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D E C I S I O N
of 28 January 2004

Case Number: T 0094/02 - 3.3.5

Application Number: 95910455.5

Publication Number: 0748302

IPC: C04B 7/42

Language of the proceedings: EN

Title of invention:
Method and plant for manufacturing mineralized Portland cement clinker

Patentee:
F. L. Smidth & Co. A/S, et al

Opponents:
(1) KHD Humboldt Wedag AG
(2) Polysius AG

Headword:
Mineralised clinker/SMIDTH

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Inventive step - non obvious combination of known features"

Decisions cited:
-

Catchword:
-

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Case Number: T 0094/02 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 28 January 2004

Party as of rights: (Opponent 01)
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-

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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 10 December 2001 concerning maintenance of European patent No. 0748302 in amended form.

Composition of the Board:

Chairman: M. M. Eberhard
Members: E. O. Waeckerlin
H. Preglau

Summary of Facts and Submissions

I. European patent No. 0 748 302 based on application No. 95 910 455.5 was granted on the basis of 15 claims.

II. The appellant (opponent 02) and the party as of right (opponent 01) filed notices of opposition requesting the revocation of the patent in its entirety on the grounds of lack of novelty and lack of inventive step. Opponent 02 submitted a further ground of opposition, *viz.* insufficient disclosure. The parties relied *inter alia* on the following documents:

D1: S. Sprung: Technologische Probleme beim Brennen des Zementklinkers, Ursache und Lösung. Schriftenreihe der Zementindustrie, Heft 43/1982, pages 18, 19, 26 to 29 and 36-39.

D2: Zement - Kalk - Gips, Jg. 23, Heft 6, 1970, pages 249 to 253.

D5: GB-B-1 498 057

III. In a decision posted on 10 December 2001 the Opposition Division maintained the patent in amended form on the basis of claims 1 to 7 as amended during the oral proceedings held on 6 November 2001. The single independent claim 1 as amended reads as follows:

"1. A method for preparing mineralised Portland cement clinker, said clinker having a sulphur content of at least 1.5 % by weight calculated as SO_3 and a fluorine content of at least 0.15 % by weight calculated as F, in a kiln system where the raw mix subsequently is

being subjected to preheating, calcination, burning, and, finally, cooling, wherein the composition of the raw mix feedstock is such that one or both of the following conditions are fulfilled:

1) the sulphur content X_S is at the most 1.2 % by weight calculated as SO_3 on a LOI free basis,
2) the fluorine content X_F is at the most 0.14 % by weight calculated on a LOI free basis,

and wherein a sulphur-containing component or a fluorine-containing component or both is introduced to the feedstock stream at a point in the process where the temperature of the feedstock stream is above 700°C, the amount of the sulphur-containing component or the fluorine-containing component or both being sufficient to ensure that the final Portland cement clinker has the required sulphur and fluorine content."

Dependent claims 2 to 7 as amended relate to specific embodiments of the process of claim 1.

The Opposition Division took the view that none of the documents representing the prior art contained a disclosure of the combination of all technical features of claim 1 as amended. In particular the combination of the features according to which:

– the sulphur content X_S is at most 1.2% by weight calculated as SO_3 on a LOI free basis; and/or

– the fluorine content X_F is at the most 0.14% by weight calculated on a LOI free basis; and

– a sulphur-containing component or a fluorine-containing component is introduced to the

feedstock stream at a point in the process where the temperature of the feedstock stream is above 700°C,

was not disclosed in any of the documents referred to by the Opponents. The Opposition Division concluded that the process according to claim 1 as amended was novel.

The presence of an inventive step was also acknowledged by the Opposition Division with respect to documents D1, D2 and D5 on the ground that none of these documents addressed the problem underlying the claimed invention, namely:

(i) reducing the risk of blockages in the preheating zone,

(ii) avoiding the occurrence of blockages when the raw mix feedstock passes through the temperature range of about 700-900°C, and

(iii) avoiding the formation of a melt phase in the presence of chlorides at temperatures as low as 680°C.

The Opposition Division held that, although the possibility of introducing the mineraliser, i.e. the sulphur-containing and/or fluorine-containing component, separately to the kiln system was mentioned in document D2, this did not lead the skilled person to the claimed invention because the statement was made in isolation and in a different technological context, namely the

improvement of the strength of the resulting cement clinker.

IV. The appellant lodged an appeal against this decision. In the statement of grounds of appeal he relied on additional pages of document D1, namely pages 16, 17, 20 and 53 to 82. The whole document is designated hereinafter as D1a.

Oral proceedings were held on 28 January 2004. The appellant submitted a new document at the oral proceedings, namely:

D10: W. Duda: Cement - Data - Book. Vol. 1, pages 6 to 8. International Process Engineering in the Cement Industry, 3rd edition, 1985.

Opponent 01 was not represented at the oral proceedings. He had stated in a letter dated 1 December 2003 that he would not attend the hearing. He did not present any observations and requests at the appeal stage.

V. The appellant's written and oral submissions can be summarised as follows:

According to the patent in suit the production of Portland cement clinker with a high content of mineralisers gives rise to a number of operational difficulties, namely:

– There exists the danger of blockages in the preheating zone if large amounts of sulphur-containing mineralisers are added to the raw feed.

– Particularly severe build-ups may occur in the temperature range of 700 to 900°C if the raw feed has a high content of mineralisers such as SO_3 and F.

– The presence of chlorides may result in the formation of a melt phase at temperatures of about 680°C. This may lead to severe build-ups of spurrite and to production shutdown.

These operational difficulties are known from document D1a which discloses on pages 26 to 28 a method for preparing mineralised Portland cement clinker in a kiln system, where the preheating and an essential part of the calcination process take place outside the kiln, viz. in the lowest part of the preheater. According to D1a one of the advantages of the process is the reduction of the operational difficulties caused by build-ups and ring formation. Another advantage is the possibility of using a limited amount of "ballast-rich and waste fuels", preferably in the calcination step. Since these "ballast-rich and waste fuels" may contain major amounts of sulphur, typically SO_3, and F, they act as a source of mineralisers. The use of high sulphur waste fuels, for example acid resin, leads therefore to the introduction of sulphur into the calcination zone.

As far as the temperature of calcination is concerned, D1a states that the process begins at temperatures much lower than the theoretical temperature of about 850°C, i.e. as low as about 550°C, whereas the transition from the calcination to the sintering zone takes place at temperatures in the range of about 700 to 900°C. Thus, the use of high sulphur waste fuels in the calcination

step implies the introduction of a sulphur-containing component to the feedstock at a point in the process where the temperature of the feedstock stream is above 700°C.

According to document D1a the amount of sulphur in the raw mix feed varies between 0.10 and 0.63% by weight, depending on the specific type of raw material used (see pages 77, Table 19). Moreover calculations made by the appellant on the basis of data provided by D1a lead to the conclusion that, at least in the case of raw materials like *"unterer Muschelkalk"* or *"oberer Muschelkalk"* the amount of sulphur in the final Portland cement clinker is well above 1.5% by weight, namely 1.9% and 1.75%, respectively. It is established according to various cement standards that the SO_3-content in cement is between 2.5 and 4% SO_3 (see D10, page 7).

It follows, therefore, that all features of claim 1 as amended are disclosed in document D1a.

The alternative procedure of using fluorine-containing waste fuels is also disclosed in D1a. An example is the use of fluorine-rich bleaching earths mentioned on page 18 of D1a. The contents of D1a lead to the conclusion that the fluorine content of the raw materials is on average considerably below 0.14% by weight, whereas in the case of the example on page 37 of D1a the final Portland cement clinker contained more than 0.15% by weight of fluorine. The statement in claim 1 that both the sulphur content and the fluorine content should meet simultaneously the respective requirements is based on an error, since claim 1 states

that *either* a sulphur-containing *or* a fluorine-containing compound is added.

Therefore the disclosure of document D1a is prejudicial to the novelty of the method according to claim 1 as amended.

Regarding the question of inventive step the appellant observed that, taking either document D1a or document D5 as the closest prior art, the claimed process is obvious in view of the teaching of these documents.

It was obvious to the skilled person that, by adding a fluorine-containing component as the mineraliser in accordance with the teaching of D1a, the amount of fluorine in the clinker would be increased. The problem of ring formation in the intermediate zone between the calcination and sintering zone is addressed on page 16 of D1a. This document further teaches on page 26 that the calcination has the advantage of reducing build-ups and ring formation. D5 discloses the introduction of the mineraliser with the fuel and the presence of both mineralisers in the clinker. It is obvious in view of D1a to introduce the mineraliser together with the fuel in the calcination zone.

VI. The submissions of the respondents made orally and in writing may be summarized as follows:

The main problem underlying the invention is to prevent build-ups of spurrite ($2C_2S.CaCO_3$) in the preheating zone at temperatures as low as 680°C (see description, paragraph 0015). Spurrite is quite distinct from sulphate spurrite ($2C_2S.CaSO_4$)formed at higher

temperatures and discussed extensively in document D1a. D1a does not address the problem of spurrite formation. In the method according to the invention the contents of sulphur and fluorine in the raw mix feed and the clinker have to meet the requirements set out in claim 1. This is an important aspect of the claimed method. It is not appropriate to regard the addition of a sulphur-containing component or a fluorine-containing component as two unrelated alternatives of the process. Document D1a refers to sulphur and fluorine as mineralisers, but there is no disclosure that the presence of both is required to prevent the formation of spurrite. Moreover there is no reference in D1a to the specific type of Portland cement clinker which results from the method according to the invention.

Therefore there can be no question of lack of novelty of the claimed method.

Since neither D1a nor any other document representing the prior art addresses the main problem underlying the present invention, namely the prevention of build-ups of spurrite at temperatures as low as 680°C, there can also be no question of lack of inventive step.

VII. The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondents requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments* (Article 123(2) EPC)

The amendments made to the claims fulfil the requirements of Article 123(2) and (3) EPC. This is not in dispute.

3. *Interpretation of the wording of claim 1*

At the oral proceedings the appellant submitted that the wording of claim 1 contained an error. In his view the feature according to which the clinker has *"a sulphur content of at least 1.5 % by weight calculated as SO_3 and a fluorine content of at least 0.15 % by weight calculated as F"* must be interpreted to mean in reality that the sulphur content is 1.5 % by weight *or* the fluorine content is 0.15 % by weight.

The board cannot accept this argument. The wording of the concerned features of claim 1 is clear and technically meaningful. In particular the necessity of ensuring that the clinker contains the required minimum amounts of both sulphur ***and*** fluorine is clearly set out in the last part of claim 1. This is in line with the description of the patent in suit (see column 3, paragraph 0023), and it has been confirmed explicitly at the oral proceedings by the respondents. Thus there is no room for re-interpretation of the wording of claim 1 as amended.

4. *Novelty*

Document D1a, a comprehensive monograph on technological problems related to the burning of cement clinkers, discloses a method for preparing mineralised Portland cement clinker in a kiln system, where the raw mix subsequently is being subjected to preheating, calcination, burning and, finally, cooling (see Figure 4 on page 27 of D1a).

4.1 As far as composition of the raw mix feedstock and the final Portland cement clinker are concerned, D1a gives no details regarding the calciner - kiln system described on pages 26 to 28. Some general information is provided in separate sections of D1a, however. Thus, data regarding the sulphur content of a number of different raw meals can be found in Table 19 on page 77. According to Table 19 the sulphur content, calculated as SO_3, varies between 0.10 and 0.63% by weight, depending on the type and the geological age of the raw meal (see page 77, last paragraph). It was not disputed that these contents fall within the range defined in claim 1, "calculated on a LOI free basis". On pages 77 to 80 of D1a the possibility of introducing sulphur-containing components to the feedstock during the burning process is discussed. On the basis of model calculations based on the assumption that the degree of sulphatation is 100%, it is concluded that sulphur may be introduced into the system in a total amount which varies between 3.70 and 7.59 Kg sulphur per 1000 Kg of clinker, again depending on the type and the geological age of the raw meal. According to the appellant's undisputed submissions, this corresponds to sulphur

contents of 0.92 and 1.9% by weight in the clinker, calculated as SO_3.

4.2 The fluorine content of clinker produced in kiln systems equipped with a cyclone preheater is stated in Table 21 on page 81 of D1a. On average 0.858 g fluorine per Kg of clinker have been found, the minimum being 0.725 and the maximum 1.133, corresponding to 0.0725 and 0.1133% by weight in the clinker. The appellant's submission, that the fluorine content of the raw materials, calculated on a LOI free basis, is less than 0.14%, considering that 88 to 98% of the fluorine input from the raw material and the fuel are retained in the clinker (see D1a, page 80, second paragraph), was not contested.

In a separate section of D1a the use of fluorine as mineraliser is disclosed. According to an investigation referred to in D1a the addition of 0.6% by weight of fluorine was required to obtain nearly complete sintering at a temperature of 1300°C in the case of dry processing of the raw meal (see D1a, page 37, lines 31 to 32). Taking into account that the loss of fluorine is about 20% (see D1a, page 37, lines 36 to 37), it is plausible, as pointed out by the appellant, that the fluorine content of the clinker is higher than 0.15% by weight, calculated as F.

4.3 D1a discloses that sulphur-containing or fluorine-containing components can be added during the process. Thus, D1a contains several statements according to which these components may be introduced with the fuel or with the raw material (see D1a, page 61, lines 15 to 17; page 77, lines 12 to 14; page 37, lines 38

to 40). On page 28, lines 23 to 25, it is mentioned that one of the advantages of the calcination process consists in the possibility of using limited amounts of ballast rich fuels and waste fuels in the secondary firing, i.e. the separate burner of the calciner. Such ballast rich fuels or waste fuels may comprise considerable amounts of sulphur (see page 17, Table 7; page 19, Table 8) or fluorine (see page 18, lines 28 to 29, "bleaching earths"). Although the temperature at the point in the process where the sulphur-containing or fluorine-containing component is introduced is not expressly mentioned in D1a, it was not contested that the temperature in the calcining step exceeds 700°C.

4.4 In view of the content of D1a and the appellant's undisputed calculations the board can accept in favour of the appellant that each of the features of claim 1 as amended is disclosed as such in D1a.

What is missing in D1a, however, is the specific combination of these features. In fact D1a does not establish a technological link between the diverse features, and there is no disclosure either that these specific features belong together and must be regarded as a whole. In particular the type of the process (see page 27, Figure 4), the sulphur content of the raw mix feedstock (see page 77, Table 19), the fluorine content of the raw mix feedstock calculated from Table 21 (see page 81), the sulphur content of the clinker (see pages 77 to 80), the fluorine content of the clinker (see page 37, lines 31 to 32 and 36 to 37), and the possibility of introducing sulphur and/or fluorine by means of the fuel at temperatures above 700°C (see page 61, lines 15 to 17; page 77, lines 12 to 14;

page 37, lines 38 to 40; page 28, lines 23 to 25; pages 16 to 17, Table 7; pages 19, Table 8) are presented in separate sections of document D1a dealing with different technological aspects of the production of clinker. Therefore the combination of features set out in claim 1 as amended is not derivable directly and unambiguously from the document D1a.

For the preceding reasons the board cannot accept the appellant's argumentation according to which a skilled person would automatically combine the different parts of disclosure spread over the pages 16 to 82 of document D1a, and would thereby arrive at the claimed method. The board holds on the contrary that the skilled person, when putting the various teachings of D1a into practice, would not inevitably arrive at a result falling within the terms of claim 1 as amended, and that the appellant's arguments are based on an *ex post facto* analysis.

4.5 The method according to claim 1 as amended is therefore novel (Article 54 EPC).

The method of claim 1 as amended is also new in respect of the other prior documents referred to by the parties. This was not in dispute.

5. *Inventive step*

5.1 Document D5 discloses a method for preparing mineralised Portland cement clinker wherein mineralisers, namely a sulphur-containing component and a fluorine-containing component, are introduced into the kiln either separately or together by incorporation

in the raw mix feed or by some other method such as by insufflation, or with the fuel (see D5, page 4, lines 43 to 57). The resulting clinker has a sulphur content of at least 2% by weight calculated as SO_3, preferably 2 - 5.0% by weight, and a fluorine content of at least 0.07% by weight, calculated as F, preferably 0.07 - 0.5% by weight (see D5, claim 1 and page 5, lines 8 to 9). The clinker according to Example 3 has a sulphur content of 3% by weight, calculated as SO_3, and a fluorine content of 0.23% by weight, calculated as F, respectively.

5.2 The board is of the opinion that D5 represents the closest prior art. The method according to claim 1 as amended differs from the disclosure of D5 in particular in the following respects:

(i) D5, which was filed in 1975, is concerned with various conventional methods for manufacturing clinker including wet, semi-wet, semi-dry and dry processes (see D5, page 6, lines 11 to 13), but it does not relate to more advanced methods such as the dry process involving a preheater and a calciner according to the present invention. Thus D5 does not disclose the possibility of introducing mineralisers at a point where the temperature of the feedstock is above 700°C, in a process comprising a preheating zone and a calcination zone before the burning zone.

(ii) There is no disclosure in D5 that the sulphur and/or the fluorine content of the raw mix feedstock must not exceed 1.2% and 0.14% by weight, respectively.

The adaptation of the method according to D5 to systems incorporating a preheater and a calciner gave rise to a number of operational difficulties, particularly the occurrence of blockages and build-ups in the cyclones and the riser ducts (see patent in suit, column 1, lines 35 to 48). In the presence of high contents of mineralisers in the raw mix feedstock, precipitation of solids and blockages occurred when the material passed through the temperature range of about 700 - 900°C. It has been found that the mineral spurrite ($2C_2S.CaCO_3$) may be formed in the preheating zone at temperatures as low as 680°C (see patent in suit, column 2, line 54 to column 3, line 12).

Starting from the closest prior art D5, the technical problem underlying the invention can be seen in minimising or preventing blockages and build-ups in the preheating zone caused, in particular, by the formation of spurrite.

It is proposed to solve this problem by the process as defined in claim 1 as amended.
In the absence of evidence to the contrary it is credible that this problem has actually been solved by said process.

5.3 Although D5 discloses the possibility of introducing the combination of mineralisers with the fuel (see page 4, lines 56 to 58), no example or further

information illustrating this option are given. Furthermore D5 is silent on possible technical advantages which might be achieved by this option, and it does not address the problem of minimising the formation of spurrite at relatively low temperatures in the preheating zone. Document D5 cannot, therefore, suggest the solution according to claim 1.

5.4 Similar considerations apply to document D1a which is concerned with a large number of diverse technological problems, but not specifically with the question of minimising spurrite build-ups at relatively low temperatures. It cannot be denied that the possibility of introducing fluorine-containing components into the feedstock by means of fuels, and thus at temperatures above 700°C, is mentioned as such in D1a (see page 37, lines 38 to 40). This is immaterial in the present case, however. The question is not whether the feature is known *per se*, but whether the skilled person would have considered it within the framework of the combination of all features and in the expectation of solving the technical problem stated above. The board holds that this is not the case here, since D1a does not contain a pointer towards the solution of the technical problem. In fact D1a does not disclose the introduction of fluorine containing components by means of fuels in the context of preventing the formation of spurrite, but as a consequence of the use of "natural raw materials and fuels" (see page 37, line 39). Neither the impact of the sulphur-containing or fluorine-containing compounds on the spurrite formation as such, nor their critical amounts in the raw mix feedstock and at the point of introduction above 700°C ensuring the reduction of spurrite formation are explained in D1a.

5.5 Concerning the problem of ring formation, the appellant relied in particular on pages 16 and 26 of document D1a. The appellant's arguments in this respect are not convincing. On page 16, last paragraph, it is indeed disclosed that ballast-rich coal may be used as the primary fuel without causing deposits and ring formation in the zone between calcination and sintering. However, this paragraph does not mention the formation of spurrite at all, let alone in the preheating zone. Similar considerations apply to the teaching on page 26 (see section 4.4, first paragraph, last sentence) in which it is stated that the calcinations step has the advantage of reducing the difficulties caused by deposits and ring formation. Here again D1a is completely silent on the formation of spurrite in the preheating zone.

5.6 Even if, following an alternative line of argumentation brought forward by the appellant, document D1a was taken as the starting point for the assessment of inventive step, the outcome of the present decision would be the same. The decisive question would remain the same, namely whether it was obvious for a skilled person to combine the features set out in claim 1 as amended in order to minimise or prevent blockages and build-ups in the process, in particular the formation of spurrite. In this respect the foregoing considerations apply likewise.

5.7 The other prior documents are more remote from the subject-matter of claim 1 than D1a and D5. They contain no additional information which, in combination with

the teaching of D1 and D5 would point towards the claimed method.

5.8 The board holds, therefore, that the method according to claim 1 as amended is novel and not obvious to a skilled person. Thus, the subject-matter of claim 1 as amended involves an inventive step within the meaning of Article 56 EPC.

Claim 1 as amended being allowable, the same applies to dependent claims 2 to 7, whose patentability is supported by that of claim 1 as amended.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Wallrodt M. M. Eberhard