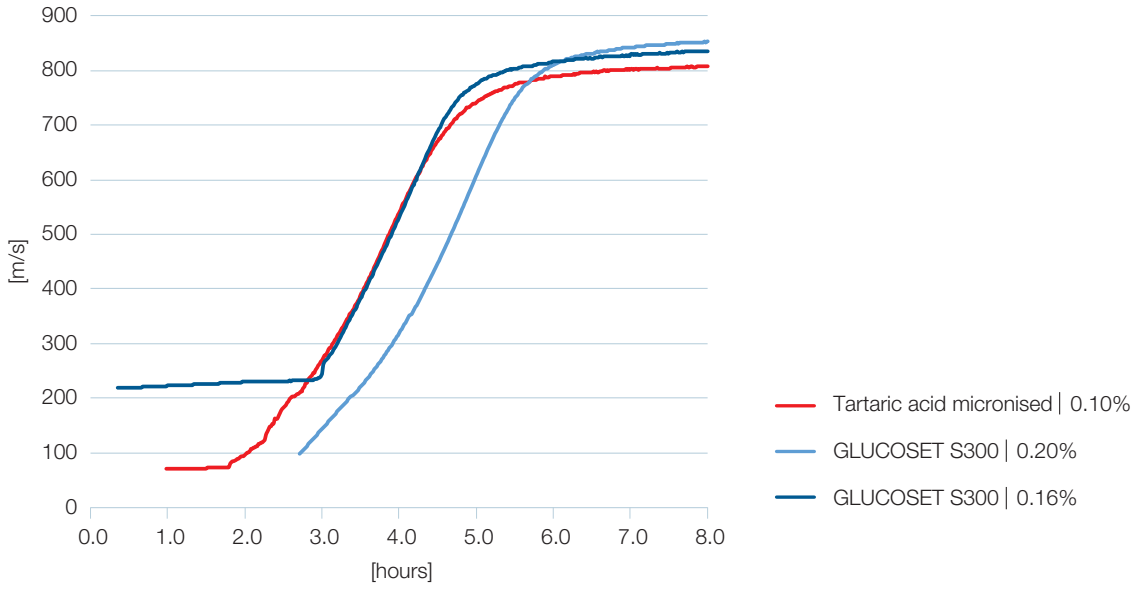
Results and discussion

Lab results GLUCOSET S300

GLUCOSET S300 was added in different concentrations to the basic gypsum spray plaster formulation: 0.16%, 0.17%, 0.20%. Firstly, we used the ultrasonic velocity measurement to test the retardation efficacy of both products versus the reference.

It turned out that GLUCOSET S300 was able to match the retardation profile of tartaric acid based on the assessment of the ultrasonic velocity time curves at a use concentration of 0.16% (see fig. 1).

Figure 1: Ultrasonic velocity measurements of GLUCOSET S300 vs. tartaric acid @ 0.10%



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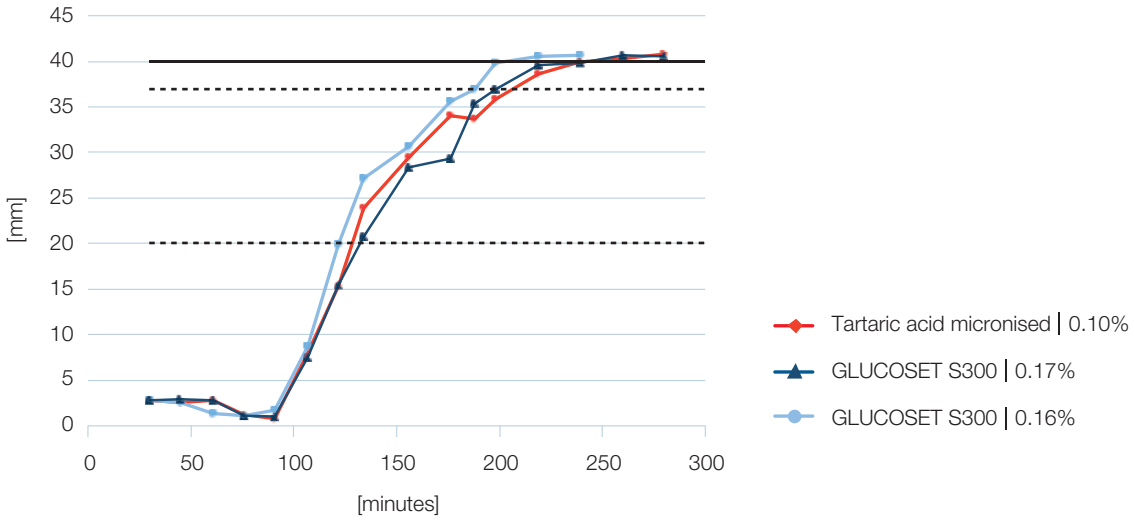
Secondly, we used the Vicat method to confirm the results of the ultrasonic velocity measurement (fig. 2). We compared GLUCOSET S300, 0.17% with the reference. The resulting Vicat Dettki curves showed that GLUCOSET S300 at 0.16% showed a good fit with the reference.

Figure 2: Vicat Dettki analysis of GLUCOSET S300 @ 0.16/0.17% vs. tartaric acid @ 0.10%



It can be concluded that the efficacy of GLUCOSET S300 is at approximately 63% compared to tartaric acid.

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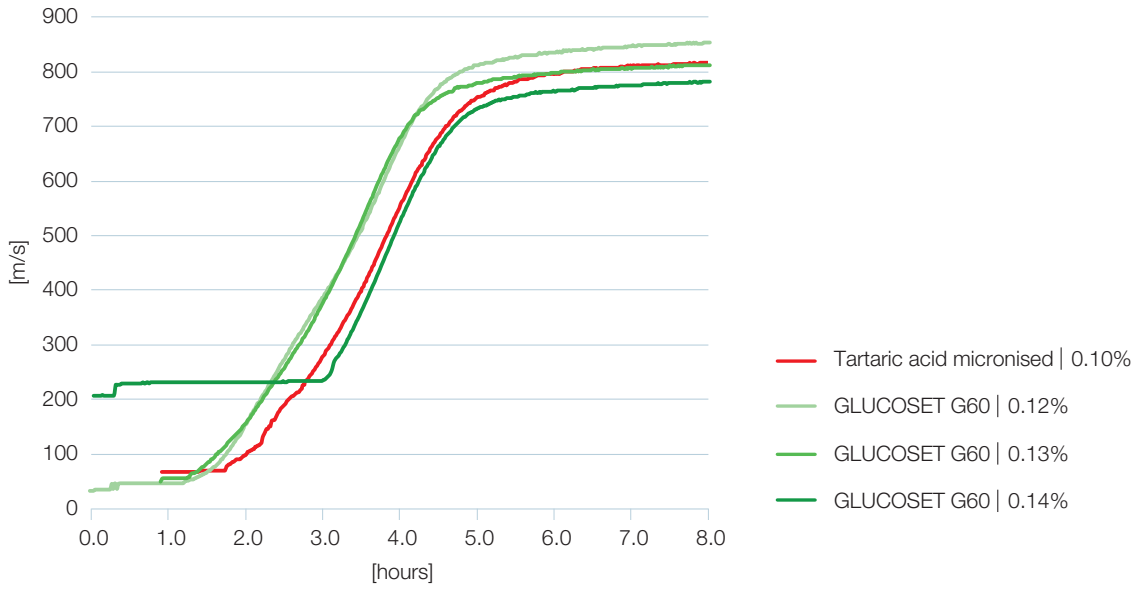
Lab results GLUCOSET G60

As with the experimental set-up for GLUCOSET S300, GLUCOSET G60 was added at different concentrations (0.12%, 0.13%, 0.14%) to the basic gypsum spray plaster formulation.

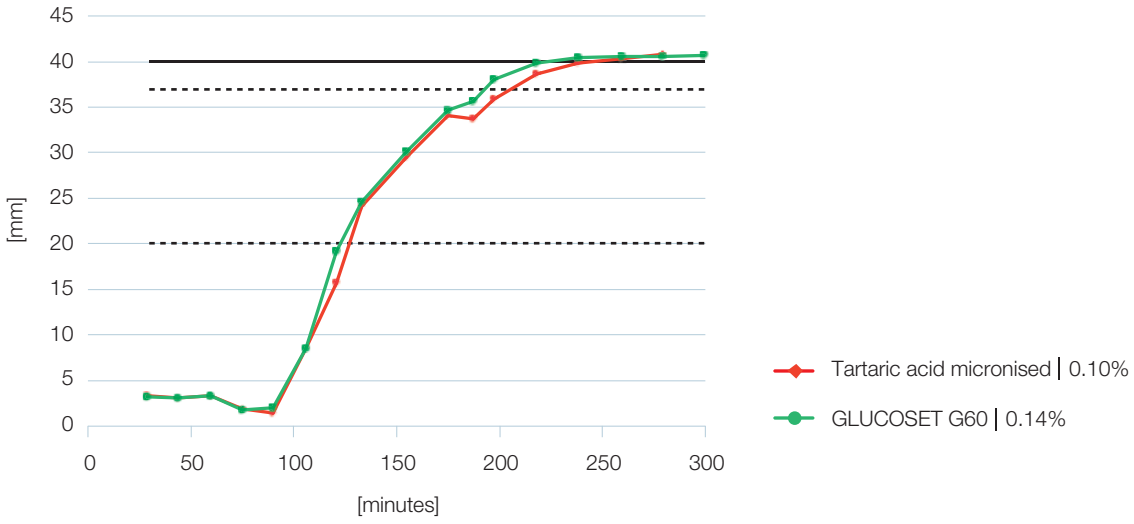
Firstly, we monitored the retardation profiles using the ultrasonic velocity method. The best fit with the reference was detected for GLUCOSET G60 at a concentration of 0.14% (fig. 3).

Figure 3: Ultrasonic velocity measurements of GLUCOSET G60 vs. tartaric acid @ 0.10%



Secondly, we used the Vicat method to confirm the efficient concentration of 0.14% for GLUCOSET G60. For both samples, a very similar Vicat curve was recorded.

Figure 4: Vicat Dettki analysis of GLUCOSET G60 @ 0.14% vs. tartaric acid @ 0.10%



We can conclude from these results that the glucono-delta-lactone based set retarder GLUCOSET G60 has an efficiency at 71%, i.e., or overdosage of 1.4 is required.

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Results of application tests for GLUCOSET S300 / G60

GLUCOSET S300 and GLUCOSET G60 were used for wall application tests.

A standard gypsum spray plaster machine was used for mixing and spraying, therefore the reference concentration was adjusted to 0.13% in order to obtain a realistic setting time:

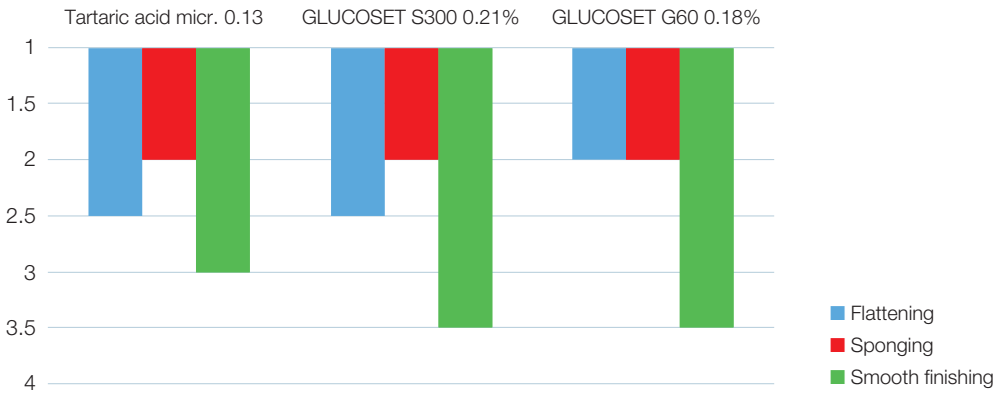
a) Reference: Tartaric acid micronised 0.13%
b) GLUCOSET S300 0.21%
c) GLUCOSET G60 0.18%

The application tests were carried out the same day and with the same basic plaster formulation (table 2).
The application process followed the five step methodology (see Methods section 2.2 C).

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

The qualitative results were summarised in fig. 5. Both GLUCOSET G60 and GLUCOSET S300 showed an equal rating versus the benchmark for the flattening and sponging step. Only in the case of the last application step was the rating for the benchmark slightly better (1/2 mark).

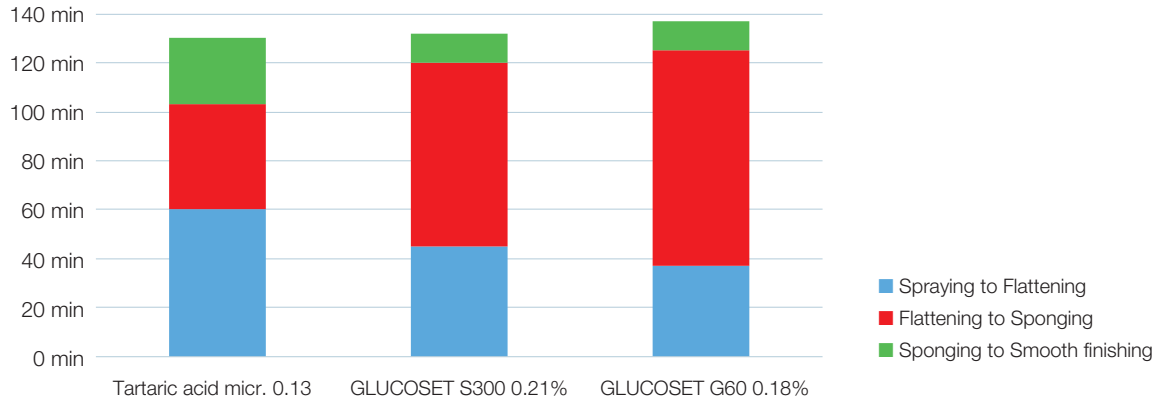
Figure 5: Rating of wall application steps for gypsum spray plaster using GLUCOSET S300 and GLUCOSET G60 versus tartaric acid 0.13% 1 = excellent and 5 = serious deficiencies



The timing of the last three processing steps for each formulation were summarised in fig. 6. The flattening step was carried out earlier for the GLUCOSET retarder and the sponging step started later. This is beneficial for the operator as he has more flexibility in the late phase of the application process.

Overall, the total duration of the application process for the five steps for all samples formulations was comparable.

Figure 6: Duration of key processing steps of the gypsum spray plaster on the wall



Conclusions

GLUCOSET S300 and GLUCOSET G60 were tested regarding their retarding properties in a standard gypsum spray plaster product. Standard lab tests – ultrasonic velocity and the Vicat-Dettki method – proved that the GLUCOSET retardants can entirely replace tartaric acid in case they are applied at a higher dosage: GLUCOSET G60 plus 40% and GLUCOSET S300 plus 60%.

In wall application tests, spray plaster compositions with GLUCOSET S300 and GLUCOSET G60 showed comparable overall processing duration versus the benchmark (tartaric acid). Wall plaster products using GLUCOSET S300 or GLUCOSET G60 got a similar subjective rating for the key application steps with the exception of the last smooth finishing steps, where tartaric acid proved to be slightly better.

Although the GLUCOSET products act with lower efficiency, they offer significant economic benefit versus tartaric acid of up to 35%.

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 as micronised form with anti-caking agent from Randi SpA (Italy; natural source) and Changmao Biochemical Engineering Co., Ltd (P. R. China, synthetic). Glucono-delta-lactone and sodium gluconate were supplied from Jungbunzlauer S.A. (France), and then micronised (max. 1% > 63um)

[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

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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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