United States Patent Office

3,436,209
Patented Apr. 1, 1969

3,436,209

PRODUCTION OF RIMMED STEELS

Matthew Stanley Lojas, Harvey, Ill., assignor, by mesne assignments, to Metallurgical Exoproducts Corporation, McKees Rocks, Pa., a corporation of New Hampshire

No Drawing. Filed Oct. 31, 1966, Ser. No. 590,550
Int. Cl. C21c 7/00; B22d 27/18
U.S. Cl. 75—53 2 Claims

ABSTRACT OF THE DISCLOSURE

A rimming agent for addition to molten steel as the steel is teemed into an ingot mold comprising at least 40 percent reactive carbon and preferably 40 to 60 percent reactive carbon, 5 to 20 percent calcium or sodium fluoride, 5 to 20 percent sodium carbonate and 0 to 20 percent aluminum.

This invention relates to the production of rimmed steels and more particularly to a method of producing high quality rimmed steel and a novel rimming agent used therein.

A high quality rimmed steel ingot must have a substantial outside ferritic zone which is known as the "rim" and a minimum of oxide inclusions. The production of rimmed steels of high quality requires the evolution of a large amount of gas, after teeming of the steel into the ingot mold and during solidification of the ingot. It is well known that high quality rimmed steel is extremely difficult to produce if the desired carbon content of the finished steel is significantly different from an optimum level of 0.09 percent to 0.12 percent. This difficulty increases as the height of the ingot mold is increased. If the height of the ingot mold is above about 70 inches, the ferrostatic pressure, i.e. the pressure exerted by the liquid steel due to gravity, inhibits a good rimming action in the bottom portion of the ingot. The diminished rimming action caused by the ferrostatic pressure diminishes the thickness of the outside ferritic zone in the bottom portion of the ingot which in turn creates serious difficulties during rolling operations by exposing a segregated center zone on the surface of the rolled product. In addition, the poor rimming action caused by the high ferrostatic pressure in this zone will result in small blowholes in the junction of the ferritic outside rim and the center core which impairs the quality of the rolled product. If the rim is thin and the blowholes are near the surface or extend to the surface, they will be oxidized. Once oxidized, they will not weld during rolling and a rolled product with numerous seams will result. From the foregoing, it is clear that a good rimming action requires the strong evolution of gases during solidification of the ingot and the production of a strong boiling action in the molds and such rimming action is necessary to produce the surface conditions and ingot structure required for a high quality rolled product.

When steel is ready to be tapped from the furnace, there is a theoretical equilibrium between the carbon and oxygen content of the liquid steel. This equilibrium can be expressed by the following formula in which [C] represents the percent carbon contained in the steel, [O] represents the percent oxygen contained in the steel, and K is a constant for a given temperature:

$$[C][O]=K$$

The value of K depends upon the temperature of the bath. The higher the temperature, the higher the value of K will be and, conversely, the lower the temperature, the lower the value of K. Equilibrium generally is obtained for a steel possessing a carbon content of approximately 0.10 percent. If the carbon content is

significantly different from 0.10 percent, there generally will be no equilibrium present when the furnace is tapped and the ingot teemed. If the carbon content is low, about 0.05 percent, the equilibrium will not be obtainable and there is present in the steel a high oxygen content. Furthermore, this oxygen content will be greatly above the theoretical equilibrium state if the bath temperature in the furnace is increased, and is exaggerated in the new oxygen converters.

I have found that the addition of highly reactive carbon in controlled quantities to the ingot mold during teeming of the liquid steel promotes a vigorous rimming action without adversely affecting the chemical composition, and particularly the carbon content of the finished product. The reactive carbon reacts with the excess oxygen in the liquid steel to form carbon monoxide and carbon dioxide bubbles. The increased gas production during solidification increases the vigor of the rimming action and thereby produces a thicker ferritic zone while eliminating blowholes in the junction zone and the possibility of oxide inclusions.

I prefer to add highly reactive carbon to the steel together with sodium or calcium fluoride, sodium carbonate and aluminum granules. The addition of these compounds with reactive carbon appears to promote the action of the reactive carbon. I have had success with rimming agents having the following composition: Reactive carbon in the form of petroleum coke, 40–60 percent; sodium or calcium fluoride, 5–20 percent; sodium carbonate, 5–20 percent; and aluminum granules, 0–20 percent. The rimming agent should be added progressively during teeming of the steel into the ingot mold. The exact amount of reactive carbon must be carefully controlled, since an excess of the rimming agent will tend to increase the carbon content of the steel and an insufficient amount will materially reduce the effectiveness of the rimming agent. The amount of the rimming agent to be added should be varied according to the carbon content of the steel in the furnace. Generally, the lower the carbon content of the steel in the furnace, the more compound that should be added. In general, the addition will range between 0.5 and 3.0 pounds of rimming agent per ton of steel. The exact amount of rimming agent to be added in specific circumstances can be calculated. In general, the amount of reactive carbon added is determined by the excess oxygen available and should not exceed the amount of carbon which will bring the steel to the equilibrium point.

The following specific examples will illustrate my invention.

Example 1

A steel bath was prepared having a carbon content of 0.05 percent. During teeming of the steel into an ingot mold a rimming agent having a composition of 50 percent carbon, 15 percent calcium fluoride, 20 percent sodium carbonate, and 15 percent aluminum was progressively added to the ingot mold at the rate of approximately two pounds of rimming agent per ton of steel. Excellent rimming action resulted and the finished product was a high quality rimmed steel.

Example 2

A steel bath was prepared having a carbon content of 0.07 percent. During teeming of the steel into an ingot mold a rimming agent having the same composition as that used in Example 1 was added to the ingot mold at the rate of approximately one pound of rimming agent per ton of steel. Again excellent rimming action resulted and the finished product was a high quality rimmed steel.

While I have described the present preferred embodiments of my invention, it may be otherwise embodied within the scope of the appended claims.

I claim:

1. A rimming agent for addition to molten steel as the steel is teemed into an ingot mold consisting of from 40 to 60 percent reactive carbon, 5 to 20 percent of a compound selected from the group consisting of calcium and sodium fluoride, 5 to 20 percent sodium carbonate, and 0 to 20 percent aluminum.

2. A method for the production of rimmed steel comprising progressively adding to liquid steel while teeming the steel into an ingot mold 0.5 to 3.0 pounds per ton of steel of a rimming agent which consists of 40 to 60 percent carbon, 5 to 20 percent of a compound selected from the group consisting of calcium and sodium fluoride, 5 to 20 percent sodium carbonate, and 0 to 20 percent aluminum.

References Cited

UNITED STATES PATENTS

2,760,859	8/1956	Graf	75—53 X
2,854,328	9/1958	Rossborough	75—53
2,854,329	9/1958	Rossborough	75—53
2,915,386	12/1959	Strauss	75—53 X
3,051,564	8/1962	Drenning	75—53
3,078,531	2/1963	Bolkcom et al.	75—53 X
3,079,250	2/1963	Bolkcom et al.	75—53
3,158,466	11/1964	Muller	75—53 X
3,208,117	9/1965	Goedecke et al.	75—53 X
3,216,078	11/1965	Zrimsek et al.	75—53 X
3,219,438	11/1965	Poole	75—53 X
3,269,828	8/1966	Hale	75—53 X
3,318,687	5/1967	Bowden	75—53
2,855,290	10/1958	Freeman	75—33

L. DEWAYNE RUTLEDGE, *Primary Examiner.*

J. E. LEGRU, *Assistant Examiner.*

U.S. Cl. X.R.

164—55, 104