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Modifying the Silicon, Manganese Alloy Formula in Steel Factories in Sudan

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Abstract: ***Steel industry is one of important sector which contributes in the development in steel sector. This reflects positively in national income the objective of this paper was to modify routinely used formula in steel bar industry, this was applied by adding (silicon and manganese) alloy for bar steel manufacturing, considering all the variation that effect on steel specification to render it more flexible with high quality and less time for treatment. Three hundred and three reports (have specifications of melting) were taken to study the relationship among all the elements in the report to determine the relation between the elements and the new formula was used in the production line of steel bar. The analysis of result by SPSS showed that newly formula used to produce steel bar has seven variations better than routinely used which had two variations, newly obtained formula had been tested three times in steel bar production process, the result was acceptable compared with routinely used in the factory. This new formula due to its reduced cost of used amounted (silicon and manganese) alloy, less time for treatment and with high quality, is highly recommended to apply in steel bar production.***

Keywords: Steel industry, SPSS, new formula for silicon and manganese alloy

1. Introduction

Steel generally consistsof alloy cabon,iron and many other elements. Other elements are added to give specific propeties [2]. According to the world steel Association, there are over 3500 different grades acting as a cleanser taking the sulfur and Oxygen out of the steel, encompassing unique physical,chemical and environmental properties in essence .[3] These elements effect on steel bar propeties,to know the optimaum ratio to add must be know these elements and their effect on the steel bar ,these elements already excite in steel melting are mainly carbon, silicon, manganese, phosphorus and Sulfur. Carbon is the most important elements in steel, it is essential in steels which have to be hardened by quenching and the degree of Carbon controls the hardness and strength, the materials as well as response to heat treatment and ductility, forgeability and machinability will decrease if the amount of Carbon increase as well as weld ability properties of the steel. [2]Is generally Carbon can be present up to 2% (although most welded steels have less than 0.5%). [1] SiliconIs one of the principal deoxidizers for steel .Silicon helps to improve bubbles of Oxygen from the molten steel, it is the element that is most commonly used to produce semi_and fully killed steels, and normally appears in amounts less than .4%usually only small amounts 0.2% are present in rolled steel when it is used as a deoxidizer, however castings 0.35% to 1% is commonly present. Silicon dissolves in iron and tends to strengthen it, some filler metals may contain up to 1% to provide enhanced cleaning and deoxidation [2]. Manganese could be the second most important element after Carbon on steel, Manganese has effects similar to those of Carbon, and the steel producer uses these two elements in combination to obtain material with desired properties, Manganese is a necessary for the process of hot rolling ofsteel by it is combination with Oxygen and Sulfur [2]. It is a mild deoxidantmelt into the slag. It increases the harden ability and tensile strength but decrease ductility. It combines with sulfur to form globular Manganese sulphides. Essential in free cutting steels for good machinability. Steels usually contains at least 0.3% Manganese because it assists in the deoxidation of the steel, prevents the formation of iron sulfide and inclusions, and promotes greater strength by increasing the hardenability of the steel. [1] Phosphorus although it increases the tensile strength of steel and improves machinability it is generally regarded as an undesirable impurity because of it is embrittling effect. Of Phosphorus element will have various effects on steel depending on concentration.[2]Is generally considered to be an undesirable impurity in steels. It is normally found in amounts up to 0.04% in most carbon steels. In hardened steels, it may tend to cause embrittlement. In low-alloy high-strength steels, phosphorus may be added in amounts up to 0.10% to improve strength and corrosion resistance. [1]Sulfur is usually an undesirable impurity in steel rather than an alloying element. In amounts exceeding 0.05% it tends to cause brittleness and reduce walkability. Alloying additions of sulfur in amounts from 0.10% to 0.30% will tend to improve the machinability of steel. Such types may be referred to as "resulfurized" or "free-machining". Free-machining alloys are not intended for use where welding is required. [4]

2. Methodology

This study was done in Dubai steel factory in Sudan .and was taken as case study as one of steel factory to improve productivity.

Optimum amount from additional materials (silicon, manganese) alloy to steel melting reduce cost, less time for treatment and more quality, all the elements in the melting were taken in consideration, already there is routinely used

formula in steel bar industry but this formula takes two variations (weight and manganese) only, this formula is:

Amount of alloy silicon, manganese= (amount of manganese in melting +amount of manganese in alloy)*weight of melting (kg) 60. [4]

Other elements which affected on the properties of melting were calculated, the ratios in every batch had explained in the ratios of the elements already exist in the melting, the three hundred and three report (have specifications of melting) had been analyzed to obtain newly formula, the specific of (silicon, manganese) alloy in Dubai steel factory illustrated in table (1) according to Vulcan alloy, Grade (2) was used when the data collected. The obtained newly formula was tested three times in production line.

Table 1: Illustrates the specific of silicon & manganese alloy

Chemical Specification	SIMN GRADE 1	SIMN GRADE 2
Manganese (Mn)	60.0%	65.0%
	min	min
Silicon (Si)	14.0%	16.0%
	max	min
Carbon (C)	2.50%	2.50%
	Max	max
Phosphorus (P)	0.35%	0.30%
	max	max
Sulphur (S)	0.05%	0.05%
	max	max
Size	Lumps/	Lumps/
Packaging	50 Kg	50 Kg
	HDPE bags	HDPE bags
	Jumbo bags	Jumbo bags

3. Result

Data analysis by SPSS (statistical package for social sciences) the results showed there were coefficient correlation between the elements and also between elements and melting. To avoid any change in properties the amount of alloy were be corrected to hinder any problems during the casting stage. New formula made according to all the elements that affect the properties of steel and already these elements were already existed in different ratios. With -

With the coefficient correlation R= 0.778 the new formula obtained is:
Amount of alloy added =Constant + A*(temperature ^{o} c) + B*(carbon) + C*(silicon) + D*(manganese) + E*(phosphorus) + F*(sulfur) + G*(weight)

Constant, A, B, C, D, E, F, G are numbers according to SPSS analysis, all the elements are percentage in the melting, temperature (^{o} c) and weight calculated (ton).

Table 2: Illustrates the data analysis by SPSS of the elements used in the new formula

Model		Unstandardized Coefficients	
	(Constant)	51.287	
	TEMPER	-0.060	A
	C	1.739	B
	SI	-0.468	C
	MN	150.017	D
	P	18.123	E
	S	58.278	F
	WEIGHT	9.855	G

This formula was tested three times, the results were convincing after discussing the results with quality control Engineer. This formula was used in induction-furnace, silicon, manganese alloy as mentioned above, so any change in this condition may be given incorrect amount.

Table 3: Illustrates the correlation between elements in the melting

Valid		si mi kg	temperature °c	c(.22-.3)	si (.25-.35)	mn (0.2)	p(0.05)	s(0.05)	weight ton
si mi kg	Pearson Correlation	1	-0.399(**)	**0.065**	0.343(**)	0.533(**)	0.147(*)	0.155(**)	0.606(**)
	Sig. (2-tailed)	.	0.000	**0.261**	0.000	0.000	0.010	0.007	0.000
temperature °c	Pearson Correlation	-0.399(**)	1	**0.009**	-.133(*)	-.179(**)	-0.139(*)	**-0.110**	-0.513(**)
	Sig. (2-tailed)	0.000	.	**0.880**	0.021	0.002	0.015	**0.056**	0.000
c(.22-.3)	Pearson Correlation	**0.065**	0.009	1	**0.068**	0.122(*)	**0.002**	**0.017**	**0.010**
	Sig. (2-tailed)	**0.261**	0.880	.	**0.240**	0.033	**0.968**	**0.764**	**0.860**
si (.25-.35)	Pearson Correlation	0.343(**)	-0.133(*)	0.068	1	0.506(**)	**0.007**	**0.012**	0.204(**)
	Sig. (2-tailed)	0.000	0.021	0.240	.	0.000	**0.908**	**0.837**	0.000
mn(0.2)	Pearson Correlation	0.533(**)	-0.179(**)	0.122(*)	0.506(**)	1	**0.029**	**0.032**	0.132(*)
	Sig. (2-tailed)	**0.000**	0.002	0.033	0.000	.	**0.621**	**0.580**	0.021
p(0.05)	Pearson Correlation	**0.147(*)**	-.0139(*)	0.002	0.007	0.029	1	0.850(**)	**-0.041**
	Sig. (2-tailed)	0.010	0.015	0.968	0.908	0.621	.	0.000	**0.481**
s(0.05)	Pearson Correlation	0.155(**)	**-0.110**	**0.017**	**0.012**	**0.032**	.850(**)	1	**-0.053**
	Sig. (2-tailed)	0.007	**0.056**	**0.764**	**0.837**	**0.580**	.000	.	**0.354**
weight ton	Pearson Correlation	0.606(**)	-0.513(**)	**0.010**	0.204(**)	0.132(*)	-.041	-0.053	1
	Sig. (2-tailed)	0.000	0.000	**0.860**	0.000	0.021	.481	0.354	.

4. Discussion

The new formula has strong correlation than previous because it covers seven variations and the previous covered two variations, more variations mean more flexibility to variations, so this formula decrease the change in properties of melting and also less treatment during the production process. Correct amount of alloy gain time during the casting these lead to the saving casting temperature therefore no need to reheat.

5. Conclusion and Recommendation

The amount of silicon , manganese alloy so important because any incorrect of amount effect on the properties of steel, leading to increase cost, optimal amount avoid any problems in pouring process this hinder any additional treatment that garantee continuous production without any delay in the operation process and that improves productivity. The previous formula took two variations in consider (weight and the numberof manganese in melting).the new formula used seven variations, so it is more strong and flexible to deal with more circumstance during the production process. Apply the new formula in induction furnace with grade (2) will gain more quality of steel melting, less time for treatment and optimal amount of silicon & manganese alloy using.

References

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