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Datasheet for the decision of 13 July 2006

Case Number: T 0892/04 - 3.2.07

Application Number: 98908563.4

Publication Number: 0972087

IPC: C21D 8/02

Language of the proceedings: EN

Title of invention:
High-tensile-strength steel and method of manufacturing the same

Applicant:
ExxonMobil Upstream Research Company, et al

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2)

Keyword:
"Extension of subject-matter beyond content of application as originally filed (yes; main request - inadmissible extraction of isolated feature, first and third auxiliary request - inadmissible generalisation)"

Decisions cited:
T 0201/83

Catchword:
-

Case Number: T 0892/04 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 13 July 2006

Appellants: ExxonMobil Upstream Research Company
3120 Buffalo Speedway
P.O. Box 2189
Houston, TX 77252-2189 (US)

Sumitomo Metal Industries Limited
5-33, Kitahama 4-chome
Chuo-ku Osaka-shi
Osaka 541-0041 (JP)

Representative: HOFFMANN EITLE
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 23 February 2004 refusing European application No. 98908563.4 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. Holtz
Members: H. Hahn
K. Poalas

Summary of Facts and Submissions

I. The applicant lodged an appeal against the decision of the Examining Division to refuse the European patent application No. 98 908 563.4.

The Examining Division held that the amendments made to the main request as filed with letter of 1 September 2003 and according to the two auxiliary requests as filed with letter of 9 January 2004 met the requirements of Articles 123(2) and (3) EPC. However, the subject-matter of claims 1 and 8 according to the main request and according to the first auxiliary request was considered to lack novelty with respect to D1 (EP-A-0 753 596) and the subject-matter of claims 1 and 8 according to the second auxiliary request lacked an inventive step with respect to D1 either taken alone or taken in combination with D3 (US-A-4 572 748). Document D4 (WO-A-96 17964) although not considered in the decision was stated to be highly relevant to novelty and inventive step.

II. With a communication dated 22 March 2006 the Board informed the appellant that claims 1 to 14 of the main request and of the first auxiliary request, both requests as submitted with the grounds of appeal dated 5 July 2004, appeared to contravene Article 123(2) EPC for either defining a Mn concentration value of "less than 1.45 wt.%" (main request) or a lower bainite value of "at least 54 vol%" (auxiliary request) which appeared to have been taken as isolated features from examples representing an inadmissible extraction of an isolated feature. The Board further stated that in case that a request were to be considered to meet the requirements of Article 123(2) EPC the issues of novelty and of inventive step would be dealt with during the oral proceedings and that document D1 appeared to represent the closest prior art.

III. With fax of 9 June 2006 the appellant submitted an amended main request and new first to third auxiliary requests, each one containing a set of claims and corresponding substitute description pages, together with arguments concerning the allowability of the proposed amendments and the patentability of the claims.

IV. Oral proceedings before the Board were held on 13 July 2006. The appellant requested that the decision be set aside and a patent be granted on the basis of claims 1 to 15 in accordance with the main request, alternatively on the basis of claims 1 to 15 of the first auxiliary request or on the basis of claims 1 to 6 of the third auxiliary request, all requests as filed with letter of 9 June 2006.

V. Claims 1 and 9 according to the main request read as follows (emphasis in bold added by the Board):

"1. A steel having a tensile strength of at least 900 MPa (130 ksi), an impact energy as measured at -40°C (-40°F) of greater than 120J (90ft-lbs), and a microstructure comprising a mixed structure of martensite and lower bainite, wherein (i) said mixed structure occupies at least 90% vol. % in said microstructure, (ii) said lower bainite occupies at least 2 vol.% in said mixed structure, and (iii) prior austenite grains have an aspect ratio of at least 3, wherein said steel is produced from a reheated steel slab comprising the following additives in the weight percents indicated and the balance Fe:

C: 0.02% to 0.1%;

Si: 0% to 0.6%;

Mn: 0.2% to **1.46**%;

Ni: 0.2% to 1.2%;

Nb: 0.01% to 0.1%;

Ti: 0.005% to 0.03%;

Al: 0% to 0.1%

N: 0.001% to 0.006%;

Cu: 0% to 0.6%;

Cr: 0% to 0.8%;

Mo: 0% to 0.6%;

V: 0% to 0.1%;

B: 0% to 0.0025%; and

Ca: 0% to 0.006%; and

other impurities, including

P: not greater than 0.015%; and

S: not greater than 0.003%; and

wherein said steel has a Vs value, as defined by equation {1} below, of 0.15 to 0.42, and further has a carbide size of less than 5 microns:

{1}: Vs = C + (Mn/5) + 5P - (Ni/10) - (Mo/15) + (Cu/10)

wherein each atomic symbol represents its content in wt.%."

"9. A method for preparing a steel plate having a tensile strength of at least 900 MPa (130 ksi), an impact energy *as* measured at -40°C (-40°F) of greater than 120J (90ft-lbs), and a microstructure comprising a mixed structure of martensite and lower bainite, wherein (i) said mixed structure occupies at least 90% in said microstructure, (ii) said lower bainite occupies at least 2 vol% in said mixed structure, and

(iii) prior austenite grains have an aspect ratio of at least 3, the steel plate comprising the following additives in the weight percents indicated and the balance Fe;

C: 0.02% to 0.1%;

Si: 0% to 0.6%;

Mn: 0.2% to **1.46%**;

Ni: 0.2% to 1.2%;

Nb: 0.01% to 0.1%;

Ti: 0.005% to 0.03%;

Al: 0% to 0.1%;

N: 0.001% to 0.006%;

Cu: 0% to 0.6%;

Cr: 0% to 0.8%;

Mo: 0% to 0.6%;

V: 0% to 0.1%;

B: 0% to 0.0025%; and

Ca: 0% to 0.006%; and

other impurities, including

P: not greater than 0.015%; and

S: not greater than 0.003%; and

wherein said steel plate has a Vs value, as defined by equation {1} below, of from 0.15 to 0.42, and a carbide size of less than 5 microns:

{1}: $Vs = C + (Mn/5) + 5P - (Ni/10) - (Mo/15) + (Cu/10)$

wherein each atomic symbol represents its content in wt.%,

said method comprising the steps of:

(a) heating a steel slab to a temperature of 950°C (1742°F) to 1250°C (2282°F);

(b) hot rolling said steel slab, under the condition that the accumulated reduction ratio at a temperature of not higher than 950°C (1742°F) is at least 25%, to form steel plate;

c) completing the hot rolling step at a temperature of not lower than the Ar_3 transformation temperature or 700°C (1292°F), whichever is higher; and
(d) cooling said steel plate from a temperature of not lower than 700°C (1292°F) at a cooling rate of 10°C/sec to 45°C/sec (18°F/sec to 81°F/sec) as measured at substantially the center of said steel plate until substantially the center of said steel plate is cooled to a temperature of not higher than 450°C (842°F) so as to facilitate completion of transformation of said steel plate to said mixed structure of martensite and lower bainite with said tensile strength and said impact energy values."

VI. Claims 1 and 9 according to the first auxiliary request differ from claims 1 and 9 of the main request in that the lower bainite value of feature (ii) has been amended to read "said lower bainite occupies at least **54 vol%** in said mixed structure" and in that the Mn concentration range has been amended to read "Mn: 0.2% to **1.7%**" (emphasis in bold added by the Board).

VII. Claim 1 according to the third auxiliary request corresponds to claim 9 of the first auxiliary request.

VIII. The appellant argued essentially as follows:

With respect to the *main request*: The upper Mn concentration value of 1.46% is derived from examples 1 and 2 in Table 1 and the new range of from 0.2% to 1.46% is not arbitrarily chosen since it includes the examples 3 and 10 with a Mn content of 1.45%. The Board's reasoning as stated in the communication cannot be followed. Firstly, while the Board appear to allude to the fact that in equation {1} C and P do not have any associated denominator, in the case of P it has an associated numerator, and the denominator for Ni, Mo and Cu is in each case somewhat larger than that for Mn, it has to be noted that the maximum amounts of each element specified in claim 1 vary significantly, so that the relative contribution of each element to the value Vs is not dependent solely on whether it has an associated denominator or an associated numerator; rather, it is the product of the numerator/denominator and the chosen amount of each element that determines the relative contribution (additive or subtractive) of each element to the value Vs. When the Mn content is at the upper limit of 1.46% the contribution of Mn to the value Vs lies close to the middle of the range defined by Vs. Consequently, there is considerable freedom to adjust the C, P, Ni, Mo and Cu amounts, such that the requirements of Vs lie within the range $0.15 \leq Vs \leq 0.42$ is satisfied. Therefore it is clear that numerous combinations of amounts of Mn, P, Ni, Mo and Cu are possible within the permitted range for Vs. It follows that Vs does not determine a close association between the concentrations of said specified elements. Rather, for the reasons given, it is clear that equation {1} permits fairly wide variation in the relative concentrations of the different constituent elements. It is admitted that there has to be a constraint on the relative amounts of said constituent elements, in order that the resulting steel should have the required blend of properties, i.e. high strength and toughness, and low centreline segregation. There is no intrinsic link between the Mn concentration and the properties of the steel. The Mn concentration is independent similarly as that of Ni, Si or Mo. Therefore the amendment is in agreement with decision T 201/83 and with Article 123(2) EPC.

With respect to the *first auxiliary request*: The Mn range is re-amended to read 0.2 to 1.7% having a basis in the application as originally filed (see e.g. claims 6 and 7). The lower bainite value is provided by example 3 of Table 8. For product claim 1 it does not matter how the lower bainite content is achieved. The process parameters for heat treatment are irrelevant to the properties of the final steel so long as the specified lower bainite content requirement is met. A claim limited to the process parameters would have no practical value. Furthermore, although a composition change affects the microstructure there is no intrinsic link between the composition and the properties. As can be derived from Annex C of the letter dated 9 June 2006 the amount of lower bainite correlates with the toughness of the steel. An increased amount of at least 54 vol% according to of samples 3, 5, 8 and 9 resulted in the highest base steel Charpy test data values while the other test data of samples no longer covered by the claims have somewhat lower values. Therefore, since these results hold true irrespective of the manufacturing process used for the example steels which were non-tempered and tempered, the other process and chemical composition parameters for heat treatment necessary to arrive at the particular microstructure of the example of Table 8 are not necessary. Consequently, the amendments made to claims 1 and 9 of the first auxiliary request meet the requirements of Article 123(2) EPC.

With respect to the *third auxiliary request*: the arguments brought forward with respect to the process claim 9 of the first auxiliary request apply likewise.

Reasons for the Decision

1. *Allowability of amendments (Articles 123(2) EPC)*

Main request

1.1 Claim 1 of the main request, except for the upper limit of the Mn concentration range, is based on claims 1, 3 and part of claim 5 in combination with page 3, lines 23 to 24 ("impact energy") and pages 31 and 35 (Tables 2 and 6 "the balance Fe") of the description of the application as originally filed (WO-A-98 38345). Process claim 9 except for the Mn range is based on claims 14, 16, 18 in combination with page 3, lines 23 to 24 ("impact energy at -40°C") and pages 31 and 35 (Tables 2 and 6 "the balance Fe") of the application as originally filed. The said upper Mn concentration value of "**1.46 wt.%**" of claims 1 and 9 is taken from Table 1, exemplifying alloys 1 and 2 and replaced the broadest range of from about 0.2% to about 2.5% Mn as defined in claims 1 and 16 of the application as originally filed. Nothing could be found anywhere in the application as originally filed for supporting this upper limitation of the Mn range to obtain the alloy's minimum tensile strength of 900 MPa (130 ksi), through-thickness toughness, reduced centreline segregation and improved toughness of a welding heat affected zone.

It is clear to the metallurgist that the overall properties of a steel or alloy are generally brought about by the interaction of **all** the constituents thereof.

This means that the individual amounts of C, Si, Mn, Ni, Nb, Ti, Al, N etc. specified in a specific example are tied to the amounts of the other components Cu, Cr, Mo, V, B, Ca, P and S etc. to promote the formation of the desired microstructure and to provide the mechanical properties including the tensile strength and toughness etc.

1.1.1 The appellant's arguments that the Mn concentration value is independent and that there exists no intrinsic link between Mn and the steel properties cannot be accepted for the following reasons.

1.1.2 First of all, no evidence has been submitted which would prove the aforementioned allegations. The absence of such evidence was admitted by the appellant during the oral proceedings.

1.1.3 Secondly, taking account of the teaching of the present application as originally filed (see page 4, line 2 to page 6, line 4; and claim 1) the Board concludes that the specific value of 1.46% Mn is arbitrarily taken from examples 1 and 2 of table 1 and is closely associated with the concentrations of the other alloying elements.

This is apparent from equation {1} of claims 1 and 9, wherein the value of index Vs is defined by the C and P content and then by the contents of Mn and the other elements specified in said equation, namely Ni, Mo and Cu. According to the present application the Vs value is controlled to improve the centreline segregation of the steels (see page 17, lines 2 to 10).

The fact that the elements C and P in equation {1} do not have any associated denominator, that P has an associated numerator, and that the denominator for Ni, Mo and Cu is in each case somewhat larger than that for Mn, and that it is the product of the numerator/denominator and the chosen amount of each element that determines the relative contribution (i.e. additive or subtractive) of each element to the value Vs - as argued by the appellant - actually proves that the Mn value cannot be freely chosen without influencing the other specified elements. Contrary to the appellant's position, it is evident from equation {1} that the concentrations of these elements are actually so closely associated that a particular choice of a limit for Mn restricts the choice for one of said other elements C, P, Ni, Mo and Cu and has to be compensated for by any of them, in order that the same result can be substantially achieved.

1.1.4 Furthermore, said examples 1 and 2 contain identical Mn contents of 1.46% and although they have undergone different conditions of thermomechanical controlling processes (TMCP), namely "A" and "B" (see page 32, Table 3, columns A and B), they produced steels having almost identical tensile strength values of 860 and 857 [in MPa] (YS), and 947 and 944 [in MPa] (TS), and Charpy test values vE-40 of 251 and 252 [in J], respectively (see page 33, Table 4). Since different TMCP conditions produce different steel microstructures

- which consequently should have different properties (compare paragraph 1.2.1, below) - the steel composition must be responsible for obtaining these almost identical steel properties, i.e. said tensile strength and toughness.

1.1.5 Consequently, there exists a substantial degree of interdependence of quantitative values, so that the isolation of one value from the rest of the conditions could not have been readily envisaged by the skilled person.

1.1.6 Given this situation, the individual amounts of the constituents of the sample alloys 1 and 2 or any other example are not allowed to be regarded in strict isolation. This may be done only in very exceptional cases. In this context reference is made to the existing longstanding Case Law, see particularly decision T 201/83 (OJ EPO 1984, 481, point 12 of the reasons, last sentence) "an amendment of a concentration range in a claim for a mixture, such as an alloy, is allowable on the basis of a particular value described in a specific example, provided the skilled man could have readily recognised this value as not so closely associated with the other features of the example as to determine the effect of that embodiment of the invention as a whole in a unique manner and to a significant degree". Taking account of the considerations in T 201/83 the conclusion must be drawn that because of the effects of the interaction of the constituents making up the claimed martensitic-lower bainitic steel composition and its properties, it is not possible to make an arbitrary selection of individual features from the single examples. To disregard the specific context would result in a new selection from the original range which was neither explicitly nor implicitly disclosed. Hence decision T 201/83 does not allow any arbitrary combination of values, isolated from the original text.

1.1.7 Therefore the incorporation of an upper Mn concentration value of 1.46% taken as an isolated feature from examples 1 and 2 of Table 1 into claims 1 and 9 according to the main request contravenes Article 123(2) EPC.

The main request is therefore not allowable.

First auxiliary request

1.2 A lower bainite value of "at least **54 vol%**" according to claims 1 and 9 of the first auxiliary request has been taken from example 3 of Table 8 which has been made in accordance with the specific rolling and heat treatment conditions of TMCP "A" (see pages 36, Table 7, column A; and page 37, Table 8).

1.2.1 From Table 8 it can be derived that the steel composition determines the amount of lower bainite in the microstructure of the produced steel since the three test samples 1, 2 and 3 containing 1.65% Mn, 1.39% Mn and 1.64% Mn were identically treated according to TMCP "A" without a tempering step and resulted in lower bainite values of 20 vol%, 32 vol% and 54 vol%, respectively (see page 34, Table 5; and page 37, Table 8). In this context the Board noted that samples 1 and 3 contained about the same Mn concentration of 1.65% and 1.64%, respectively, but resulted in totally different lower bainite values. Taking account of sample 10 of Table 8 containing 1.66% Mn - which is almost the same Mn concentration as contained in said samples 1 and 3 of Table 8 - but having undergone a similar TMCP "B" including a tempering step produced a microstructure containing 40 vol% lower bainite. Hence one could conclude from Table 8 that a tempering step reduces the amount of lower bainite. On the other hand, from samples 3 and 10 of Table 4 (both containing 1.45% Mn, the first sample 3 was tempered while the latter was not) considering their Charpy test result values of 255 [J] and 198 [J], respectively, one could conclude the opposite since the toughness measured according to the Charpy test correlates to the amount of lower bainite. It may also be interpreted that the steel composition plays a major role.

From Tables 7 and 8 it is evident that both the chemical steel composition and all the process parameters for the heat treatment are necessary in order to arrive at a specific microstructure. In this context the Board noted that the appellant acknowledged "that the Board have correctly noted that Tables 7 and 8 demonstrate that for example the cooling step temperature greatly influences the amount of bainite present in the produced steel. This merely demonstrates the well known fact that the manufacturing process and conditions (for any given steel chemistry) determine the microstructure of the steel, in particular the lower bainite content of the steel" (see appellant's letter dated 9 June 2006, page 8, last paragraph).

For these reasons the appellant's allegation that the lower bainite value is neither linked to the steel composition nor to the TMCP conditions cannot be accepted. Further evidence, which could have proven the appellants case, particularly that a lower bainite value of at least 54 vol% can be obtained with any steel composition covered by claim 1, has not been submitted.

1.2.2 Hence the generalisation of a lower bainite value of "at least 54 vol%" to all steel compositions and to all heating, rolling and cooling conditions as specified in claims 1 and 9 is not supported by the application as originally filed.

Consequently, claims 1 and 9 of the first auxiliary request do not meet the requirements of Article 123(2) EPC. The first auxiliary request is thus not allowable.

Third auxiliary request

1.3 Claim 1 of the third auxiliary request corresponds to process claim 9 of the first auxiliary request. Hence the conclusion with respect to claim 9 of the first auxiliary request applies *mutatis mutandis*.

The Board therefore considers that claims 1 and 9 of the main request contravene Article 123(2) EPC. The third auxiliary request is therefore not allowable.

1.4 The Board thus must conclude that none of the appellant's requests is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Nachtigall C. Holtz