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Datasheet for the decision of 12 July 2012

Case Number: T 1914/10 - 3.2.08

Application Number: 05816475.7

Publication Number: 1970457

IPC: C21D 9/46, B21B 37/00, B21B 37/76, C22C 38/00, C22C 38/06, C22C 38/58

Language of the proceedings: EN

Title of invention:
Method for control of cooling of steel plate

Applicant:
Nippon Steel Corporation

Headword:
-

Relevant legal provisions (EPC 1973):
EPC Art. 84, 114

Keyword:
"Main request and auxiliary requests 1 to 4: clarity (no)"
"Auxiliary requests 5 to 6: late filed, not admitted"

Decisions cited:
-

Catchword:
-

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Case Number: T 1914/10 - 3.2.08

D E C I S I O N
of the Technical Board of Appeal 3.2.08
of 12 July 2012

Appellant: (Applicant)
Nippon Steel Corporation
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Chiyoda-ku
Tokyo 100-8071 (JP)

Representative:
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted 1 April 2010 refusing European patent application No. 05816475.7 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman: T. Kriner
Members: M. Alvazzi Delfrate
U. Tronser

Summary of Facts and Submissions

I. By decision posted on 1 April 2010, the examination division refused European Patent application No. 05 816 475.7 on the grounds of Articles 83 and 84 EPC (1973).

II. The appellant lodged an appeal against this decision on 10 June 2010, paying the appeal fee on the same day. The statement setting out the grounds for appeal was filed on 11 August 2010.

III. The appellant requested that the appealed decision be set aside and that a patent be granted on the basis of the main request or first auxiliary request filed with the grounds of appeal or one of the auxiliary requests 2 to 6 submitted during the oral proceedings on 12 July 2012.

IV. Claim 1 of the **main request** reads as follows:

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by:

preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of an austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process, obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein ($X\gamma$) is an untransformed fraction of austenite at said high cooling rate, which is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, or predicted by a preliminarily obtained transformation curve, or predicted by a transformation prediction calculation model which simulates a transformation process of the steel sheet,

obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperatures, predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model, and operating the cooling system based on the predicted temperatures of the steel sheet:

$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula(1)"

Claim 1 of the **auxiliary request 1** reads as follows (differences over claim 1 of the main request underlined):

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by:

preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of an austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process,

obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein ($X\gamma$) is an untransformed fraction of austenite at said high cooling rate, which is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, or predicted by a preliminarily obtained transformation curve, or predicted by a transformation prediction calculation model which simulates a transformation process of the steel sheet,
obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperatures,
predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model, and
controlling the cooling of the steel sheet by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas based on the predicted temperatures of the steel sheet:
$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula (1)"

Claim 1 of **auxiliary request 2** reads as follows (differences over claim 1 of auxiliary request 1 emphasised):

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by;

preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of the austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process, <u>wherein the enthalpies ($H\gamma$ and $H\alpha$) are experimentally obtained results or calculated results obtained by the Thermo-Calc,</u>

obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein $X\gamma$ is an untransformed fraction of austenite at said high cooling rate, and $X\gamma$ is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, ~~or predicted by a preliminarily obtained transformation curve,~~ or predicted by a transformation prediction calculation model which simulates a transformation process of the steel sheet,

obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperature,

predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model, and

controlling the cooling the steel sheet by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas <u>by using the basic heat transfer equation based on the coefficient of heat transfer and dynamic specific heat and processing the sheet thickness, sheet width, pass rate, entry-side temperature, cooling stop target temperature, and other input data to determine the number of valves to operate based on the predicted</u>

temperatures of the steel sheet, to achieve the target temperature pattern:

Hsys=Hγ(Xγ)+Hα(l-Xγ) … formula (1)"

Claim 1 of **auxiliary request 3** reads as follows (differences over claim 1 of auxiliary request 2 underlined):

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by;

preliminarily obtaining enthalpies (Hγ and Hα) of the austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process, wherein the enthalpies (Hγ and Hα) are experimentally obtained results or calculated results obtained by the Thermo-Calc,

obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein Xγ is an untransformed fraction of austenite at said high cooling rate, and Xγ is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, or a table of the change in transformation fraction for the ingredients of the steel sheet and the target temperature pattern in advance by experiments or a mathematical formula having the ingredients and the target temperature pattern as functions based on the experiments, or a prediction by a transformation

prediction calculation model for a temperature pattern at a high cooling rate which simulates a transformation process of the steel sheet,
obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperature,
predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model, and
controlling the cooling the steel sheet by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas by using the basic heat transfer equation based on the coefficient of heat transfer and dynamic specific heat and processing the sheet thickness, sheet width, pass rate, entry-side temperature, cooling stop target temperature, and other input data to determine the number of valves to operate based on the predicted temperatures of the steel sheet, to achieve the target temperature pattern:
$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula (1)"

Claim 1 of **auxiliary request 4** reads as follows (differences over claim 1 of auxiliary request 3 underlined):

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by:

preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of the austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process, wherein the enthalpies ($H\gamma$ and $H\alpha$) are experimentally obtained results or calculated results obtained by the Thermo-Calc,

obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein $X\gamma$ is an untransformed fraction of austenite at said high cooling rate, and $X\gamma$ is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, or a table of the change in transformation fraction for the ingredients of the steel sheet and the target temperature pattern in advance by experiments or a mathematical formula having the ingredients and the target temperature pattern as functions based on the experiments, or a prediction by a transformation prediction calculation model for a temperature pattern at a high cooling rate which simulates a transformation process of the steel sheet, wherein the transformation prediction calculation model is one described in Suehiro et al.: Iron and Steel, vol. 73, No. 8, (1987), p.111,

obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperature,

predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model, and controlling the cooling the steel sheet by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas by using the basic heat transfer equation based on the coefficient of heat transfer and dynamic specific heat and processing the sheet thickness, sheet width, pass rate, entry-side temperature, cooling stop target temperature, and other input data to determine the number of valves to operate based on the predicted temperatures of the steel sheet, to achieve the target temperature pattern:

$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula (1)"

Claim 1 of **auxiliary request 5** reads as follows (differences over claim 1 of the main request emphasised):

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by:

preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of an austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process, obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein ($X\gamma$) is an untransformed fraction of austenite at said high cooling rate, which is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, ~~or predicted by~~

~~a preliminarily obtained transformation curve, or predicted by a transformation prediction calculation model which simulates a transformation process of the steel sheet,~~
obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperatures,
predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model by applying said dynamic specific heat instead of the specific heat of the conventional temperature prediction model, and
operating the cooling system based on the predicted temperatures of the steel sheet:
$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula(1)"

Claim 1 of the **auxiliary request 6** reads as follows (differences over claim 1 of auxiliary request 5 underlined)

"A method for controlling cooling of a steel sheet by controlling the end of cooling temperature in a cooling process of a production process from the Ae3 or above temperature of the steel sheet according to a target temperature pattern having a high cooling rate at which a delay in transformation from an austenite phase to a ferrite phase occurs, and operating a cooling system, characterized by:
preliminarily obtaining enthalpies ($H\gamma$ and $H\alpha$) of an austenite phase and ferrite phase respectively at some temperatures of the steel sheet in the cooling process,
obtaining at said some temperatures a dynamic enthalpy (Hsys) defined by formula (1), wherein ($X\gamma$)is an

untransformed fraction of austenite at said high cooling rate, which is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line,
obtaining the gradient of the obtained dynamic enthalpy (Hsys) as the dynamic specific heat at said some temperatures,
predicting temperatures of the steel sheet based on the obtained dynamic specific heat with respect to said some temperatures in a conventional temperature prediction model by applying said dynamic specific heat instead of the specific heat of the conventional temperature prediction model, and
controlling the cooling of the steel sheet by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas based on the predicted temperatures of the steel sheet:

$Hsys=H\gamma(X\gamma)+H\alpha(l-X\gamma)$ … formula (1)"

V. The following documents play a role in the present decision:

Annex B: JP -A- 7 214132;
Annex C: drawings (Figures 1 to 7) submitted with letter dated 11 August 2010; and
Annex D: Suehiro et al." Development of Mathematical Model for Predicting Transformation of High-Carbon Steel During Cooling of Runout Table and Its Application to On-line Temperature Control of Hot Strip Mill", Nippon Steel Technical Report No. 67 (1995).

VI. The arguments of the appellant can be summarised as follows:

The importance of controlling the cooling of a steel sheet to obtain the desired properties was known in the art. To this purpose, the operation of the cooling system had to be based on the predicted temperature. This could be done in a way known to the person skilled in the art. The application disclosed, for instance in paragraph [0005], how the cooling could be controlled by the operation of water or gas valves. Conventional methods of predicting the temperature were also known to the person skilled in the art. One of them was disclosed in annex B, cited in the application, and another in annex D. Since all said conventional methods used the steel specific heat for their predictions, they failed to take into account the delay in transformation from the austenite to the ferrite phase. Hence, in the case of high cooling rates their temperature prediction and the cooling control based on it were not accurate.

The contribution of the claimed invention resided in the use, in a conventional temperature prediction model, of the dynamic specific heat instead of the specific heat. In this way account was taken of the delay in transformation from the austenite to the ferrite phase.

Claim 1 clearly defined how to obtain the dynamic specific heat with the help of formula (1), as illustrated in Annex C. The untransformed fraction of austenite $X\gamma$ which appeared in that formula could be either measured or predicted. Both possibilities were available to the person skilled in the art before the priority date.

As to the features pertaining to the way of operating the cooling system based on the predicted temperatures of the steel sheet and to the conventional temperature prediction model, it was not necessary to define them in detail, since they were known to the person skilled in the art and did not represent the contribution of the claimed invention.

Accordingly, claim 1 of the main request was clear. The auxiliary requests, which further defined the claimed process were submitted in case the board should not agree with this view.

Auxiliary request 1 specified the device used for cooling the sheet.

Auxiliary requests 2 to 4 were essentially based, apart from a minor correction, on auxiliary requests 2 to 4 as submitted with the grounds of appeal. These requests further specified the way of predicting the temperature and of obtaining the untransformed fraction of austenite.

Auxiliary requests 5 to 6 should be admitted into the proceedings despite their lateness, since they provided further clarifications. In particular, they specified that the untransformed austenite fraction was calculated based on measured values and that the dynamic specific heat was to be used instead of the specific heat.

Reasons for the Decision

1. The appeal is admissible.

2. Main request

2.1 Claim 1 is directed to a method for controlling the cooling of a steel sheet. According to the claim, this is realised by operating the cooling system based on the predicted temperatures of the steel sheet, based on the dynamic specific heat in a conventional temperature prediction model. However, the claim neither defines how the operation of the cooling system is based on the predicted temperature nor states what is to be considered a conventional temperature model.

It is true that methods of predicting the temperature of the steel sheet during cooling were known in the art, as shown for instance in annex B and annex D. However, the person skilled in the art would not know which of the known methods can be seen as conventional. Moreover, he would not know either when the operation of the cooling system could be considered to be based on the predicted temperature. Accordingly, the person skilled in the art does not know the exact meaning of the features according to which the operation of the cooling system is based on the predicted temperature, which is predicted based on the obtained dynamic specific heat with respect to said temperatures in a conventional temperature prediction model.

The appellant submitted that it was not necessary to define said features since they did not represent the contribution of the claimed invention. However, to meet the requirements of Article 84 EPC (1973), the claims should define the matter for which protection is sought. In the case of claim 1 of the main request, said definition comprises also said features relating to the operation of the cooling system and to the conventional temperature prediction model. Since their exact meaning cannot be established, claim 1 lacks clarity.

2.2 Moreover, the definition of the dynamic specific heat too, which according to the appellant represents the contribution of the claimed invention, is not clear. This parameter is defined with the help of a formula which comprises the untransformed fraction of austenite $X\gamma$. According to claim 1 $X\gamma$ is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line, or predicted by a preliminarily obtained transformation curve, or predicted by a transformation prediction calculation model which simulates a transformation process of the steel sheet. However, the claim specifies neither which prediction calculation model is used to predict the untransformed fraction of austenite, nor how the transformation curve is obtained, nor, in particular, how $X\gamma$ can be measured. The description does not shed light on the measurement of $X\gamma$ either, since it does not indicate a measuring device to be used for this purpose. Nor is such a device, capable of operating on-line under a high cooling rate, known to the person skilled in the art from his common general knowledge.

The appellant disagreed with this view and submitted that possibilities of measuring $X\gamma$ were available to the person skilled in the art before the priority date. However, it did not provide any evidence in this respect. In particular Annex C does not show how $X\gamma$ can be measured. Accordingly, this argument is not convincing.

For this reason too, claim 1 lacks clarity.

3. Auxiliary request 1 to 4

The auxiliary requests 1 to 4 fail to overcome the objections above.

It is true that claim 1 comprises the additional features according to which the cooling of the steel sheet is controlled by operating water valves or gas valves of the cooling system to spray the surface of the steel sheet with water or a gas (auxiliary requests 1 to 4). Said control is realised on the above features by using the basic heat transfer equation based on the coefficient of heat transfer and dynamic specific heat and processing the sheet thickness, sheet width, pass rate, entry-side temperature, cooling stop target temperature, and other input data to determine the number of valves to operate based on the predicted temperatures of the steel sheet, to achieve the target temperature pattern (auxiliary request 2 to 4). However, it is not clear what the basic heat transfer equation is and how this equation is to be used. Moreover, it is not clear either, how the sheet thickness, sheet width, pass rate, entry-side temperature, cooling stop target temperature, and other input data are to be processed to determine the number of valves to operate based on the predicted temperatures of the steel sheet.

Additionally, claim 1 of each of the auxiliary requests 1 to 4 still comprises the step according to which Xγ is calculated based on measured values actually measured by a transformation fraction measuring device attached to the line. That step lacks clarity, as shown under section 2. above.

Accordingly, claim 1 of each of the auxiliary requests 1 to 4 lacks clarity, too.

4. Auxiliary request 5 to 6

According to Article 114 EPC (see also Article 13(1) of the Rules of Procedure of the Boards of Appeal (OJ EPO 11/2007, page 536)), any amendment to a party's case after it has filed its grounds of appeal or reply may be admitted and considered at the Board's discretion. That discretion is to be exercised in view of inter alia the complexity of the new subject-matter submitted, the current state of the proceedings and the need for procedural economy.

In the present case, auxiliary requests 5 and 6 were filed at a very late stage of the appeal proceedings, namely at the oral proceedings. A request filed at such a late stage should be admitted only if it at least complies without doubt with the formal requirements of the EPC and constitute a promising attempt to counter the objection raised.

According to present auxiliary requests 5 and 6 $X\gamma$ is calculated based on measured values, measured by a transformation fraction measuring device attached to the line. Moreover, they refer to conventional temperature prediction models to predict the temperatures of the steel sheet. Hence, these request do not constitute a promising attempt to counter the objections under Article 84 EPC (1973) raised against the higher-ranking requests.

Under these circumstances they are not admitted into the proceedings.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare T. Kriner