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(54) METHOD FOR PRODUCING MULTI-STAGE STRUCTURAL STEEL BLANK FOR ONE STEEL

(57) The present disclosure discloses a method for manufacturing a structural steel billet for use in multi-grade steels, which relates to the technical field of steelmaking. A peritectic reaction with 0.08% ≤ C < 0.22% and a medium-carbon composition system design are adopted for the structural steel billet, and the content of alloys is adjusted on the basis, to meet the requirements of the ordered products on the mechanical properties. According to the manufacturing standards, specifications, and performance requirements of ordered products, a unified composition design for a building structural steel, a wind turbine tower steel, a bridge structural steel, and a low-alloy high-strength structural steel is adopted based on a steel grade, and a smelting grade is formulated. The peritectic reaction and the medium-carbon composition design are adopted in a unified manner according to the manufacturing standards and the mechanical properties of the ordered products. Meanwhile, a carbon equivalent is adjusted by adopting C, Mn, Cr, Ni, Mo, Cu, V and other elements according to the requirements of the ordered products, to meet the mechanical properties. In this way, the performance of the ordered products is more stable, the production scheduling is faster and smoother, and the number of remaining billets is significantly reduced.

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of steelmaking, and particularly relates to a method for manufacturing a structural steel billet for use in multi-grade steels.

BACKGROUND ART

[0002] Structural steel, with the largest production, is the most widely used in the steel plate manufacturing of iron and steel enterprises. Since there are too many smelting grades, the production efficiency of the iron and steel enterprises is limited by the structural steel. At the same time, a large amount of the remaining billets is generated, which would seriously affect the capital turnover of the iron and steel enterprises. Currently, there are 115 grades of the structural steel produced by the iron and steel enterprises, including 50 grades of the structural steel in Grade 345. In the continuous casting process, each steel grade requires a production process, and there is a casting sequence between different steel grades, which cause high pressure on the production, and the continuous casting segment is generally downgraded to use. Ultimately, the waste is serious, and the development of productivity is limited to a certain degree.

SUMMARY

[0003] To solve the above-mentioned technical problems, the present disclosure provides a method for manufacturing a structural steel billet for use in multi-grade steels, comprising:

S1. adopting a peritectic reaction with 0.08% ≤ C < 0.22% and a medium-carbon composition system design for a building structural steel, a wind turbine tower steel, a bridge structural steel, and a low-alloy high-strength structural steel according to manufacturing standards and specifications of ordered products, then conducting a unified composition design according to a steel grade, formulating a smelting grade, and adjusting a content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on mechanical properties;

S2. designing a smelting process according to the requirements of the ordered products on crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;

S3. scheduling the production according to the requirements of the ordered products on quantity and delivery time; and

S4. collecting remaining billets after smelting, and preferentially using the remaining billets for the production of subsequent ordered products.

[0004] The technical effects of the present disclosure are: the peritectic reaction and the medium-carbon composition design are adopted in a unified manner according to the manufacturing standards and the mechanical properties of the ordered products. Meanwhile, a carbon equivalent is adjusted by adopting C, Mn, Cr, Ni, Mo, Cu, V and other elements according to the requirements of the ordered products, to meet the mechanical properties. Thus, the performance of the ordered products is more stable, the production scheduling is faster and smoother, and the number of the remaining billets is significantly reduced.

[0005] The technical solution that the present disclosure is further limited is:

[0006] The method for manufacturing the structural steel billet for use in the multi-grade steels comprises:

S1. adopting the peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system design for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products, conducting the unified composition design according to the steel grade, formulating the smelting grade, and adjusting the content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on the mechanical properties; wherein, the requirements are specifically as follows:

the composition requirements of the National Standard GB/T 19879 on Q235GJ steel plate for building structures are: C ≤ 0.18%, Mn: 0.60%-1.50%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.020%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.08%, and Cu ≤ 0.30%;

the composition requirements of the National Standard GB/T 28410 on Q235FT steel plate for wind turbine towers are: C ≤ 0.18%, Mn: 0.50%-1.40%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.050%, V ≤ 0.060%, Ti ≤ 0.050%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.10%, Cu ≤ 0.30%, and N ≤ 0.012%;

the composition requirements of the National Standard GB/T 714 on Q235q steel plate for bridge structures are: C ≤ 0.17%, Mn ≤ 1.40%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Ni ≤ 0.30%, Cr ≤ 0.30%, Cu ≤ 0.30%, and N ≤ 0.012%;

according to the mechanical properties and quantity of the ordered products, a unified smelting grade J-1 is formulated for the above-mentioned three steel plates under conditions that rolling and heat treatment are consistent, and the composition design is: C: 0.15%-0.17%, Mn: 0.90%-1.10%, Si: 0.20%-0.30%, P ≤ 0.015%, S ≤ 0.005%, Nb ≤ 0.020%, Al: 0.020%-0.050%, N ≤ 0.012%, V ≤ 0.030%, Ni ≤ 0.030 %, Cr ≤ 0.050%, Mo ≤ 0.030%, Cu ≤ 0.050%, Ti: 0.006%-0.020%, B ≤ 0.0005%, Ca: 0.0008%-0.00400%, and Ceq: 0.26%-0.33%;

S2. designing the smelting process according to the requirements of the ordered products on the crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;
S3. scheduling the production according to the requirements of the ordered products on the quantity and the delivery time; and
S4. collecting the remaining billets after smelting, and preferentially using the remaining billets for the production of the subsequent ordered products.

[0007] The method for manufacturing the structural steel billet for use in the multi-grade steels comprises:

S1. adopting the peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system design for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products, conducting the unified composition design according to the steel grade, formulating the smelting grade, and adjusting the content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on the mechanical properties; wherein, the requirements are specifically as follows:

the composition requirements of the National Standard GB/T 19879 on steel plate Q420GJ for building structures are: C ≤ 0.18%, Mn ≤ 1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.030%, Al ≥ 0.020%, Ni ≤ 1.0%, Cr ≤ 0.80%, Mo ≤ 0.50%, and Cu ≤ 0.30%;
the composition requirements of the National Standard GB/T 28410 on Q420FT steel plate for wind turbine towers are: C ≤ 0.20%, Mn: 1.00%-1.70%, Si ≤ 0.50%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Nb ≤ 0.060%, V ≤ 0.15%, Ti ≤ 0.050%, Ni ≤ 0.50%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, N ≤ 0.010%;
the composition requirements of the National Standard GB/T 714 on Q420q steel plate for bridge structures are: C ≤ 0.18%, Mn: 1.00%-1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.060%, V ≤ 0.08%, Ti ≤ 0.030%, Al ≥ 0.015%, Ni ≤ 0.70%, Cr ≤ 0.80%, Mo ≤ 0.35%, Cu ≤ 0.55%, B ≤ 0.0040%, and N ≤ 0.012%;
the composition requirements of the National Standard GB/T 1591 on Q420 steel plate for low-alloy high-strength structures are: C ≤ 0.20%, Mn ≤ 1.70%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.20%, Ni ≤ 0.80%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, and N ≤ 0.015%;
according to the mechanical properties and monthly quantity of the ordered products, a unified smelting grade J-19 is formulated for the above-mentioned four steel plates under conditions that the rolling and the heat treatment are consistent, and the composition design is: C: 0.060%-0.080%, Mn: 1.30%-1.50%, Si: 0.20%-0.40%, P ≤ 0.020%, S ≤ 0.005%, Nb: 0.020%-0.030%, V: 0.020%-0.040%, Ti: 0.010%-0.020%, Al: 0.020%-0.050%, N ≤ 0.0080%, Ni ≤ 0.30%, Cr: 0.20%-0.30%, Mo ≤ 0.03%, Cu ≤ 0.05%, B ≤ 0.0010%, Ca: 0.0008%-0.00400%, and Ceq: 0.36%-0.46%;

S2. designing the smelting process according to the requirements of the ordered products on the crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;
S3. scheduling the production according to the requirements of the ordered products on the quantity and the delivery time; and
S4. collecting the remaining billets after smelting, and preferentially using the remaining billets for the production of the subsequent ordered products.

[0008] The beneficial effects of the present disclosure are as follows:

(1) The present disclosure breaks the restrictions on steel grades, and formulates the reasonable and unified smelting grade based on the product performance and customer requirements. Thus, the structural steel billet that meet various purposes is manufactured, and the problems such as the long delivery cycle of the scattered orders and the over-accumulation of the remaining billets are solved, as well as the operation rate of the continuous casting ma-

chine and the crude steel output are improved. Ultimately, the economic benefits of the enterprise is increased.

(2) The present disclosure reduces the number of structural steel grades from 115 to 65. Thus, the structure grade is optimized, the smelting cost is reduced, the market competitiveness of the steel plates is improved, and the market share of advantageous steel grade is expanded.

(3) The present disclosure has more unified smelting and manufacturing standards, and more orderly smelting operation. Thus, the production quality is steadily improved.

(4) The present disclosure reduces the number of continuous casting segment and the remaining billets, so that the resource waste is reduced, the capital utilization rate of the enterprise is improved, the production capacity is liberated, and the annual smelting output and benefits are improved.

(5) Through the method of the present disclosure, the enterprise's ability to accept orders of different steel grades is improved, the delivery cycle of the scattered orders is shortened, and the customer satisfaction is improved. Thus the economic benefits and competitiveness of the enterprise are improved.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Example 1

[0009] The present disclosure provides the method for manufacturing the structural steel billet for use in the multi-grade steels, including the following steps:

S1. The peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system design are adopted for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products. According to the steel grade, the unified composition design is adopted, and the smelting grade is formulated, as well as the content of alloys is adjusted on the basis, to meet the requirements of the ordered products on the mechanical properties. The requirements are specifically as follows:

The composition requirements of the National Standard GB/T 19879 on Q235GJ steel plate for building structures are: C ≤ 0.18%, Mn: 0.60%-1.50%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.020%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.08%, and Cu ≤ 0.30%.

The composition requirements of the National Standard GB/T 28410 on Q235FT steel plate for wind turbine towers are: C ≤ 0.18%, Mn: 0.50%-1.40%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.050%, V ≤ 0.060%, Ti ≤ 0.050%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.10%, Cu ≤ 0.30%, and N ≤ 0.012%.

The composition requirements of the National Standard GB/T 714 on Q235q steel plate for bridge structures are: C ≤ 0.17%, Mn ≤ 1.40%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Ni ≤ 0.30%, Cr ≤ 0.30%, Cu ≤ 0.30%, and N ≤ 0.012%.

According to the mechanical properties and quantity of the ordered products, a unified smelting grade J-1 is formulated for the above-mentioned three steel plates under conditions that the rolling and heat treatment are consistent, and the composition design is: C: 0.15%-0.17%, Mn: 0.90%-1.10%, Si: 0.20%-0.30%, P ≤ 0.015%, S ≤ 0.005%, Nb ≤ 0.020%, Al: 0.020%-0.050%, N ≤ 0.012%, V ≤ 0.030%, Ni ≤ 0.030 %, Cr ≤ 0.050%, Mo ≤ 0.030%, Cu ≤ 0.050%, Ti: 0.006%-0.020%, B ≤ 0.0005%, Ca: 0.0008%-0.00400%, and Ceq: 0.26%-0.33%.

S2. The smelting process is designed according to the requirements of the ordered products on the crack detection. The smelting process of the ordered products required the crack detection includes molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection includes molten iron desulfurization → BOF smelting → LF refining → CCM casting.

S3. The production is scheduled according to the requirements of the ordered products on the quantity and delivery time.

S4. The remaining billets is collected after smelting, and preferentially used for the production of the subsequent ordered products.

Example 2

[0010] The present disclosure provides the method for manufacturing the structural steel billet for use in the multi-grade steels, including the following steps:

S1. The peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system design are adopted for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products. According to the steel grade, the unified composition design is adopted and the smelting grade is formulated, as well as the content of alloys is adjusted on the basis, to meet the requirements of the ordered products on the mechanical properties. The requirements are specifically as follows:

The composition requirements of the National Standard GB/T 19879 on steel plate Q420GJ for building structures are: C ≤ 0.18%, Mn ≤ 1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.030%, Al ≥ 0.020%, Ni ≤ 1.0%, Cr ≤ 0.80%, Mo ≤ 0.50%, and Cu ≤ 0.30%.

The composition requirements of the National Standard GB/T 28410 on Q420FT steel plate for wind turbine towers are: C ≤ 0.20%, Mn: 1.00%-1.70%, Si ≤ 0.50%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Nb ≤ 0.060%, V ≤ 0.15%, Ti ≤ 0.050%, Ni ≤ 0.50%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, N ≤ 0.010%.

The composition requirements of the National Standard GB/T 714 on Q420q steel plate for bridge structures are: C ≤ 0.18%, Mn: 1.00%-1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.060%, V ≤ 0.08%, Ti ≤ 0.030%, Al ≥ 0.015%, Ni ≤ 0.70%, Cr ≤ 0.80%, Mo ≤ 0.35%, Cu ≤ 0.55%, B ≤ 0.0040%, and N ≤ 0.012%.

The composition requirements of the National Standard GB/T 1591 on Q420 steel plate for low-alloy high-strength structures are: C ≤ 0.20%, Mn ≤ 1.70%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.20%, Ni ≤ 0.80%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, and N ≤ 0.015%.

According to the mechanical properties and quantity of the ordered products, a unified smelting grade J-1 is formulated for the above-mentioned three steel plates under conditions that the rolling and heat treatment are consistent, and the composition design is: C: 0.060%-0.080%, Mn: 1.30%-1.50%, Si: 0.20%-0.40%, P ≤ 0.020%, S ≤ 0.005%, Nb: 0.020%-0.030%, V: 0.020%-0.040%, Ti: 0.010%-0.020%, Al: 0.020%-0.050%, N ≤ 0.0080%, Ni ≤ 0.30%, Cr: 0.20%-0.30%, Mo ≤ 0.03%, Cu ≤ 0.05%, B ≤ 0.0010%, Ca: 0.0008%-0.00400%, and Ceq: 0.36%-0.46%.

S2. The smelting process is designed according to the requirements of the ordered products on the crack detection. The smelting process of the ordered products required the crack detection includes molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection includes molten iron desulfurization → BOF smelting → LF refining → CCM casting.

S3. The production is scheduled according to the requirements of the ordered products on the quantity and delivery time.

S4. The remaining billets is collected after smelting, and preferentially used for the production of the subsequent ordered products.

[0011] The peritectic reaction and the medium-carbon composition design are adopted in a unified manner according to the manufacturing standards and mechanical properties of the ordered products. Meanwhile, the carbon equivalent is adjusted by adopting C, Mn, Cr, Ni, Mo, Cu, V and other elements according to the requirements of the ordered products, to meet the mechanical properties. Thus, the performance of the ordered products is more stable, the production scheduling is faster and smoother, and the number of the remaining billets is significantly reduced. The number of structural steel grades is reduced from 115 to 65. Thus, the structure grade is optimized, the smelting cost is reduced, the structural steel billet that meet various purposes is manufactured, and the problems such as the long delivery cycle of scattered orders and the over-accumulation of the remaining billets are solved, as well as the operation rate of the continuous casting machine and the crude steel output are improved. Ultimately, the economic benefits of the enterprise is increased.

[0012] In addition to the above-described examples, the present disclosure may also have other examples. All technical solutions made by equivalent replacement or equivalent transformation shall fall within the protection scope of the present disclosure.

Claims

1. A method for manufacturing a structural steel billet for use in multi-grade steels, wherein, the method comprises:

   S1. adopting a peritectic reaction with 0.08% ≤ C < 0.22% and a medium-carbon composition system design for a building structural steel, a wind turbine tower steel, a bridge structural steel, and a low-alloy high-strength structural steel according to manufacturing standards and specifications of ordered products, then conducting a unified composition design according to a steel grade, formulating a smelting grade, and adjusting a content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on mechanical properties;

   S2. designing a smelting process according to the requirements of the ordered products on crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;

   S3. scheduling the production according to the requirements of the ordered products on quan-

tity and delivery time; and
S4. collecting remaining billets after smelting, and preferentially using the remaining billets for the production of subsequent ordered products.

2. The method for manufacturing the structural steel billet for use in the multi-grade steels according to claim 1, wherein, the method comprises:

S1. adopting the peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system design for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products, conducting the unified composition design according to the steel grade, formulating the smelting grade, and adjusting the content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on the mechanical properties; wherein, the requirements are specifically as follows:

the composition requirements of the National Standard GB/T 19879 on Q235GJ steel plate for building structures are: C ≤ 0.18%, Mn: 0.60%-1.50%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.020%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.08%, and Cu ≤ 0.30%;
the composition requirements of the National Standard GB/T 28410 on Q235FT steel plate for wind turbine towers are: C ≤ 0.18%, Mn: 0.50%-1.40%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.050%, V ≤ 0.060%, Ti ≤ 0.050%, Ni ≤ 0.30%, Cr ≤ 0.30%, Mo ≤ 0.10%, Cu ≤ 0.30%, and N ≤ 0.012%;
the composition requirements of the National Standard GB/T 714 on Q235q steel plate for bridge structures are: C ≤ 0.17%, Mn ≤ 1.40%, Si ≤ 0.35%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Ni ≤ 0.30%, Cr ≤ 0.30%, Cu ≤ 0.30%, and N ≤ 0.012%;
according to the mechanical properties and quantity of the ordered products, a unified smelting grade J-1 is formulated for the above-mentioned three steel plates under conditions that rolling and heat treatment are consistent, and the composition design is: C: 0.15%-0.17%, Mn: 0.90%-1.10%, Si: 0.20%-0.30%, P ≤ 0.015%, S ≤ 0.005%, Nb ≤ 0.020%, Al: 0.020%-0.050%, N ≤ 0.012%, V ≤ 0.030%, Ni ≤ 0.030 %, Cr ≤ 0.050%, Mo ≤ 0.030%, Cu ≤ 0.050%, Ti: 0.006%-0.020%, B ≤ 0.0005%, Ca: 0.0008%-0.00400%, and Ceq: 0.26%-0.33%;

S2. designing the smelting process according to the requirements of the ordered products on the crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;
S3. scheduling the production according to the requirements of the ordered products on the quantity and the delivery time; and
S4. collecting the remaining billets after smelting, and preferentially using the remaining billets for the production of the subsequent ordered products.

3. The method for manufacturing the structural steel billet for use in the multi-grade steels according to claim 1, wherein, the method comprises:

S1. adopting the peritectic reaction with 0.08% ≤ C < 0.22% and the medium-carbon composition system for the building structural steel, the wind turbine tower steel, the bridge structural steel, and the low-alloy high-strength structural steel according to the manufacturing standards and specifications of the ordered products, conducting the unified composition design according to the steel grade, formulating the smelting grade, and adjusting the content of alloys on the above-mentioned basis, to meet the requirements of the ordered products on the mechanical properties; wherein, the requirements are specifically as follows:

the composition requirements of the National Standard GB/T 19879 on steel plate Q420GJ for building structures are: C ≤ 0.18%, Mn ≤ 1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.030%, Al ≥ 0.020%, Ni ≤ 1.0%, Cr ≤ 0.80%, Mo ≤ 0.50%, and Cu ≤ 0.30%;
the composition requirements of the National Standard GB/T 28410 on Q420FT steel plate for wind turbine towers are: C ≤ 0.20%, Mn: 1.00%-1.70%, Si ≤ 0.50%, P ≤ 0.020%, S ≤ 0.010%, Al ≥ 0.015%, Nb ≤ 0.060%, V ≤ 0.15%, Ti ≤ 0.050%, Ni ≤ 0.50%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, N ≤ 0.010%;
the composition requirements of the National Standard GB/T 714 on Q420q steel plate for bridge structures are: C ≤ 0.18%, Mn: 1.00%-1.70%, Si ≤ 0.55%, P ≤ 0.020%, S ≤ 0.010%, Nb ≤ 0.060%, V ≤ 0.08%, Ti ≤

0.030%, Al ≥ 0.015%, Ni ≤ 0.70%, Cr ≤ 0.80%, Mo ≤ 0.35%, Cu ≤ 0.55%, B ≤ 0.0040%, and N ≤ 0.012%;

the composition requirements of the National Standard GB/T 1591 on Q420 steel plate for low-alloy high-strength structures are: C ≤ 0.20%, Mn ≤ 1.70%, Si ≤ 0.50%, P ≤ 0.025%, S ≤ 0.020%, Al ≥ 0.015%, Nb ≤ 0.070%, V ≤ 0.20%, Ti ≤ 0.20%, Ni ≤ 0.80%, Cr ≤ 0.30%, Mo ≤ 0.20%, Cu ≤ 0.30%, and N ≤ 0.015%;

according to the mechanical properties and monthly quantity of the ordered products, a unified smelting grade J-19 is formulated for the above-mentioned four steel plates under conditions that the rolling and the heat treatment are consistent, and the composition design is: C: 0.060%-0.080%, Mn: 1.30%-1.50%, Si: 0.20%-0.40%, P ≤ 0.020%, S ≤ 0.005%, Nb: 0.020%-0.030%, V: 0.020%-0.040%, Ti: 0.010%-0.020%, Al: 0.020%-0.050%, N ≤ 0.0080%, Ni ≤ 0.30%, Cr: 0.20%-0.30%, Mo ≤ 0.03%, Cu ≤ 0.05%, B ≤ 0.0010%, Ca: 0.0008%-0.00400%, and Ceq: 0.36%-0.46%;

S2. designing the smelting process according to the requirements of the ordered products on the crack detection; wherein, the smelting process of the ordered products required the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → RH vacuum degassing → CCM casting, and the smelting process of the ordered products without requiring the crack detection comprises: molten iron desulfurization → BOF smelting → LF refining → CCM casting;

S3. scheduling the production according to the requirements of the ordered products on the quantity and the delivery time; and

S4. collecting the remaining billets after smelting, and preferentially using the remaining billets for the production of the subsequent ordered products.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/103544

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/02(2006.01)i; C22C 38/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, DWPI, SIPOABS, EPTXT, USTXT, 中国期刊网全文数据库, 南京钢铁, 翟冬雨, 洪君, 吴俊严, 方磊, 姜金星, 杜海军, 刘帅, 陈飞, 刘汝营, 张臣臣, 严生平, 丁叶, 一钢多级, 多钢同级, 探伤, RH, 钢, 碳, 硅, 锰, 磷, 硫, 铝, 钛, 钙, 铌, 钒, CARBON, MANGANESE, SILICON, ALUMINIUM, NIOBIUM, VANADIUM, TITANIUM, C, Si, Mn, Al, Nb, Ti, V

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 110656285 A (NANJING IRON & STEEL CO., LTD.) 07 January 2020 (2020-01-07) claims 1-3	1-3
PX	CN 110656274 A (NANJING IRON & STEEL CO., LTD.) 07 January 2020 (2020-01-07) claims 1-3	1-2,
PX	CN 110656284 A (NANJING IRON & STEEL CO., LTD.) 07 January 2020 (2020-01-07) claims 1-3	1-3
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Y	CN 1586750 A (CENTRAL IRON & STEEL RESEARCH INSTITUTE) 02 March 2005 (2005-03-02) description page 2 paragraph 3, page 3 paragraph 2, page 4 paragraph 3	1-3

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 September 2020	**27 October 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. **PCT/CN2020/103544**

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A	CN 102676947 A (LAIWU IRON & STEEL GROUP CO., LTD.) 19 September 2012 (2012-09-19) entire document	1-3
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A	JP 2011202237 A (SHINNITTETSU SUMIGANE STAINLESS K.K.) 13 October 2011 (2011-10-13) entire document	1-3
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CN	110656285	A	07 January 2020	None			
CN	110656274	A	07 January 2020	None			
CN	110656284	A	07 January 2020	None			
CN	110656275	A	07 January 2020	None			
CN	110735079	A	31 January 2020	None			
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