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(54) **MANUFACTURING METHOD OF HIGH STRENGTH, HIGH TOUGHNESS SEAMLESS STEEL PIPE FOR LINEPIPE**

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(57) **ABSTRACT**

A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe comprises: (1) hot piercing a billet, in which the carbon equivalent value Ceq defined by expression (a): Ceq=C+Mn/6+(Cu+Ni)/5+(Cr+Mo+V)/5 [%] . . . (a) is not greater than 0.60 wt %, and then subjecting the pierced billet to hot rolling at a temperature of 950° C. or higher to obtain a seamless steel pipe; (2) putting the seamless steel pipe immediately, without cooling to Ar3 point or lower, into a furnace kept at Ar3 point+50° C. to 1100° C. to carry out heating; (3) cooling the seamless steel pipe at a cooling rate of 5° C./sec or higher; and (4) tempering the seamless steel pipe at temperature of 550° C. to Ac1 point. A high-strength and high-toughness seamless steel pipe with little strength unevenness can be manufactured, which can be effectively employed for linepipes in cold areas.

MANUFACTURING METHOD OF HIGH STRENGTH, HIGH TOUGHNESS SEAMLESS STEEL PIPE FOR LINEPIPE

TECHNICAL FIELD

[0001] The present invention relates to a manufacturing method of seamless steel pipe for linepipe, and more particularly, the invention relates to a manufacturing method of high-strength and good-toughness seamless steel pipe for linepipe.

BACKGROUND ART

[0002] In prior art, in order to obtain high-strength and good-toughness steel, structure-grain-refinement is usually applied by using the process comprising in sequence of hot rolling, cooling to Ar1 or lower, reheating, quenching, and tempering (herein after referred to as "reheating-quenching process"), or by controlling the rolling step.

[0003] When using the reheating-quenching process to refine structures and thus manufacturing linepipe having high strength of API, X60 or greater, precipitation-enhancing elements such as Ti, Nb, and/or hardness-improving elements such as Cr, Mo, Cu, Ni need to be added.

[0004] However, excessive addition of these elements would cause the deterioration of toughness of welded joints and crack in welding. Therefore, the additions of these elements are usually restricted, and thus the high-strength to be realized thereby has its limit.

[0005] In another aspect, when using the control of rolling to realize refined steel structure, the finish rolling in a biphase temperature region of Ar1 to Ar3 is required. But, the finish rolling temperature is hard to lower since lubrication is difficult during the rolling of seamless steel pipe. Therefore, sufficient refinement of structure cannot be obtained.

[0006] As a substitute process, so-called "direct quenching," in which quenching is performed directly after rolling without re-heating, is suggested. However, according to this process, unevenness of strength in the longitudinal direction and the circumferential direction of a steel pipe would probably occur due to the ununiform temperature after rolling.

[0007] As a measure to solve these problems, Japanese Patent Laid-Open No. H9-287029 publishes a manufacturing method of seamless steel pipe without strength unevenness by preserving steel pipe in a furnace after rolling.

[0008] However, through further investigations, the inventors found when using the method published in Japanese Patent Laid-Open No. H9-287029 to carry out mass production, strength unevenness still exists between the seamless steel pipes produced thereof, thus the suppression of this defect is indispensable. For example, the seamless steel pipes produced according to the method published in Japanese Patent Laid-Open No. H9-287029 show the unevenness as their yield strength covering a range of 13 to 20 MPa and the tensile strength covering a range of 9 to 16 MPa.

DISCLOSURE OF INVENTION

[0009] An object of the present invention is to provide a manufacturing method of a high-strength, high-toughness seamless steel pipe for linepipe with little unevenness between the pipes in mass production.

[0010] In order to realize this object, the inventor has carried out repeated researches and found that the precipitating behaviors of Ti, Nb and V vary along with the alteration of the finish rolling temperature, and thus resulting in great strength unevenness between each steel pipe. Specifically, with respect to Ti and Nb, (1) in the direct quenching process (including heat preservation), a part of Ti and Nb precipitates in the form of carbonitrides in quenching, and their precipitation amount as well as the the solid-dissolving amount are influenced by the finish rolling temperature and N content contained in steel. (2) The carbonitrides precipitated in quenching would congregated to form coarse structure due to continuous temperature, and therefore do not contribute to strength. (3) Ti and Nb in the form of solid-dissolving state in quenching precipitates finely in continuous tempering, which contributes to high strength of steel. Therefore, the unevenness of the strength of steel occurs due to the variation of addition amounts of Ti and Nb and the finish rolling temperature as well. On the other hand, with respect to V, (4) V is almost in the form of solid-dissolving state in quenching and precipitates finely in continuous tempering, which contributes to high strength of steel. Therefore, for the stell containing V, its strength is not greatly effected by the change of finish rolling temperature.

[0011] The present invention completed on the basis of investigation described above includes the following aspects.

[0012] A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe comprising the steps of:

[0013] (1) hot-piercing a billet wherein the carbon equivalent value Ceq defined by expression (a):

$$Ceq=C+Mn/6+(Cu+Ni)/15+(Cr+Mo+V)/5[\%] \quad (a)$$

is not greater than 0.60 wt %, and then subjecting the same to hot rolling at temperature of 950° C. or higher to obtain a seamless steel pipe;

[0014] (2) putting the seamless steel pipe immediately, without cooling to Ar3 point or lower, into a furnace kept at Ar3 point+50° C. to 1100° C. for carrying out heating;

[0015] (3) cooling the seamless steel pipe at a cooling rate of 5° C./sec or higher; and

[0016] (4) tempering the seamless steel pipe at temperature of 550° C. to Ac1 point, Further, if necessary, the billet used in the present invention may comprises 0.02 to 0.15% of C, not greater than 1.0% of Si, 0.3 to 2.5% of Mn, not greater than 0.015% of P, not greater than 0.010% of S, 0 to 0.10% of Ti, 0 to 0.05% of Nb, 0.01 to 0.10% of V and not great than 0.006% of N, and the balance are Fe and unavoidable impurities.

[0017] Furthermore, if necessary, the billet used in the present invention may comprise one or more of elements selected from not greater than 1.0% of Cr, not greater than 1.0% of Mo, not greater than 1.0% of Cu, not greater than 1.0% of Ni, not greater than 0.003% of B and not greater than 0.005% of Ca, and the balance are Fe and unavoidable impurities.

BEST MODE OF THE INVENTION

[0018] Next, the best modes for carrying out the manufacturing method of seamless steel pipe for linepipe according to the present invention are described. First, the reasons for limiting the chemical compositions of the billet are described.

[0019] Carbon equivalent value (Ceq): not great than 0.60%

[0020] Limiting the carbon equivalent value defined by expression (a) to 0.06 or lower is for ensuring the weldability of steel pipe. Generally, seamless steel pipes for linepipe are peripherally welded and jointed at laying location. For the steel pipe having a great carbon equivalent value, cracks occur during the welding and thus pre-heating is required for preventing the cracking. When the Ceq is controlled to be 0.60 or lower, the peripheral welding can be carried out without excessive operations such as pre-heating.

[0021] C: 0.02 to 0.15%

[0022] C is an indispensably added element for improving the strength of steel. In order to ensure the required strength of steel, the addition of C should be 0.02% or more. However, if the C content exceeds 0.15%, the toughness of base metal and heat affected zones at the welded joints would be impaired. Therefore, the C content is defined within a range of 0.02% to 0.15%.

[0023] Si: not greater than 1.0%

[0024] Si is added for the purpose of deoxidization, and it also contributes to the improvement of strength. If the Si content exceeds 1.0%, the toughness of base metal and heat affected zones at the welded joints would be degraded. Therefore, the Si content is controlled at not great than 1.0%.

[0025] Mn: 0.3 to 2.5%

[0026] Mn is an effective element for ensuring strength and toughness of steel. If the Mn content is lower than 0.3%, it is unable to obtain anticipated effects. On the other hand, if the Mn content exceeds 2.5%, the toughness of base metal would be degraded. Therefore, the Mn content is defined within a range of 0.3% to 2.5%.

[0027] P: not greater than 0.015%

[0028] P exists in steel as an impurity that impairs the toughness of base metal. The P content is desirably controlled as low as possible. However, the extreme reduction of P would lead to cost increase. Therefore, the P content is controlled at not greater than 0.015%.

[0029] S: not greater than 0.010%

[0030] S, similar to P, exists in steel as an impurity that impairs the toughness of base metal. The S content is desirably controlled as low as possible. However, the extreme reduction of S would lead to cost increase. Therefore, the S content is controlled at not greater than 0.010%.

[0031] Ti: 0 to 0.10%

[0032] Ti is not an indispensably added element. But, its suitable addition and the control of finish rolling temperature (that will be described hereinafter) would suppress the unevenness of strength and simultaneously improve strength owing to precipitate enhancement. However, if the addition of Ti exceeds 0.10%, the excessive precipitate enhancement would degrade toughness. Therefore, the Ti content is defined within a range of 0% to 0.10%.

[0033] Nb: 0 to 0.05%

[0034] Similar to Ti, Nb is not an indispensably added element. But, its suitable addition and the control of finish rolling temperature (that will be described hereinafter) would suppress the unevenness of strength while improving strength owing to precipitate enhancement and simultaneously improving the toughness due to the refinement of crystal grains. However, if the addition of Nb exceeds 0.05%, toughness would be degraded. Therefore, the Nb content is defined within a range of 0% to 0.05%.

[0035] V: 0.01 to 0.10%

[0036] As described above, V is in form of solid-dissolving state in quenching and it precipitates in tempering. Thus it can improve strength substantially without influence of the finish rolling temperature. However, if the V content is lower than 0.01%, it is difficult to obtain desirable effects. On the other hand, if the V content exceeds 0.10%, excessive precipitates would impair the toughness.

[0037] Therefore, the V content is defined within a range of 0.01% to 0.10%.

[0038] Al: 0.001 to 0.1%

[0039] Al is added for the purpose of deoxidization. If the Al content is lower than 0.001%, insufficient deoxygenization would impair the steel quality. On the other hand, if the Al content exceeds 0.1%, deoxygenizing effect does not change any longer while the impurities increases and thus impairing the toughness. Therefore, the Al content is defined within a range of 0.001% to 0.1%.

[0040] N: not greater than 0.006%

[0041] N exists in steel as an impurity. When Ti is added, it is fixed in the form of form TiN and causes little bad influence to the quality of steel. On another aspect, if Ti is not added, N would precipitate in the form of V nitrides during tempering, and thereby contribute to improvement of strength. However, in any case, if the N content exceeds 0.006%, it would become coarse impurities and thus impairing toughness. Therefore, the N content is controlled at not greater than 0.006%.

[0042] The billet used in the present invention may also contain one or more of elements selected from Cr, Mo, Cu, Ni, B and Ca as the optionally added elements. The reasons for addition of these elements are described below. Although these elements are not indispensably added elements, the strength and toughness of steel is expected to be further improved by the adding these elements to the essential chemical composition of steel.

[0043] Cr: not greater than 1.0%

[0044] Cr is an element for improving hardness. The addition of Cr contributes to high strength. However, if the Cr content exceeds 1.0%, it would impair the toughness of welded joint. Therefore, the content of Cr, if added, is preferably controlled at not greater than 1.0%.

[0045] Mo: not greater than 1.0%

[0046] Mo, similar to Cr, is an element for improving hardness. The addition of Mo contributes to high strength.

However, if the Mo content exceeds 1.0%, it would impair the toughness of welded joints. Therefore, the content of Mo, if added, is preferably controlled at not greater than 1.0%.

[0047] Cu: not greater than 1.0%

[0048] Cu is an element contributing to high strength, and simultaneously improving corrosion resistance. However, excess addition of Cu would increase material cost and impair field weldability. Therefore, the content of Cu, if added, is preferably controlled at not greater than 1.0%.

[0049] Ni: not greater than 1.0%

[0050] Ni contributes to high strength without impairing the toughness. However, excess addition of Ni would increase material cost and impair field weldability. Therefore, the content of Ni, if added, is preferably controlled at not greater than 1.0%.

[0051] B: not greater than 0.003%

[0052] Slight addition of Ca can improve hardness. However, if its addition exceeds 0.003%, the toughness of base metal and heat affected zones at welded joints would be degraded. Therefore, the content of B, if added, is preferably controlled at not greater than 0.003%.

[0053] Ca: not greater than 0.005%

[0054] Ca reacts with S contained in steel to form sulfide, but it maintains the spherical shape after rolling without extending along the rolling direction. Therefore, the generation of hydrogen-induced crack or like that starts from tips of extended inclusions such as MnS can be suppressed. However, excess addition of Ca would deteriorate the cleanness of steel and impair the toughness of base metal. Therefore, the content of Ca, if added, is preferably controlled at not greater than 0.005%.

[0055] Besides the elements described above, the remains are Fe and unavoidable impurities. According to the present invention, the billet having the above-described steel composition is subjected to the steps of pipe-making, heating and preserving, quenching and tempering. The steps are described in sequence as follows.

Pipe-Making

[0056] First, any conventional methods for manufacturing the billet used as the raw material and piercing the billet to obtain a raw hollow pipe may be employed without any limitation. For example, a raw hollow pipe may be obtained by heating a billet produced by continuous casting machine to a temperature of 100 to 1300° C., and the piercing the same with a piercer such as skew-rolling piercing mill.

[0057] Conventional methods may also be employed to carry out stretch rolling and finish rolling without any limitation. For example, according the Mammesman mandrel milling process, finish rolling and size adjusting may be carried out using a sizer or a reducer after stretch rolling with a mandrel mill.

[0058] Here, the temperature of finish rolling is desirable as low as possible from the viewpoint of refinement of structure. However, if the temperature of finish rolling is lower than 950° C., a part of carbonitrides of Ti, Nb and V would precipitate and coarsen in tempering, thus not contribute to strength improvement but causing unevenness of strength. Therefore, the temperature of finish rolling is defined to be not less than 950° C.

Heating and Preserving

[0059] In direct quenching process, which means quenching is carried out directly after finish rolling, although the strength improvement is readily expected dur to the high hardness owing to the coarsened structure after rolling, the ununiform temperature after rolling would probably cause unevenness of the strength in the longitudal and peripheral directions of the steel pile. Therefore, in the present invention, the steel pipe is, before quenching, put into a furnace for homogeneous heating.

[0060] However, if the steel pipe is cooled to Ar3 or lower during the period from the point of completing the finish rolling till the point of putting the pipe into the furnace, a part of ferrite would precipitate, and thus being able to obtain required strength. Therefore, according to the present invention, the steel pipe is put into furnace immediately after finish rolling without being cooled to Ar3 point or lower.

[0061] Furthermore, if the temperature in the furnace does not reach Ar3 point+50° C., the strength unevenness would occur. On another hand, if the temperature in the furnace exceeds 1100° C., crystal grains would be coarsened, thus impairing toughness. Therefore, in the present invention, the temperature in the furnace is defined to a range of (Ar3 point+50° C.) to 1100° C.

Quenching

[0062] Quenching is carried out by cooling the steel pipe, that has been homogeneously heated in the furnace, at a cooling rate of 5° C./sec or greater to, for example, room temperature. If the cooling rate in this quenching does not reach 5° C./sec, the structure comprising martensite and bainite cannot be obtained, and thereby the required strength cannot be obtained.

Tempering

[0063] The temperature of tempering needs to be 550° C. or higher for realizing sufficient precipitation of Ti, Nb and V carbonitrides in solid-dissolving state during the quenching and thus obtaining high strength. However, if the temperature of tempering exceeds Ac1 point, the strength would be lowered. Therefore, according to the present invention, the temperature of tempering is defined to a range of 550° C. to Ac1 point.

[0064] If requirements described above can be satisfied, the strength unevenness of the seamless steel pipe manufacture by the present invention can be suppressed to a level of yield strength being 9 to 15 MPa and tensile strength being 7 to 14 MPa. Therefore, according to the present invention, even in mass production, high-strength and high-toughness seamless steel pipe for linepipe can be obtained with little unevenness between each steel pipes.

EXAMPLES

[0065] The present invention is further described in details with reference of examples. Each of steels having the compositions shown in Table 1 was melt in a 150t converter, and was cast by a continuous casting machine to make a billet, and then the billet was formed into a raw hollow pipe by a skew-roll piercing mill. The raw hollow pipe was subjected to hot-rolling and thermal process under the conditions shown in Table 2 using Mammesman mandrel mill and a sizer to obtain each 10 pieces of all seamless steel pipes with an outer diameter of 323.9 mm and a wall thickness of 15.88 mm.

[0066] JIS 12 tensile test pieces and JIS 4 Charpy impact test pieces were taken from these steel pipes to determine yield strength, tensile strength, fracture appearance transition temperature (hereinafter refer to vTrs) and the unevenness thereof. The results of the determination are shown in Table 2.

[0067] The seamless steel pipe obtained according to the present invention (Test pieces marked with 1 to 22) in table 2 showed the yield strength of 400 MPa or higher and vTrs −50° C. or lower, and simultaneously the unevenness of the yield strength is suppressed to not greater than 15 MPa and the unevenness of tensile strength is suppressed to not greater than 14 MPa.

[0068] Compared with the steel pipes obtained according to the present invention, comparative examples (Test pieces marked with 23 to 36) showed lower strength, higher vTrs, and simultaneously greater unevenness of yield strength as from 9 to 33 MPa and the greater unevenness of tensile strength as from 7 to 34.

[0069] Consequently, the strength unevenness between the seamless steel pipes obtained according to the manufacturing method of the present invention was suppressed significantly.

EFFECTS OF PRESENT INVENTION

[0070] According to the present invention, high-strength and high-toughness seamless steel pipe with little strength unevenness can be manufactured. Thus seamless steel pipes can be subjected to welding operation and extremely effectively employed for linepipes in cold areas.

TABLE 1

	Steel	Chemical Composition (weight %)												Transformation Point (° C.)	
	Marks	C	Si	Mn	P	S	Ti	Nb	V	Al	N	Others	Ceq	Al	A3
The present invention	A	0.06	0.21	1.23	0.012	0.003	0.025	—	0.02	0.030	0.0042	—	0.269	724	861
	B	0.06	0.18	1.10	0.011	0.002	—	0.006	0.03	0.027	0.0038	—	0.249	726	862
	C	0.05	0.22	1.30	0.012	0.003	—	—	0.04	0.029	0.0032	Cu: 0.25, Ni: 0.22	0.306	717	852
	D	0.06	0.21	1.29	0.011	0.002	—	—	0.04	0.027	0.0037	Cr: 0.19, Mo: 0.09	0.339	725	854
	E	0.05	0.19	1.30	0.010	0.001	—	—	0.03	0.031	0.0035	Cu: 0.27, Ni: 0.20, Ca: 0.0030	0.304	716	850
	F	0.10	0.25	1.44	0.014	0.004	—	—	0.05	0.021	0.0037	Cr: 0.27 Mo: 0.10	0.424	722	843
	A	0.12	0.19	1.45	0.010	0.002	—	—	0.08	0.031	0.0026	Cr: 0.25 Mo: 0.12	0.452	719	833

[0071]

TABLE 2

(Number marked with underline goes beyond scope of present invention)

	Test piece Mark	Steel Marks	Finish Rolling ° C.	Temp. before Furnace ° C.	Temp. in Furnace ° C.	Cooling Rate	Tempering Temp. ° C.	Yield Strength MPa Max	Min	Average	Dev.
The Present Invention	1	A	980	930	950	40	600	449	464	455.0	15
	2	A	980	930	970	40	600	456	470	463.5	14
	3	A	980	930	970	40	700	447	461	456.2	14
	4	A	1000	940	960	40	600	456	467	462.5	11
	5	A	1000	940	980	40	600	462	471	466.9	9
	6	A	1000	940	980	40	700	457	469	463.9	12
	7	B	980	930	970	40	600	447	460	453.9	13
	8	B	980	930	970	40	700	444	452	448.6	8
	9	C	980	930	950	40	600	467	481	476.2	14
	10	C	980	930	970	40	600	476	491	482.0	15
	11	C	980	930	970	40	700	472	484	478.9	12
	12	C	1000	940	950	40	600	478	489	484.5	11
	13	C	1000	940	980	40	600	485	499	482.5	14
	14	C	1000	940	980	40	700	481	490	485.8	9
	15	D	980	930	970	40	600	491	504	497.6	13
	16	D	980	930	970	40	700	489	499	492.7	10
	17	E	980	930	970	40	600	480	492	485.6	12
	18	E	980	930	970	40	700	476	487	482.3	11
	19	F	980	930	970	40	600	494	509	502.2	15
	20	F	980	930	970	40	700	488	501	495.6	13
	21	G	980	930	970	40	600	528	543	535.1	15
	22	G	980	930	970	40	700	521	535	529.0	14

TABLE 2-continued

(Number marked with underline goes beyond scope of present invention)

Comparative Examples	23	A	930	900	950	40	600	436	469	452.4	33
	24	A	980	800	970	40	600	386	400	393.5	14
	25	A	980	930	850	40	600	430	457	446.5	27
	26	A	980	930	1150	40	600	499	511	505.6	12
	27	A	980	930	980	1	600	350	360	355.0	10
	28	A	980	930	980	40	500	434	466	440.0	12
	29	A	980	930	980	40	750	423	436	430.0	13
	30	C	930	900	950	40	600	459	489	474.3	30
	31	C	980	800	970	40	600	408	423	415.6	15
	32	C	980	930	850	40	600	452	477	467.9	25
	33	C	980	930	1150	40	600	521	535	527.8	14
	34	C	980	930	980	1	600	392	401	396.9	9
	35	C	980	930	980	40	500	453	466	461.5	13
	36	C	980	930	980	40	750	445	457	451.9	12

	Test piece	Tensile Strength MPa				Fracture appearance Transition temp.° C.			
	Mark	Max	Min	Average	Dev.	Max	Min	Average	Dev
The Present Invension	1	550	564	555.2	14	−64	−56	−59.5	8
	2	558	571	565.5	13	−59	−50	−54.5	9
	3	548	559	556.6	11	−60	−53	−56.5	7
	4	558	567	564.3	9	−57	−51	−54.4	6
	5	565	573	569.7	8	−56	−50	−52.7	6
	6	559	570	566.0	11	−59	−52	−55.2	7
	7	553	564	558.2	11	−61	−52	−55.8	9
	8	546	555	550.3	9	−60	−53	−56.2	7
	9	562	574	571.0	12	−65	−58	−61.5	7
	10	573	587	577.9	14	−68	−60	−63.5	8
	11	568	578	574.2	10	68	−61	−64.2	7
	12	577	584	580.9	7	−65	−59	−62.4	6
	13	584	596	590.5	12	−65	−56	−60.5	9
	14	578	586	582.5	8	−64	−58	−61.0	6
	15	598	610	606.2	12	−68	−59	−63.8	9
	16	594	605	600.9	11	71	−64	−66.0	7
	17	576	586	583.5	10	−65	−56	−60.5	9
	18	574	582	578.7	8	−68	−60	−64.3	8
	19	626	640	632.9	14	−60	−51	−55.3	9
	20	616	629	622.7	13	−64	−54	−57.4	10
	21	678	691	684.7	13	−52	−44	−48.9	8
	22	669	683	677.8	14	−55	−45	−50.6	10
Comparative Examples	23	535	569	552.0	34	−68	−52	−58.8	16
	24	472	485	480.1	13	−75	−66	−70.5	9
	25	527	554	544.8	27	−67	−53	−59.1	14
	26	610	621	616.9	11	−36	−28	−32.3	8
	27	429	436	433.2	7	−82	−76	−78.7	6
	28	531	544	536.9	13	−56	−49	−51.8	7
	29	518	529	524.7	11	−68	−60	−63.3	8
	30	553	582	568.7	29	−70	−57	−62.8	13
	31	493	505	498.3	12	−83	−73	−78.4	10
	32	544	571	561.0	27	−75	−60	−66.2	15
	33	628	639	632.9	11	35	−25	−32.0	10
	34	471	478	475.9	7	−85	−79	−81.7	6
	35	547	556	553.4	9	−50	−42	−46.5	8
	36	535	546	541.8	11	−74	−67	−70.2	7

1. A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe comprising the steps of:

(1) hot piercing a billet, in which the carbon equivalent value Ceq defined by expression (a):

$$Ceq=C+Mn/6+(Cu+Ni)/5+(Cr+Mo+V)/5[\%] \quad (a)$$

is not greater than 0.60 wt %, and then subjecting the pierced billet to hot rolling at a temperature of 950° C. or higher to obtain a seamless steel pipe;

(2) putting the seamless steel pipe immediately, without cooling to Ar3 point or lower, into a furnace kept at Ar3 point+50° C. to 1100° C. to carry out heating;

(3) cooling the seamless steel pipe at a cooling rate of 5° C./sec or higher; and

(4) tempering the seamless steel pipe at temperature of 550° C. to Ac1 point.

2. A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe according to claim 1, wherein the billet comprises, by weight percent, 0.02 to 0.15% of C, not greater than 1.0% of Si, 0.3 to 2.5% of Mn, not greater than 0.015% of P, not greater than 0.010% of S, 0 to 0.10% of Ti, 0 to 0.05% of Nb, 0.01 to 0.10% of V and not great than 0.006% of N.

3. A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe according to claim 1, wherein the billet comprises, by weigh percent, one or more of elements selected from not greater than 1.0% of Cr, not greater than 1.0% of Mo, not greater than 1.0% of Cu, not greater than 1.0% of Ni, not greater than 0.003% of B and not greater than 0.005% of Ca.

4. A manufacturing method of high-strength, high-toughness seamless steel pipe for linepipe according to claim 2, wherein the billet comprises, by weigh percent, one or more of elements selected from not greater than 1.0% of Cr, not greater than 1.0% of Mo, not greater than 1.0% of Cu, not greater than 1.0% of Ni, not greater than 0.003% of B and not greater than 0.005% of Ca.

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