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DESULPHURIZING MOLTEN IRON

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This invention relates to a process for desulfurizing a melt of ferrous base metal or alloy and is especially useful in desulfurizing silicon steel and carbon steel.

Heretofore attempts have been made to effect desulfurization of ferrous base alloys within the furnace where such alloys are melted. Predominantly, these attempts have not been too successful because they have been extremely slow and inflicted damage to the furnace lining, all of which have materially contributed to increasing the cost of melting the alloy. From the standpoint of end results, these prior art processes have been ineffective for reducing the sulfur content in the end product to less than 0.010%. In the open hearth furnace type melting procedure, the sulfur contents are rarely decreased to less than 0.020%. Considerable amount of research has been done to investigate the removal of sulfur from a melt of ferrous base alloy, and considerable effort has been placed on investigating the rate of transfer of sulfur through a metal-slag interface. Through the efforts of this research, various factors have been determined which tend to influence the removal of sulfur from the melt. The present invention is effective for removing sulfur from ferrous base alloys consistently from heat to heat to a very low level. It is also effective for removing sulfur from molten cast iron to levels of less than 0.020%.

An object of this invention is to provide a process for consistently removing sulfur from a melt of ferrous base metal and alloy to a very low level.

Another object of this invention is to provide a process for the manufacture of ferrous base alloys which is not detrimental to the furnace or equipment used therein, and which may be practiced in any conventional steel mill to remove sulfur from a melt of ferrous base metal and alloy to very low levels.

A more specific object of this invention is to provide a process for effectively removing sulfur from ferrous base metal and alloy through controlled pouring rates, temperatures and slag compositions without adversely affecting any of the chemical, physical, or mechanical properties of the various metals.

Other objects of this invention will become apparent when taken in conjunction with the following description and the claims:

In its broader aspects, the process of this invention sequentially contemplates that a melt of ferrous base alloy is made in a furnace under the usual conditions. At the end of the oxidizing period, the metal is removed from the furnace and poured into a ladle containing solid, basic, slag-forming ingredients which, when melted, form a slag having a composition within predetermined limits. The temperature of the metal is thereafter adjusted to a temperature within a range between 2800° F. and 2950° F. The slag is thereafter decanted from the melt and the melt is poured to effect a turbulent reaction into another ladle containing other solid, basic, slag-forming ingredients and any other necessary alloying additions for compositional purposes, following which the melt is teemed into ingots in the usual manner. The process of this invention is effective for removing sufficient sulfur from the metal so that a metal having a sulfur content of about 0.025% when originally tapped from the furnace, assays less than 0.009% sulfur when the metal has solidified into ingot form. The process of this invention is effective regardless of what fundamental melting process or furnace is used. Predominantly, the larger tonnages of steel are made in either a carbon electrode electric arc melting furnace or the conventional open hearth type furnace. The process is also effective regardless of the fact that the starting material is cold scrap, hot metal or whether the duplex melting process is employed which utilizes both cold scrap and hot metal.

Essentially, the process involves making a melt of ferrous base alloy by melting scrap and/or hot metal in a furnace usually containing a basic type refractory lining. In the open hearth practice existing in some steel mills, the carbon content is adjusted through the addition of iron ore and its effect in producing the so-called "ore reboil." In other instances, both in the open hearth practice and in the electric arc furnace practice, oxygen is injected into the melt to adjust the carbon content. The period of the melting cycle during which the carbon content is adjusted by whatever means, is commonly referred to as the oxidizing period. This follows because the slag on melt at this time is highly oxidizing in character. When a predetermined carbon content is attained within the melt, the slag is decanted or in the alternative, the metal is tapped and the slag retained in the furnace or it is run off into a separate slag thimble. The temperature of the melt at the end of the oxidizing period is usually quite high, being of the order of 2850° F. to about 3050° F. The slag is highly oxidizing at this point.

As was stated hereinbefore, the process of this invention is effective, regardless of the fundamental melting practice used, to produce the melt of ferrous base alloy. After the carbon content of the melt is adjusted to the desired level, it is preferred, in following the process of this invention, to tap the furnace and pour the metal into a ladle. In so tapping the furnace, it is preferred to remove the metal as fast as possible and in such a manner as to substantially prevent any of the oxidizing slag from being carried over with the melt into the ladle. For example, in an electrical furnace it is preferred to tilt the furnace as fast as possible so that the oxidizing slag is maintained above the tap hole. Pouring is continued at a rate sufficiently fast to keep the slag within the furnace. Other types of slag removal devices can be used, for example, the pouring spout may be provided with a slag skimmer which permits the metal to flow under the skimmer dam and the slag is diverted to a slag thimble. It will be appreciated that in practice it is impossible to completely eliminate all slag from the melt; however, it is desired to maintain the metal within the ladle substantially free of the oxidizing slag without relying upon any undue or costly scheme or mechanism for the removal of the oxidizing slag. Regardless of how the oxidizing slag is separated from the melt, it is preferred to tap or pour the metal as rapidly as possible in order to effect the greatest mixing of the melt with the materials contained in the ladle, as will be explained more fully hereinafter.

In practice, it is preferred to prepare the ladle into which the melt of ferrous alloys is to be tapped by placing therein sufficient deoxidizing compounds as to thoroughly deoxidize the melt within the ladle. In this respect, ferrosilicon, ferromanganese, pig aluminum, silicomanganese alloys or any of the various commercial deoxidizers which are compatible with the chemical composition of the steel being melted may be used. Alloying additions for the purpose of the final chemistry of the metal to be produced may also be present. In addition to the deoxidizers and any alloying additions, the ladle is also provided with solid, basic, slag-forming ingredients. These solid, basic, slag-forming ingredients should

be present in such amounts and proportions so that when the solid, basic, slag-forming ingredients are melted, they will form a liquid slag having a composition as analyzed by well known mill practices comprising between about 40% and about 65% CaO, between about 15% and about 25% SiO_2, between about 5% and 10% Al_2O_3 and between about 2% and about 6% MgO. It will be appreciated that not all of the components of the slag formed in the ladle will be obtained from the slag-forming ingredients referred to hereinbefore.

Thus as is well known, the process of deoxidation is accomplished through the addition of metals or alloys which have a higher affinity for oxygen than a metal being melted or any of its alloying components. Deoxidation is accomplished by adding these materials to the melt which contains a high deegree of oxygen within solution therein, and through the reaction of the deoxidizer with the dissolved oxygen, a liquid or solid slag component is formed. These slag components, whether liquid or solid, float out of the melt into the slag. Hence, the reaction of the deoxidizers adds to the final analysis of the components of the slag.

In addition, other elements or compounds also contribute to the composition of the slag. In this respect, it will be appreciated that when the melt of ferrous alloys is originally prepared in the furnace and the melt is oxidized through the use of iron ore or oxygen, a highly oxidizing slag is formed. Because of the highly oxidizing slag on the melt, the solubility of iron oxide within the melt under an oxidizing slag is very high. Hence, the melt will also contain a high percentage of iron oxide when tapped from the furnace into the ladle. The slag-forming ingredients which are contained within the ladle are highly basic and reducing in nature. Since the equilibrium of the distribution of iron oxide within the melt with the iron oxide contained in the slag is disturbed when the metal is tapped from the furnace to the substantial exclusion of the oxidizing slag, and the basic, slag-forming ingredients contained within the ladle are highly reducing in nature, some of the iron oxide in solution within the melt diffuses through the slag-metal interface where a portion of it is reduced to iron and a new equilibrium is established. Hence, the final composition of the slag contained within the ladle is formed from the solid, basic, slag-forming ingredients, the completed reaction of the deoxidizers and the reverse reaction of the equilibrium distribution of the oxides of alloying elements. In total, the slag thus formed usually comprises between 0.5% and 4% of the total weight of molten materials.

At this point it is interesting to note the effect of the pouring of the melt from the furnace into the ladle. Chemical analysis of both the slag and the metal indicates there has been little change in the sulfur content of the melt. While there is some change in the sulfur content of the slag, this would be expected, because the original oxidizing slag has been removed and replaced by a highly basic or reducing slag. In other words, this step in the over-all process is not effective in and of itself for reducing the sulfur content of the metal. It must be pointed out, however, that this is a very critical step in the process of the invention because this step performs the function of conditioning the melt for the ultimate removal of sulfur from the metal. After the melt of ferrous alloy is tapped from the furnace and rapidly poured into the ladle containing the ingredients mentioned hereinbefore, it is necessary to adjust the temperature of the melt so that it will be at a temperature within the range between 2800° F. and 2950° F. While the particular method for adjusting the temperature of the melt is of little importance unless the method employed would introduce extraneous deleterious substances within the melt, the primary concern is limited to the temperature range of the melt. In practice, the easiest method of adjusting the temperature is to merely hold the melt in the ladle until it attains the desired temperature. The temperature can be readily determined through the use of an immersion thermocouple or an optical pyrometer. When the melt attains a temperature within the range between 2800° F. and 2950° F., the liquid-reducing slag is thereafter decanted, usually by lip-pouring from the ladle. The melt is then poured from the tapping ladle into a teeming ladle at a rate sufficiently fast to create a turbulent reaction.

The teeming ladle is preferably prepared to contain the final amount of alloying elements sufficient to obtain a steel having the desired chemical analysis and, in addition, it is also provided with a predetermined amount of solid, basic, slag-forming ingredients which, when melted, form liquid slag having a composition including between about 55% and 75% CaO, between about 2% and about 8% MgO, between about 4% and 10% SiO_2, between about 10% and about 25% Al_2O_3 and not more than about 1.5% FeO. It appears that it is during the pouring of the melt from the tapping ladle into the teeming ladle in such a fashion to effect a turbulent reaction in the teeming ladle that the sulfur content of the melt is greatly reduced and in some cases to below about 0.009%. When the metal contained in the teeming ladle has attained the desired temperature, which varies depending upon the analysis of the metal being teemed, the metal is cast into ingots in the usual manner which, when solidified, will possess a sulfur content of less than 0.009%. While the precise mechanism by which the sulfur is removed from the melt is not known, it is believed that the cooperation of the chemical composition of the slag which is formed from the solid, basic, slag-forming ingredients being intimately mixed with the melt together with the turbulent reaction caused in the manner of pouring and the reaction of the components within the ladle is effective for removing the sulfur from the melt into the slag in the form of sulfides.

In order to more clearly demonstrate the process of this invention, reference may be had to the following schedule which illustrates the use of the process of this invention in producing a heat of intermediate grade silicon steel:

Heat 327925 is typical of the present process and produced 167,400# of ingots having an analysis of 0.03% carbon, 0.25% manganese, 2.88% silicon, 0.01% chromium, 0.05% nickel, 0.32% aluminum, 0.008% sulfur and the balance iron with incidental impurities. The total charge to the furnace included 180,000# of scrap, fluxing agents and deoxidizers. After deoxidation sufficient to reduce the carbon content to about 0.03%, the furnace was tapped into a tapping ladle which had been previously prepared to contain 6,700# of 75% ferrosilicon, 550# mansilloy, 90# aluminum pig, 300# of spar, 150# of aluminum grain and 15–80# bags of lime. The slag which formed in the tapping ladle had a composition which included 0.25% sulfur, 50.87% CaO, 17.94% SiO_2, 7.12% Al_2O_3 and 9.81% FeO. The metal had a sulfur content of 0.025%. Thermocouple readings indicated a temperature of 2900° F. The metal was held in the tapping ladle for a period of 7 minutes and thereafter the slag was lip-poured into a slag thimble. The tapping ladle was then placed in position over the teeming ladle and elevated directly above it approximately 18 feet in order to obtain a greater amount of turbulence in pouring. The molten metal was lip poured from the tapping ladle into the teeming ladle which had been previously prepared to contain 600# of aluminum pig, 150# aluminum grain, 300# of spar, 100# of soda ash and 12 bags of lime. It required approximately 2 minutes to pour the metal from the tapping ladle into the teeming ladle. The slag which formed within the teeming ladle was analyzed and had a composition which included 0.49% sulfur, 59.37% CaO, 4.26% SiO_2, 23.04% Al_2O_3, 1.70% Na_2O and 0.75% FeO. The final sulfur content of the metal was reduced from 0.025% to less than

0.010%. Note in particular that this was substantially a two-step operation which was highly effective for reducing the sulfur content of the finished melt. Soda ash was included in this heat, it being noted that considerable turbulence was effected through the use of the soda ash which in a two-step operation may be preferred in order to obtain the greatest beneficial effect of sulfur removal.

The process of this invention is also effective for desulfurizing molten pig iron. Heat No. 336681 having an analysis of 3.98% carbon, 1.12% manganese, 1.6% silicon, an initial sulfur content 0.09% and the balance iron with incidental impurities was made in the following manner:

The furnace was charged with 100,500# of pig iron along with the requisite fluxing agents and melted in the normal manner. Prior to removing the molten pig iron from the furnace, the slag was analyzed and had a composition including 0.82% sulfur, 0.06% P_2O_5, 36.21% CaO, 4.61% FeO, 29.92% SiO_2, 20.64% MgO and 2.78% Al_2O_3. The tapping ladle was prepared by the addition thereto of 800# of lime, 225# of grain aluminum, 350# of spar, 100# of soda ash and 400# of spar. The melt was rapidly poured into the tapping ladle, being careful to preserve as much slag as possible within the furnace. Analysis of the slag from the tapping ladle indicated a composition including 1.35% sulfur, 0.06% P_2O_5, 58.2% CaO, 4.61% FeO, 5.32% SiO_2, 7.13% MgO and 7.08% Al_2O_3. Test of the metal contained within the tapping ladle indicated a sulfur content of 0.071%. After adjusting the temperature to about 2800° F., the slag was decanted and the metal was poured from the tapping ladle into the teeming ladle which had been previously prepared through the addition therein of 800# of lime, 150# of grain aluminum, 250# of spar, 100# of soda ash and 200# of spar. The metal was rapidly poured from the tapping ladle into the teeming ladle to effect a turbulent reaction therein. Chemical analysis of the slag indicated a composition including 1.05% sulfur, 0.04% P_2O_5, 59.52% CaO, 1.36% FeO, 2.46% SiO_2, 6.34% MgO and 7.64% Al_2O_3. The melt had an analysis including a sulfur content of 0.015%. Thus, through the process of this invention the sulfur content has been reduced from an initial content of about 0.09% to about 0.015%. It will be appreciated, however, that while the final sulfur content in the pig iron is somewhat higher than for example that obtained in the making of silicon steel, it is clear that the process of this invention is effective for showing a great improvement in the amount of sulfur which is extracted from the heat.

Substantially similar results were obtained when this process was utilized to prepare austenitic type stainless steel the reduction of sulfur content being from 0.03% to 0.01% or less in the final ingots. The process is also effective when used on AISI Type 400 series stainless steels. It is also interesting to point out that substantially similar results may be obtained when using a three-step process, wherein an intermediate ladle is employed as next described.

Where it is desirable to obtain an extremely low sulfur content within the steel as in the making of certain grades of silicon or electrical steels, the same fundamental process described hereinbefore is used, the difference being that another ladling is interposed between the tapping ladle and the teeming ladle. Such interposed ladle is also prepared to contain solid, basic, slag-forming ingredients and may also contain deoxidizers and compositional alloying elements. The solid, basic slag-forming ingredients are so proportioned in the intermediate ladle as to form a liquid slag having a composition including between about 40% and 65% CaO, between about 15% and about 25% SiO_2, between about 5% and about 10% Al_2O_3 and between about 2% and about 6% MgO.

In order to more clearly illustrate the three-step process of the present invention, reference may be had to the following processing schedule:

Heat No. 336,469 having an analysis of 0.03% carbon, 0.24% manganese, 0.013% phosphorus, 2.94% silicon, 0.01% chromium, 0.085% nickel, an initial sulfur content of 0.035% and the balance iron with incidental impurities, was made utilizing the process of this invention and produced a total of 134,100# of ingots. The furnace was initially prepared by the addition thereto of 15,000# iron ore and 136,000# of scrap to a basic lined carbon electrode electric arc furnace. When the initial charge of scrap and fluxing agents was completely melted, oxygen was blown into the molten metal for a period of 65 minutes at a pressure of 120# per square inch to reduce the carbon content to below 0.035%. During the time that the oxygen was being injected into the melt, the tapping ladle was prepared through the addition of 4,000# of 75% ferrosilicon, 450# manganese silicide, 70# of aluminum pig, 18 bags of lime, each weighing 80#, 250# of spar, and 150# of aluminum grain. An intermediate ladle was also prepared to contain 70# of aluminum pig, 12–80# bags of lime, 250# of spar, 150# of aluminum grain. It should be noted that the tapping ladle and the intermediate ladle contained all of the requisite silicon source for both composition and deoxidation purposes. At the end of the oxygen blow, a test was sent to the laboratory to determine the carbon content as well as the other requisite elements and upon receipt of the report thereof, the furnace was tapped. The carbon electrodes were retracted and the furnace rapidly tilted so that the slag was above the furnace tap hole. The molten metal from the furnace was poured directly into the tapping ladle as rapidly as possible, the entire furnace charge having been removed in approximately 8 minutes. Temperature measurements indicated that the tapping temperature was 2960° Fahrenheit. The fast pouring of the molten metal from the furnace into the solid basic slag-forming ingredients contained within the tapping ladle was effective for creating considerable turbulence. The reaction of the deoxidizers in the slag-forming ingredients with the melt also added to the turbulent reaction witnessed in the tapping ladle. Chemical analysis of the metal in the tapping ladle revealed a sulfur content of 0.035%. The slag which formed within the teeming ladle had a composition including 0.24% sulfur, 46.77% CaO, 3.71% MgO, 21.68% SiO_2, 7.0% Al_2O_3 and 12.24% FeO. The metal was held within the tapping ladle for a period of 12 minutes since the thermocouple readings indicated a temperature of 3060° F. This increase in temperature resulted from the heat of formation and the heat of solution of the slag formed ingredients. Thereafter, the slag was lip-poured into a slag thimble. Thereafter, the melt was poured into the intermediate holding ladle which had been previously prepared with the solid, basic, slag-forming ingredients as set forth hereinbefore. The tapping ladle was maintained in position over the intermediate ladle and displaced thereabove a distance of approximately 18 feet in order to pour the melt as rapidly as possible and to obtain as much turbulence as possible within the intermediate ladle. It required approximately 2 minutes to pour the entire contents from the tapping ladle into the intermediate ladle. Chemical analysis of the slag which had formed in the intermediate ladle revealed a sulfur content of 0.49%, 66.12% CaO, 2.69% MgO, 13.92% SiO_2, 10.15% Al_2O_3 and 1.19% FeO. Chemical analysis of the metal revealed that the sulfur content had been reduced from 0.035% to 0.010%. Immediately the slag was lip-poured into a slag thimble and thereafter the metal was poured into the teeming ladle which had been previously prepared to contain 450# of aluminum pig, 800# of lime, 250# of spar and 150# of aluminum grain. After the metal was poured into the teeming ladle, the slag which formed thereon was analyzed and revealed a sulfur con-

tent of 0.60%, 64.94% CaO, 3.51% MgO, 6.42% SiO_2, 17.12% Al_2O_3 and 0.60% FeO. The chemical analysis of the metal indicated a final sulfur content of 0.008% sulfur. Thereafter, the melt was teemed into ingots and a check analysis on the ingots indicated a sulfur content of 0.008% or less.

From the foregoing, it is clear that the process of this invention is effective for desulfurizing ferrous base metal and alloy. The ultimate level to which the sulfur content is reduced will vary with the type of ferrous base alloy being manufactured; however, it appears that regardless of the type of metal being manufactured, the relative amount of sulfur removal depends upon the degree of success in maintaining the FeO content of the slag at a minimum. This appears to be the primary function of the initial pour from the furnace into the tapping ladle which conditions the melt for the subsequent removal of sulfur. The process is effective whether it is done in a two-step or three-step manner so long as the temperatures are controlled between each successive step as set forth hereinbefore and so long as the metal is poured to effect the greatest amount of turbulence and the slag composition is controlled within the limits set forth hereinbefore.

The process of this invention requires no special skills or equipment. The procedures involved are ordinarily those usually encountered within the basic steel-making facilities and are readily adapted to any of the known commercial melting procedures.

We claim:

1. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of a ferrous alloy in a furnace under slag, adjusting the composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle to effect a turbulent reaction therein, said ladle containing solid, basic, slag-forming ingredients which when melted form a liquid slag having a composition comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO and from about 5% to about 30% FeO, adjusting the temperature of the melt in said ladle to a temperature in the range between about 2800° F. and 2950° F., decanting the liquid slag, pouring the melt into another ladle containing other solid basic slag-forming ingredients to effect a turbulent reaction within the ladle, said other basic slag-forming ingredients forming a slag during said turbulent reaction having a composition containing from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, and not more than 1.5% FeO, and teeming the melt into ingots, said turbulent reactions and slags cooperating to desulfurize the ferrous alloys.

2. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of a ferrous alloy in a furnace under slag, said melt having an initial sulfur content in the range between 0.020% and 0.050%, adjusting the composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle containing solid, basic, slag-forming ingredients which when melted form a liquid slag having a composition comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO and from about 5% to about 30% FeO, adjusting the temperature of the melt in said ladle to a temperature in the range between about 2800° F. and 2950° F., decanting the liquid slag, pouring the melt into another ladle containing other solid basic slag-forming ingredients to effect a turbulent reaction within the ladle, said other solid, basic, slag-forming ingredients forming a slag during said turbulent reaction having a composition containing from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, and not more than 1.5% FeO, and teeming the melt into ingots, said turbulent reactions and slags cooperating to reduce the sulfur content from an initial concentration in the range between 0.020% and 0.050% to less than 0.010%.

3. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of a ferrous alloy in a furnace under slag, said melt having an initial sulfur content in the range between 0.050% and 0.15%, adjusting the composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle containing solid, basic, slag-forming ingredients which when melted form a liquid slag having a composition comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO and from about 5% to about 30% FeO, adjusting the temperature of the melt in said ladle to a temperature in the range between about 2800° F. and 2950° F., decanting the liquid slag, pouring the melt into another ladle containing other solid basic slag-forming ingredients to effect a turbulent reaction within the ladle, said other basic slag-forming ingredients forming a slag during said turbulent reaction having a composition containing from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, and not more than 1.5% FeO, and teeming the melt into ingots, said turbulent reactions and slags cooperating to reduce the sulfur content from an initial concentration in the range between 0.50% and 0.15% to less than 0.02%.

4. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of a ferrous alloy in a furnace under slag, said melt having an initial sulfur content in the range between 0.020% and 0.050% adjusting the composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle containing solid, basic, slag-forming ingredients which when melted form a liquid slag having a composition comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO and from about 5% to about 30% FeO, adjusting the temperature of the melt in said ladle to a temperature in the range between about 2800° F. and 2950° F., decanting the liquid slag, pouring the melt into another ladle containing other solid basic slag-forming ingredients to effect a turbulent reaction within the ladle, said other basic slag-forming ingredients forming a slag during said turbulent reaction having a composition containing from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, up to 3.0% Na_2O and not more than 1.5% FeO and teeming the melt into ingots, said turbulent reactions and slags cooperating to desulfurize the ferrous alloys.

5. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of ferrous alloys in a furnace under an oxidizing slag, adjusting the chemical composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle to the substantial exclusion of the oxidizing slag, and to effect a turbulent reaction therein, said ladle into which the melt is tapped containing solid, basic, slag-forming ingredients which when melted and mixed with the melt form a liquid slag comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO and from about 5% to about 30% FeO, adjusting the temperature of the melt to a temperature in the range between about 2800° F. and 2950° F., decanting the basic slag, pouring the uncovered melt into another ladle to effect a turbulent reaction therein, said ladle containing other basic slag-forming ingredients which when melted form a slag having a composition including from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, and not more than 1.5% FeO, decanting

the liquid basic slag, pouring the uncovered melt into another ladle to effect a turbulent reaction therein, said ladle containing solid, basic, slag-forming ingredients which when melted form a liquid slag having a composition including from 55% to 75% CaO, from 5% to 8% MgO, from 4% to 10% SiO_2, from 10% to 25% Al_2O_3, and not more than 1.5% FeO, and teeming the melt into ingots, said turbulent reactions and slags cooperating to desulfurize the ferrous alloys.

6. In the process of desulfurizing ferrous alloys, the steps comprising, making a melt of ferrous alloys in a furnace under an oxidizing slag, said melt having an initial sulfur content in the range between 0.020% and 0.050% adjusting the chemical composition of the melt, conditioning the melt for desulfurization by tapping the melt into a ladle to the substantial exclusion of the oxidizing slag, the ladle into which the melt is tapped containing solid, basic, slag-forming ingredients which when melted and mixed with the melt form a liquid comprising between about 40% and 65% CaO, between about 15% and 25% SiO_2, between about 5% and 10% Al_2O_3, between about 2% and 6% MgO, and from about 5% to about 30% FeO, adjusting the temperature of the melt to a temperature in the range between about 2800° F. and 2950° F., decanting the basic slag, pouring the uncovered melt into another ladle to effect a turbulent reaction therein, said ladle containing other basic slag-forming ingredients which when melted form a slag having a composition including from about 55% to 75% CaO, between about 2% and 8% MgO, between about 4% and 10% SiO_2, between about 10% and 25% Al_2O_3, and not more than 1.5% FeO, decanting the liquid basic slag, pouring the uncovered melt into another ladle to effect a turbulent reaction therein, said ladle containing solid basic slag-forming ingredients which when melted form a liquid slag having a composition including from 55% to 75% CaO, from 5% to 8% MgO, from 4% to 10% SiO_2, from 10% to 25% Al_2O_3, and not more than 1.5% FeO, and teeming the melt into ingots, said turbulent reactions and slags cooperating to reduce the sulfur content from an initial concentration in the range between 0.020% and 0.050% to less than 0.010%.

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