US 20250257421A1

(19) United States
(12) Patent Application Publication
JEONG
(10) Pub. No.: US 2025/0257421 A1
(43) Pub. Date: Aug. 14, 2025

(54) **DIFFERENTIAL HEAT TREATMENT METHOD FOR FORMING ROLLER**

(71) Applicant: **Sang Seok JEONG**, Dasan-myeon (KR)

(72) Inventor: **Sang Seok JEONG**, Dasan-myeon (KR)

(21) Appl. No.: **18/881,621**

(22) PCT Filed: **Jun. 7, 2023**

(86) PCT No.: **PCT/KR2023/007757**

§ 371 (c)(1),
(2) Date: **Jan. 6, 2025**

(30) **Foreign Application Priority Data**

Jul. 7, 2022 (KR) 10-2022-0083886

Publication Classification

(51) **Int. Cl.**
C21D 9/38 (2006.01)
C21D 1/18 (2006.01)

(52) **U.S. Cl.**
CPC *C21D 9/38* (2013.01); *C21D 1/18* (2013.01)

(57) **ABSTRACT**

The present disclosure includes a differential heat treatment method for a forming roller including an outer circumferential surface heat treatment step for heating the outer circumferential surfaces of roller units. The method may additionally include a first natural cooling step for naturally cooling until the surface temperature reaches 100-150° C., an inner circumferential surface heat treatment step for heating the inner circumferential surfaces of the roller units. The method may additionally include a second cooling step for naturally cooling until the roller units reach a room temperature state after the inner circumferential heat treatment. Further, the method may include an inspection and release step for inspecting the hardness of the outer circumferential surface and the inner circumferential surface after the second cooling and releasing when the hardness is within an error range.

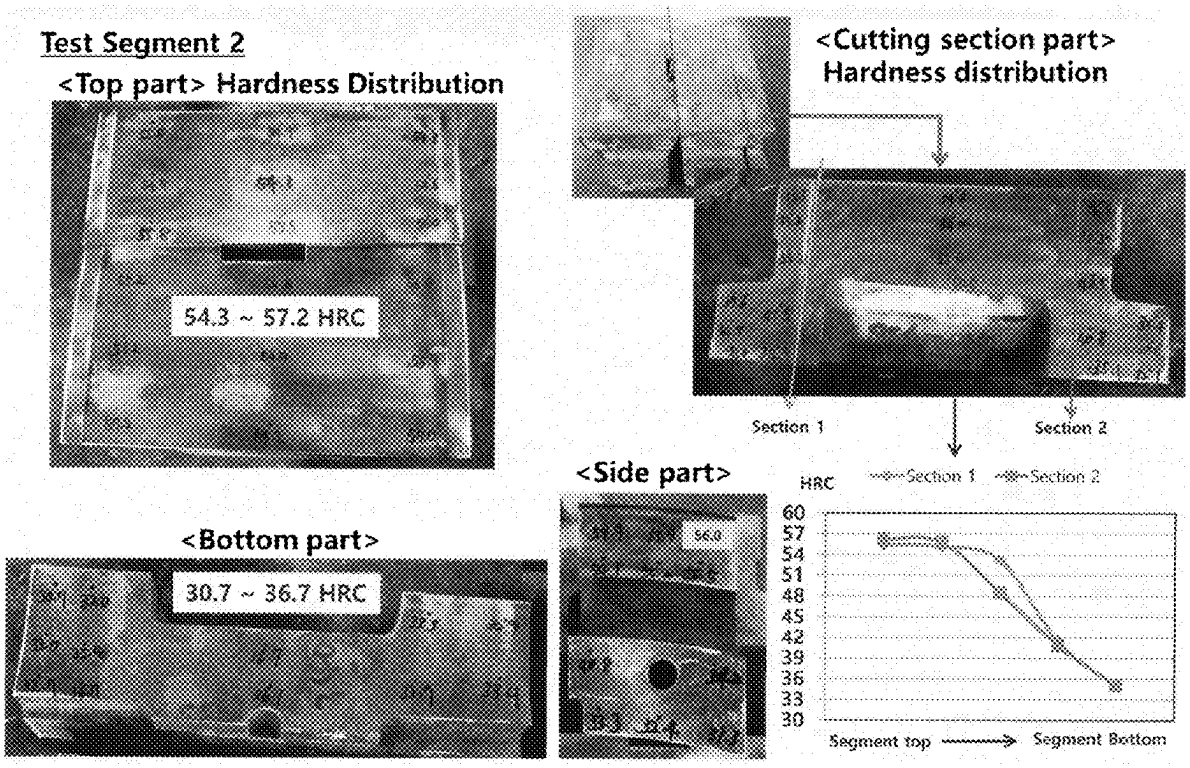


FIG. 1

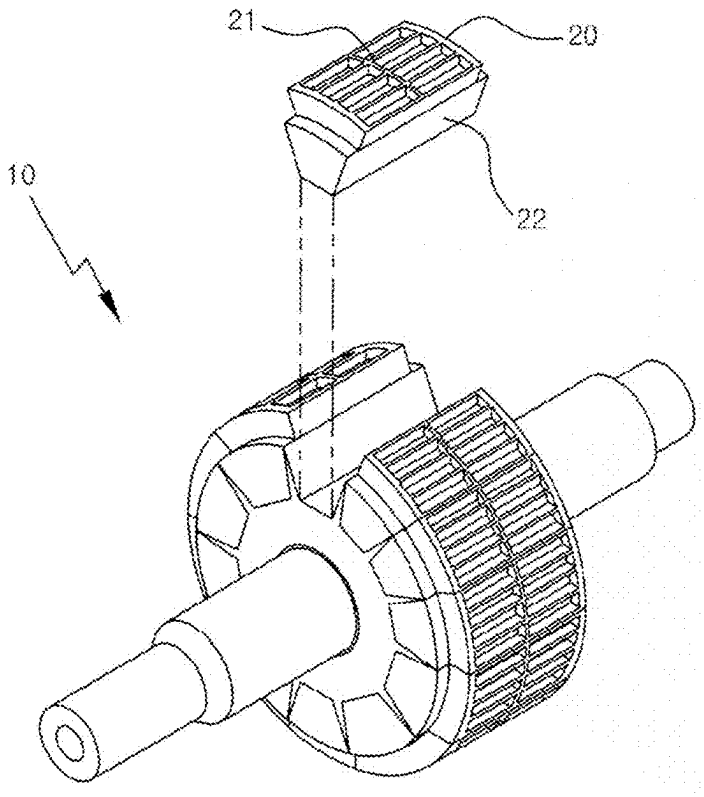


FIG. 2

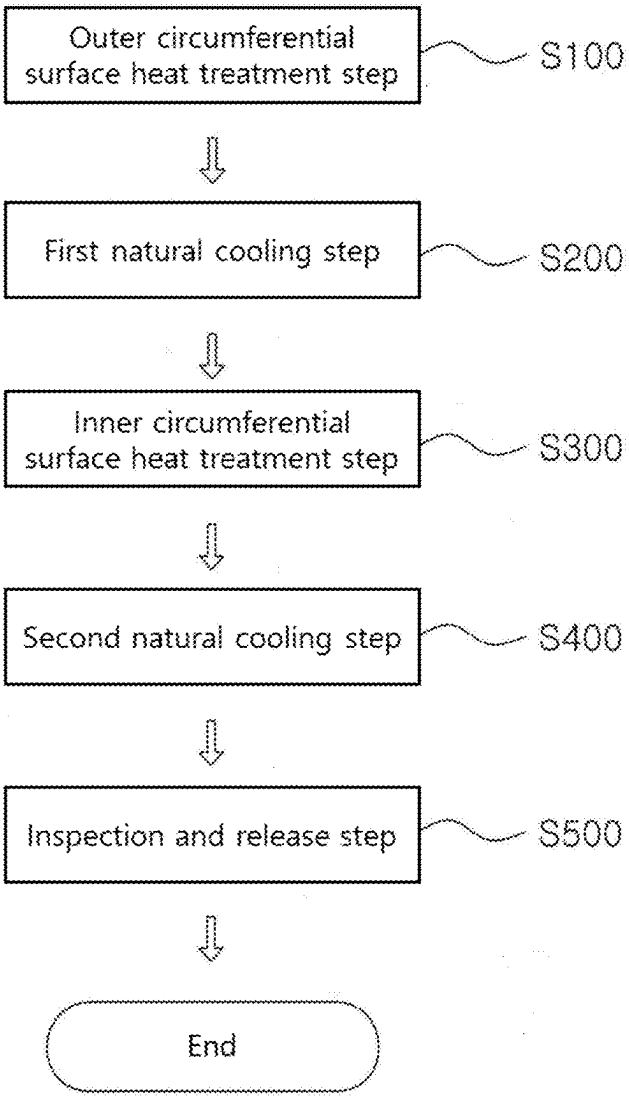

Outer circumferential surface heat treatment step
S100
First natural cooling step
S200
Inner circumferential surface heat treatment step
S300
Second natural cooling step
S400
Inspection and release step
S500
End

FIG. 3

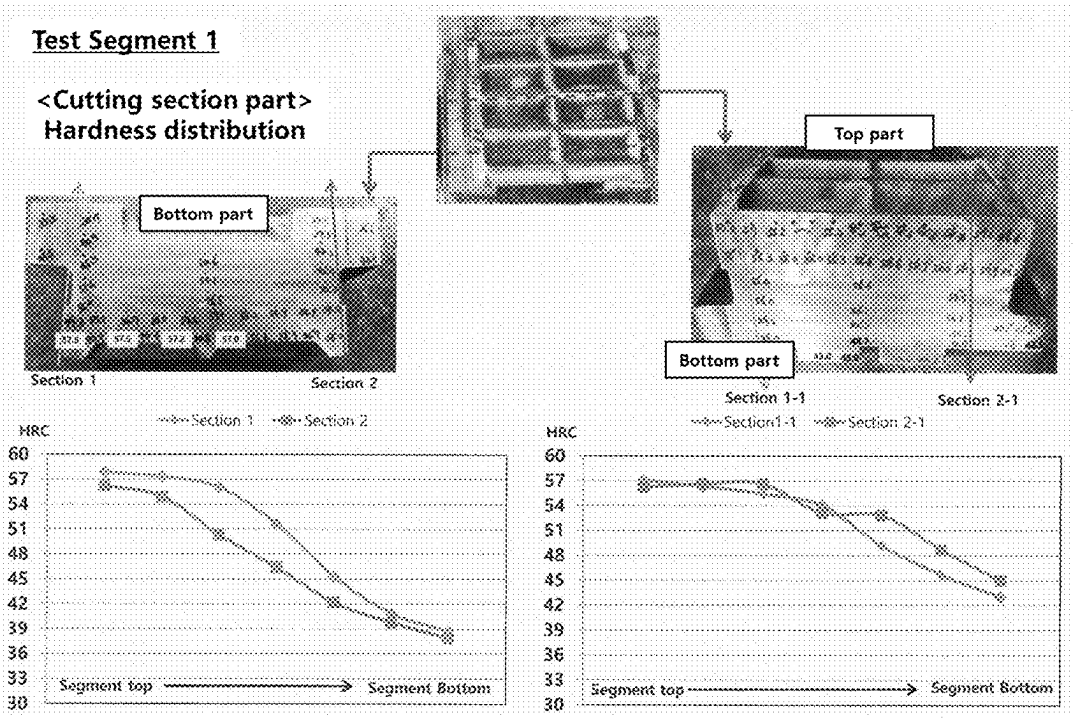

Test Segment 1
<Cutting section part>
Hardness distribution
Bottom part
Section 1
Section 2
Top part
Bottom part
Section 1-1
Section 2-1
Section 1
Section 2
Section1-1
Section 2-1
HRC
60
57
54
51
48
45
42
39
36
33
30
Segment top
Segment Bottom

FIG. 4

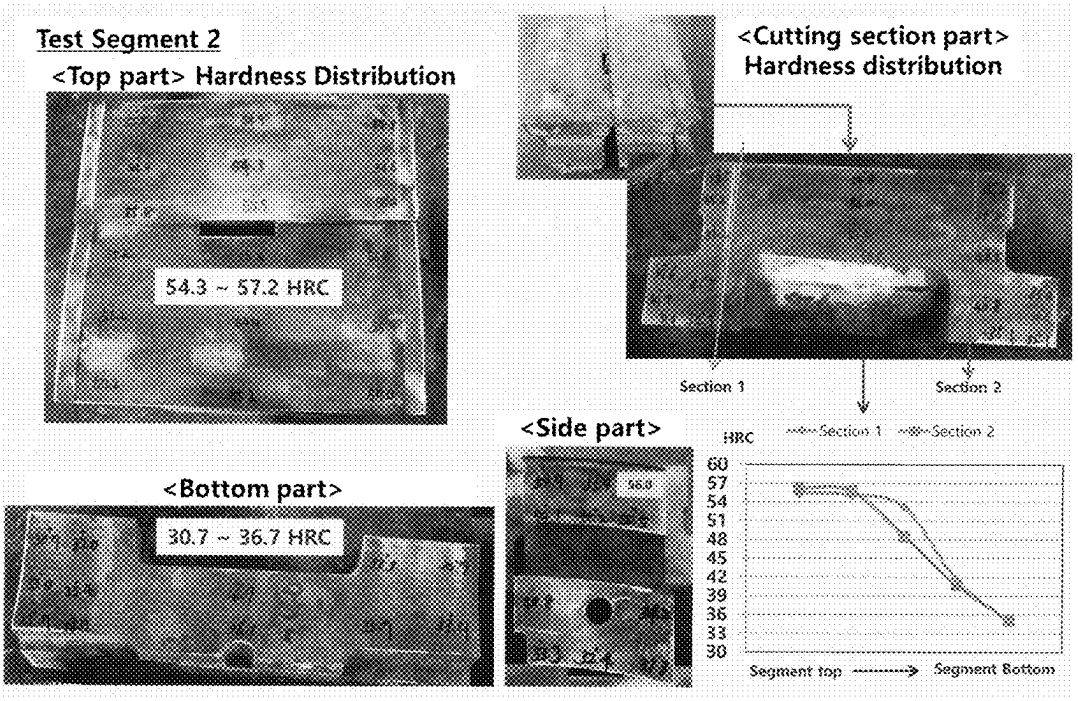

Test Segment 2
<Top part> Hardness Distribution
54.3 ~ 57.2 HRC
<Cutting section part>
Hardness distribution
Section 1
Section 2
<Side part>
<Bottom part>
30.7 ~ 36.7 HRC
HRC
Section 1
Section 2
60
57
54
51
48
45
42
39
36
33
30
Segment top
Segment Bottom

FIG. 5

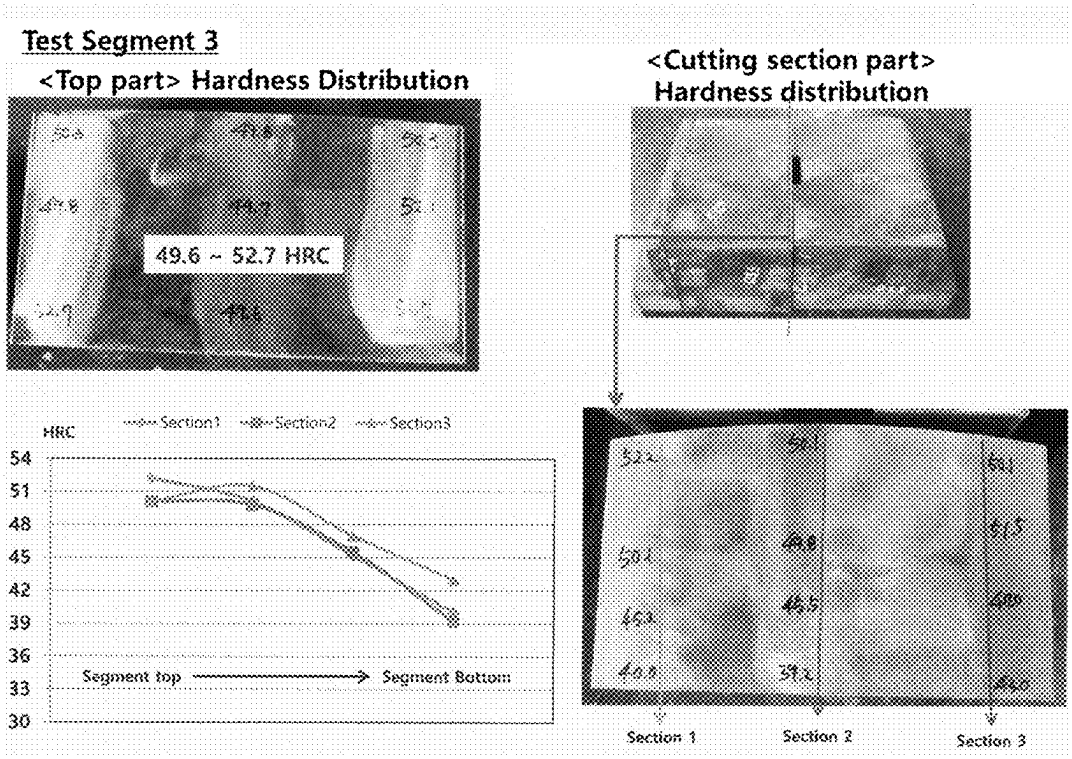

Test Segment 3
<Top part> Hardness Distribution
49.6 ~ 52.7 HRC
<Cutting section part>
Hardness distribution
HRC
Section1
Section2
Section3
54
51
48
45
42
39
36
33
30
Segment top
Segment Bottom
Section 1
Section 2
Section 3

FIG. 6

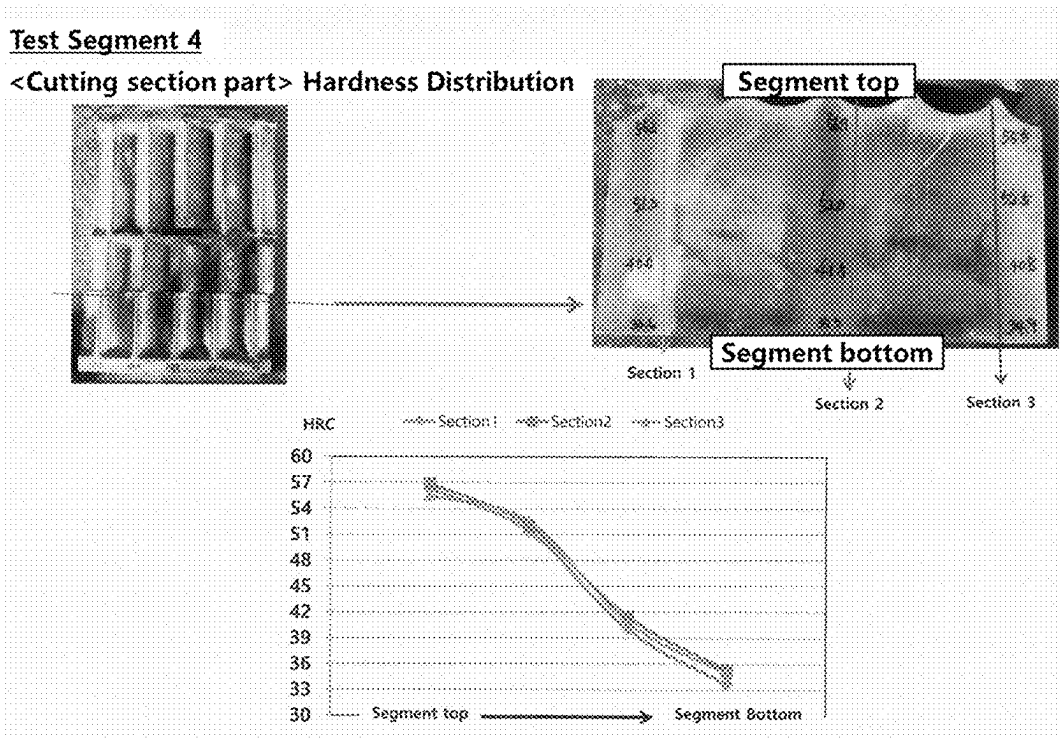
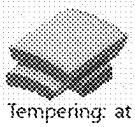

Test Segment 4
<Cutting section part> Hardness Distribution
Segment top
Segment bottom
Section 1
Section 2
Section 3
HRC
Section1
Section2
Section3
60
57
54
51
48
45
42
39
36
33
30
Segment top
Segment Bottom

FIG. 7

Summary table of mechanical property values of surface hardening heat treatment test

Classification		Test segment type			
		Test Segment 1 320L x 260W x 156T	Test Segment 2 320L x 260W x 156T	Test Segment 3 400L x 240W x 143T	Test Segment 4 400L x 240W x 143T
		 Tempering: at 580 ℃	 Tempering: at 580 ℃	 Tempering: at 580 ℃	 Tempering: at 200 ℃
Hardness (HRC)	Surface hardness distribution	57.5~59.4HRC	54.3 ~ 57.2 HRC	49.6 ~ 52.1HRC	58.2 ~ 60.2HRC
	Differential hardness distribution (Top→ bottom)	59.2 → 39.6 HRC	56.3 → 31.0 HRC	52.2 → 39.2 HRC	58.2 → 35.6 HRC
Impact toughness (J/cm2)	Surface portion	-	20.9 21.1	7.4 9.9	4.7 6.9
	Center portion	-	11.9 13.1	7.2 8.2	9.7 8.1
	Bottom portion	-	11.6 10.0	7.3 7.3	7.4 9.7

DIFFERENTIAL HEAT TREATMENT METHOD FOR FORMING ROLLER

TECHNICAL FIELD

[0001] The present invention relates to a differential heat treatment method for a forming roller, and more particularly, to a differential heat treatment method for a forming roller, capable of extending a lifespan of the forming roller while improving productivity by performing a differential heat treatment on an inner circumferential surface of the forming roller that has the inner circumferential surface requiring moderate strength and durability and an outer circumferential surface requiring high strength.

BACKGROUND ART

[0002] In general, two forming rollers are combined into one set so as to be engaged with each other to rotate, and a desired forming product is manufactured in a rotation process.

[0003] The forming rollers are used in sites requiring high strength, such as a formed coal rapid freezing manufacturing device that compresses raw coal for manufacture and a steel waste briquetting device that forms a recycled formed body to recycle steel waste such as steel slag, sludge, and oxide scale generated from industrial sites such as steel companies, or in a pill manufacturing device that forms pills or foods having a spherical shape and a die-cutting device that cuts a sheet-type material such as paper, fiber, a resin film, a metal sheet, a PCB, an FPCB, and an optical film.

[0004] In particular, as shown in FIG. **1**, a forming roller **10** used in an industrial site that requires high strength may have a structure in which a plurality of roller units **20** are coupled to an outer circumferential surface of a shaft **30** around the shaft **30**, and although a shape of the forming roller **10** varies depending on the purpose of use, rigidity and durability that the forming roller **10** has to have may be the same.

[0005] In other words, since the forming roller **10** used in the industrial site that requires high strength has an outer circumferential surface requiring strength that is greater than or equal to a predetermined level, the forming roller **10** is subjected to a heat treatment at a high temperature.

[0006] Strength of an inner circumferential surface as well as the strength of the outer circumferential surface may be increased according to the heat treatment. However, when the strength of the inner circumferential surface is increased, a component (e.g., a shaft) that rotates while making surface contact may be abraded (worn away).

[0007] In order to solve such a problem, there may be a method of manufacturing the roller unit **20** of the forming roller by dividing the roller unit **20** into two portions, which are an outer circumferential surface portion and an inner circumferential surface portion. However, in this case, a manufacturing cost may rise rapidly.

[0008] Therefore, a forming roller required in the art may be a product in which strength of an outer circumferential surface has to be greater than or equal to a predetermined level, and strength of an inner circumferential surface has a significant difference with the strength of the outer circumferential surface in consideration of durability of a component that rotates while making surface contact.

DISCLOSURE

Technical Problem

[0009] Accordingly, the present invention has been devised to recognize the problems described above and propose a solution thereto, and an object of the present invention is to provide a differential heat treatment method for a forming roller, capable of extending a lifespan of the forming roller while improving productivity due to the extended lifespan by performing a differential heat treatment on inner and outer circumferential surfaces to obtain a forming roller in which an inner circumferential surface of a roller unit requires moderate strength and durability according to a component interworking therewith, and an outer circumferential surface of the roller unit requires high strength.

Technical Solution

[0010] To achieve the object described above, according to the present invention, there is provided a differential heat treatment method for a forming roller, the differential heat treatment method including: an outer circumferential surface heat treatment step (S**100**) of heating an outer circumferential surface (**21**) of a roller unit (**20**) constituting a forming roller (**10**) such that a heat treatment is performed under a condition of a temperature of 1150 to 1200° C. for 25 to 35 minutes; a first natural cooling step (S**200**) of performing, after the outer circumferential surface heat treatment, natural cooling until a surface temperature reaches 100 to 150° C.; an inner circumferential surface heat treatment step (S**300**) of heating, after the natural cooling, an inner circumferential surface (**22**) of the roller unit (**20**) such that a heat treatment is performed under a condition of a temperature of 680 to 730° C. for 35 to 45 minutes; a second cooling step (S**400**) of performing, after the inner circumferential surface heat treatment, natural cooling until the roller unit reaches a room temperature state; and an inspection and release step (S**500**) of inspecting, after the second cooling, hardness of the outer circumferential surface and the inner circumferential surface to perform release when the hardness is within an error range.

[0011] In this case, a material of the roller unit (**20**) may be one selected from high-speed tool steel, alloy tool steel, and special-purpose steel.

[0012] In addition, a heat source in the heating process may be one selected from gas or electricity.

Advantageous Effects

[0013] According to a differential heat treatment method for a forming roller of the present invention, which has characteristics described above, a heat treatment may be performed such that outer and inner circumferential surfaces of a roller unit constituting the forming roller have a significant difference in hardness, so that a lifespan of the forming roller can be extended, and productivity can be improved due to the extended lifespan.

DESCRIPTION OF DRAWINGS

[0014] FIG. **1** is a perspective view showing a conventional forming roller.

[0015] FIG. **2** is a block diagram showing an exemplary heat treatment process according to the present invention.

[0016] FIGS. **3** to **6** are hardness result tables obtained by inspecting hardness of a sample roller unit.

[0017] FIG. **7** is a result summary table summarizing results of FIGS. **3** to **6**.

BEST MODE

[0018] Hereinafter, a differential heat treatment method for a forming roller according to an exemplary embodiment of the present invention will be described with reference to the accompanying drawings.

[0019] First, as shown in FIG. **2**, in the differential heat treatment method for the forming roller according to the present invention, an outer circumferential surface **21** of a roller unit **20** constituting a forming roller **10** may be heated such that a heat treatment is performed under a condition of a temperature of 1150 to 1200° C. for 25 to 35 minutes (S**100**).

[0020] After the outer circumferential surface heat treatment, first natural cooling may be performed until a surface temperature reaches 100 to 150° C. (S**200**), and, after the natural cooling, an inner circumferential surface **22** of the roller unit **20** may be heated such that a heat treatment is performed under a condition of a temperature of 680 to 730° C. for 35 to 45 minutes (S**300**).

[0021] After the inner circumferential surface heat treatment, second natural cooling may be performed until the roller unit reaches a room temperature state (S**400**), and, after the second cooling, hardness of the outer circumferential surface and the inner circumferential surface may be inspected to perform release when the hardness is within an error range (S**500**), thereby completing a heat treatment process.

[0022] In this case, the heating may be performed to perform the heat treatments on the outer circumferential surface and the inner circumferential surface, respectively, by using gas as a heat source after insertion into a heating furnace or using electricity as a heat source.

[0023] As shown in FIGS. **3** to **6** and **7**, when the heat treatment is performed as described above, the hardness of the outer circumferential surface may be 52 to 60 HRC, and the hardness of the inner circumferential surface may be 31 to 39 HRC, so that the hardness may have a significant difference. Due to the difference, abrasion of the outer circumferential surface may be delayed, which may extend a lifespan and improve productivity, and wearing-away of the inner circumferential surface upon friction with a component that rotates while making surface contact may be reduced, which may improve durability.

[0024] In addition, a material of the roller unit **20** may be one selected from high-speed tool steel, alloy tool steel, and special-purpose steel.

[0025] The high-speed tool steel may be a steel material to which a relatively large amount of an alloy element such as tungsten, molybdenum, cobalt, chromium, and vanadium is added in combination, and may be mainly used for a cutting tool. Since the high-speed tool steel excellently withstands frictional heat generated during high-speed cutting and has high hardness at a high temperature so as to enable high-speed cutting, the high-speed tool steel may be referred to as high-speed steel (HSS), and a type of the high-speed tool steel may include tungsten-based steel (SKH2, SKH3, SKH4, and SKH10), molybdenum-based steel (SKH50 to SKH59), and powder metallurgy molybdenum-based steel (SKH40).

[0026] Symbols of the alloy tool steel have been standardized and used as STD/STS in KS and SKD/SKS in JIS, a material called STD11 may refer to alloy tool steel for a cold die, and the alloy tool steel may be classified into alloy tool steel for a cutting tool, impact-resisting tool steel, a cold die, and a hot die in the KS standard.

[0027] The special-purpose steel may be steel for special purposes, which is a steel material for special purposes, and may have a type such as tool steel, hollow drill steel, bearing steel, stainless steel, heat-resisting steel, superalloy, spring steel, free-cutting steel, and clad steel in KS.

[0028] Although the embodiments of the present invention have been described above, various modifications and changes can be made to the present invention by a person having ordinary skill in the art through supplement, change, removal, addition, and the like of components within the scope that does not depart from the idea of the present invention described in the appended claims, and such modifications and changes will also fall within the scope of the present invention.

1. A differential heat treatment method for a forming roller, the differential heat treatment method comprising:

an outer circumferential surface heat treatment step (S**100**) of heating an outer circumferential surface of a roller unit constituting a forming roller such that a heat treatment is performed under a condition of a temperature of 1150 to 1200° C. for 25 to 35 minutes;

a first natural cooling step (S**200**) of performing, after the outer circumferential surface heat treatment, natural cooling until a surface temperature reaches 100 to 150° C.;

an inner circumferential surface heat treatment step (S**300**) of heating, after the natural cooling, an inner circumferential surface of the roller unit such that a heat treatment is performed under a condition of a temperature of 680 to 730° C. for 35 to 45 minutes;

a second cooling step (S**400**) of performing, after the inner circumferential surface heat treatment, natural cooling until the roller unit reaches a room temperature state; and

an inspection and release step (S**500**) of inspecting, after the second cooling, hardness of the outer circumferential surface and the inner circumferential surface to perform release when the hardness is within an error range.

2. The differential heat treatment method of claim **1**, wherein a material of the roller unit is one selected from high-speed tool steel, alloy tool steel, and special-purpose steel.

3. The differential heat treatment method of claim **1**, wherein a heat source in the heating process is one selected from gas or electricity.

* * * * *