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PROCESS FOR PRODUCING NONAGEING SUPER DEEP-DRAWING STEEL SHEETS

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1 Claim. (Cl. 148—2)

This invention relates to processes for producing nonageing super deep-drawing steel sheets to be cold-press-shaped.

For the above mentioned purpose, there has been mostly used an aluminum killed steel. When aluminum killed steel is hot-rolled and thereafter cooled down as quickly as possible, then cold-rolled and then annealed for recrystallization, aluminum nitride will thereby be precipitated from solution and in consequence a peculiar elongated crystal grain will be formed. This is generally recognized to the cause for the aluminum killed steel to have a higher deep-drawability than of a rimmed steel. Further, as the nitrogen contained in the steel is fixed as aluminum nitride as described above, the steel is nonageing.

However, as there is no rimming action in casting the aluminum killed steel, it is necessary to extend the refining time, in order to reduce the carbon content to be as low as in the rimmed deep drawing steel sheet. Moreover, due to the shrinkage pipe produced at the upper portion of the ingot, the yield of such aluminum killed steel is low and its cost is higher than of the rimmed steel.

Further, there is a defect that the surface properties of the killed steel are inferior to those of the rimmed steel, because comparatively many nonmetallic inclusions reside in the surface layer of the former.

On the other hand, a nonageing steel sheet can be obtained by stabilizing the nitrogen in the steel by adding vanadium and/or boron. However, as vanadium and boron have no strong deoxidating action, the steel to which such elements have been added is a rimmed steel. Therefore, such steel sheet is superior to the aluminum killed steel in the surface properties but is substantially the same as or rather inferior to the latter in deep-drawability.

Generally, in order to improve the press-formability of a steel sheet, it is desirable to reduce the carbon content in the steel as low as possible. Usually it is made less than 0.08%. The other accompanying elements are also kept as low as possible. However, if the carbon content in the steel is made low in the refining process, the oxygen content will increase with it, the cleanliness of the steel will be reduced and the workability of the steel sheet will be thereby rather reduced. Therefore, it is not practical in general to reduce the carbon content to less than about 0.03% in the melting and casting process.

An object of the present invention is to provide at a low cost and a high yield a steel sheet which is nonageing and whose surface properties and deep drawability are higher than of a steel sheet made of a conventional aluminum killed steel.

Such object of the present invention is attained by tapping a molten steel composed of less than about 0.10% C, about 0.20% to 0.80% Mn, less than about 0.03% P, less than about 0.03% S, less than about 0.20% Cu and the rest being Fe and unavoidable impurities in a steel making process, pouring into a mold the said molten steel after subjecting it to a vacuum degassing or casting it in a vacuum or an inert gas atmosphere so as to extremely reduce the oxygen content in the steel, making a cold-rolled steel sheet from the said steel by the conventional method and then annealing the said steel sheet

for the recrystallization while decarburizing and denitriding it in an atmosphere containing wet hydrogen so that the carbon content in the steel may be less than about 0.01% and the nitrogen content therein may be less than about 0.001%.

In the thus obtained steel sheet, the oxygen content is so low that impurities of oxides in the steel are very low. The carbon content is less than 0.01% and the nitrogen content is less than 0.001%. Thus, the steel sheet of the present invention is substantially nonageing and is so soft that its press-formability and surface properties are higher than those of the conventional aluminum killed steel. Moreover, its yield is also very high.

In the process of the present invention, the starting composition of the steel is substantially the same as that of an ordinary deep drawing rimmed steel but the steel is decarburized and denitrided so positively in the annealing process as to be remarkably softened. Consequently, the manganese content in the steel sheet of the present invention can be made higher than in the ordinary deep drawing steel and is allowed to be up to about 0.80%.

This is the more advantageous, because this manganese can be utilized to reduce the oxygen content in the steel and to eliminate the bad influence of sulphur which is comparatively magnitudinous in the concentrated segregated part in the head part of the steel ingot.

The present invention shall be explained with reference to an example.

Example

A molten steel refined in an open-hearth furnace having ladle analysis of 0.07% C, 0.32% Mn, 0.01% Si, 0.016% P and 0.018% S was successively sucked up into a vacuum container, was vacuum-degassed therein and was cast, slabbed, hot-rolled and cold-rolled. The steel was then annealed to be decarburized and denitrided by using an open-coil type annealing furnace. The chemical analysis of the thus obtained deep drawing steel sheet was as follows:

0.003% C, 0.008% Si, 0.32% Mn, 0.014% P, 0.015% S, 0.073% Cu, 0.030% Ni, 0.016% Cr, 0.020% As, 0.001% V,
0.002% Mo, 0.005% W, 0.000% Co, 0.010% Sn, 0.002% Ti,
0.005% O_2, 0.002% soluble Al,
0.001% insoluble Al,
0.0004% total N_2.

After the skin pass of a reduction ratio of 0.5%, the mechanical properties of the product were as follows:

Thickness	1.0 mm.
Yield strength	11.5 kg./mm.^{2}.
Tensile strength	28.1 kg./mm.^{2}.
Total elongation	53.6% in 50 mm. gage length.
Erichsen value	12.2 mm.
Conical cup value	44.12 mm.
Hardness HRB	34.5 Rockwell B scale.
Grain size (A.S.T.M.)	No. 7.6.

In the ordinary refining process, when the C content was as little as this, the O_2 content was inevitably more than 0.1%. Even when the steel was tapped with the composition of an ordinary rimmed low carbon steel, about 0.05% O_2 was contained therein. But the O_2 content was reduced to 0.005% by the vacuum-degassing treatment. According to the A.S.T.M. pointing counting method, the nonmetallic inclusions in the steel sheet produced by the present invention were shown as d=0.05 to 0.10% as compared with an ordinary cold-rolled steel sheet, the nonmetallic inclusions of which are normally shown as d=0.2 to 0.41%, that is, being reduced down to only a quarter of those in an ordinary steel sheet.

Moreover, the size of inclusion became very small and distribution was uniformly dispersed.

Due to the decarburization annealing, the C content was reduced from 0.07% to 0.003%. As regards the N_2 content it was reduced to 0.0004% as the result of denitrification by wet hydrogen, which means a very low N_2 content, because even a rimmed steel containing less than 0.10% C produced in an ordinary pure oxygen top blowing converter contains N_2 normally still in the order of 0.0017%. That is, the N_2 content was also reduced to less than a quarter by denitrification in the process of annealing. Thus, nonageing sufficient for practical use was obtained.

What we claim is:

A process for producing a non-ageing deep-drawable steel sheet which comprises vacuum-degassing a molten rimmed steel consisting essentially of about 0.04 to 0.10% C, about 0.20 to 0.80% Mn, about 0.04 to 0.10% O and Fe whereby the oxygen content of the steel is reduced, casting, slabbing and cold-rolling said vacuum-degassed rimmed steel, and then decarburizing annealing said cold-rolled steel thereby producing a steel containing less than 0.01% C, less than 0.01% O, and less than 0.001% N.

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