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by

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SUMMARY

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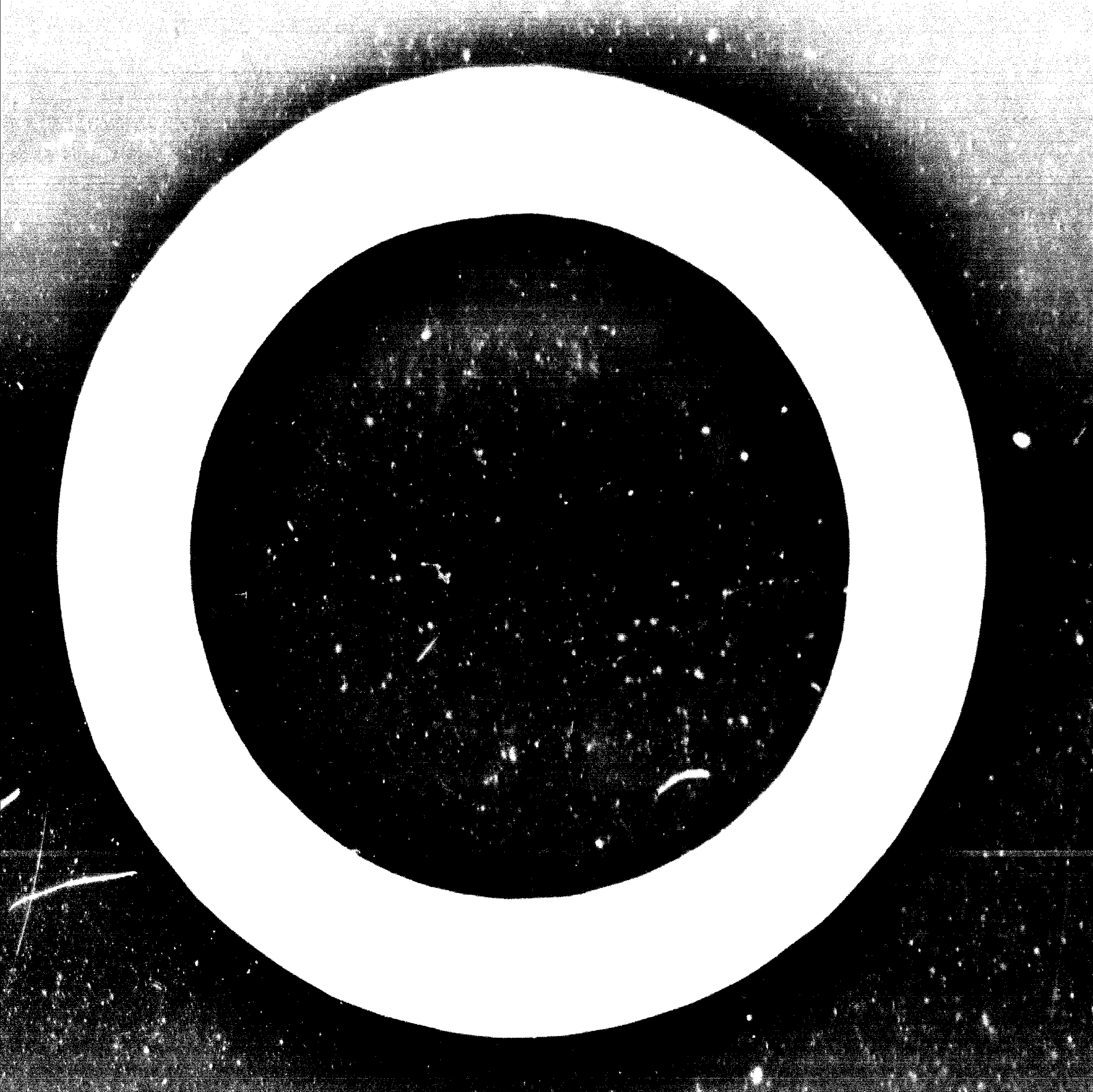

Of late the problem of raising the standards of quality and properties of metal utilised in various branches of machine industry has become increasingly urgent. In addition to that, a large-scale construction of industrial projects in the districts of the Extreme North has added up to the urgency of the problem by the necessity of a substantial improvement of the quality of mass production metal. The standards of metal have become more rigid in the sense that depending upon its utilization it is a must to keep down detrimental impurities (sulphur, phosphorus, oxygen), nonmetallic inclusions, as well as to improve mechanical properties along the transversal planes of rolling and to decrease the anisotropy of the properties. It is also of vital importance to decrease the limit of cold-shortness and increase the factor of ductility to increase the contact strength and steel weldability.

The analysis of the commonly practised industrial process of steel-melting in electrical furnaces, open-hearth furnaces and oxygen converters and the results of a host of research seeking further development of the above process showed that its potentialities with regard to fully meeting the said requirements and metal standards had been exhausted to a great extent. It was necessary to develop new process methods to substantially increase the metal quality indices without any appreciable increase of the capital investments and the production cost of finished rolled products.

In metallurgical practice there has been a well-known method of improving the quality of steel whose characteristic feature was to mix the molten metal, when tapping the furnace, with the so-called synthetic slag previously put in the ladle, the slag possessing high refining qualities with regard to metal.

Owing to a highly extensive increase of the metal-slag contact surface added up by vigorous mixing and high refining qualities of synthetic slag, the processes of metal-to-slag conversion of sulphur and oxygen take places much faster and fuller than by the ordinary method of steel melting in electric arc furnaces and, the more so, in open-hearth furnaces and converters. In addition to that, under certain conditions synthetic slag can absorb nonmetallic inclusions present in the metal.

A large-scale industrial trial in electric-furnace steelmaking, open hearth and converter shops of the refining method by liquid synthetic slag gave every ground to consider that the application of this method enables the above requirements of consumers to the quality of steel to be met to a greater extent.

In addition to that, however, it was found that the efficiency of synthetic slag application can vary to a great extent depending upon many factors and first of all, upon the metal deoxidation technology.

With a view to finding the optimum parameters of the steel refining process by synthetic slag and the maximum utilization of its potentialities, research on physico-chemical properties of synthetic slags as well as on the characteristic features of their reaction with metal in the course of intensive mixing was undertaken. Based upon this, the laws governing the formation of nonmetallic inclusions in steel under the conditions of its refining by synthetic slag were found and the industrial process of steel melting in the furnace before the treatment by synthetic slag was worked out. The technology of the process provides for inclusions with required properties, for a low content of all kinds of inclusions in the finished metal and for a high level of mechanical properties of finished rolled products.

During 1963-1967 five electric-furnace steel making and open-hearth shops of four metallurgical works introduced the industrial process of steel melting with its refining in the ladle containing liquid lime and alumina synthetic slag.

By the end of 1967 more than 1.5 mill. t of steel had been melted by the above method, the steel types being as follows: ball-bearing, carbon, alloyed constructional, tool, carbon and alloyed for tube strips, carbon and low-alloyed for big diameter pipes etc..

The metal melted by the new process has undergone allround research at metallurgical works and machine building plants, as well as in specialized machine building institutes. As a result of this research, it is found that the steel refined by synthetic slag has the following advantages:

1. The sulphur content is 2 to 3 times lower and the oxygen content is 30 to 50 per cent lower than in the ordinary steel.

2. The content of non-metallic inclusions is 2 to 4 times less and fine cracks presence is 5 to 10 times less, depending upon the steel grade.

3. The impact strength of alloyed constructional steel across the texture increases by 1.5 to 2.0 times at the room temperature and approximately by 1.5 times at low temperatures.

4. The steel becomes much less prone to embrittlement and possesses a greater ductility factor up to the moment of fracture. The deformability of steel under most difficult conditions of voluminous strain, the strain concentration and low temperatures increases by 2 to 3 times.

5. The impact strength to fracture steel refined by synthetic slag is 30 per cent higher than that for fracturing ordinary steel.

6. The ductility of steel is by 30 to 40 per cent higher at temperatures of hot mechanical treatment.

7. The steel is much less prone to cristallizing cracks during welding which makes for speeding up the welding process and broadening the range of application of the highly efficient electroslag welding. It should be noted that it is particularly important for structures of a special make for Northern regions that the metal is much less prone to embrittlement during welding and the impact strength of the nearthe-weld area increases by 2 to 3 times.

These advantages are pronounced in diminishing the number of rejected steel products in metallurgical works and machine plants as well as in increasing the life of steel products. For example, the life of ball bearings increases on an average by 70 per cent.

In the Soviet Union the outlook of raising the quality of steels for various purposes by liquid synthetic slag refining in the ladle is appreciated very highly. Within the next few years to come it is envisaged not only to practise an ever increasing application of this industrial process of alloyed steels melting but also to introduce it for melting low alloyed and carbon steels for welded structures. In this case the goal will be to raise the quality of metal and welded joints, as well as to realise the potentiality of improving the steel strength by increasing the carbon content in it with a very small sulphur presence and consequently, without any deterioration of steel weldability.

IMPROVING THE QUALITY OF STEEL BY TREATING IT WITH SYNTHETIC SLAG

The metal quality depends to a considerable extent on the content of such detrimental impurities as sulphur and oxygen, and of non-metallic inclusions of which they form part. Also of considerable importance is the content of gases in the metal. For this reason the efforts of metallurgists were always aimed at searching for new ways of producing steel, which would warrant a low content of different detrimental impurities. This originated the methods of arc and vacuum electro-slag refining of steel, which have found a rather extensive application in the iron and steel industry. The vacuum arc and ESR steel is noted for its valuable properties and high quality, but at the same time it is expensive, and the scale of its production can neither at present nor in the future meet all the requirements for higher-quality metal.

A tendency for the future has become quite distinctly pronounced toward a widening range of high quality metal consumers.

There arose an imperative necessity to find ways of radically improving the quality of mass-produced metal, which could be implemented, using the existing steelmaking units, without large capital investments.

Accelerated passage of impurities from metal to slag and, consequently, their more complete removal can be achieved by enlarging the surface of contact between the metal and the slag phases by melting slag in a special slag-melting furnace and draining it off to a pouring ladle before tapping the heat of steel. In the course of tapping, owing to the work done by the jet of metal falling into the ladle, the slag emulsifies in the metal and, as a result, the surface of their contact increases considerably. The other no less important advantage of such a method of removing impurities from the metal consists in the fact that special furnaces can be used for melting slag which has a greater refining effect on the metal than conventional electric arc furnace slag. This is due to the possibility of having in the slag-melting furnace a lining which practically does not interact with slag and which does not pollute it with impurities. Finally, the third advantage of the method consists in that it is capable in principle of treating the steel produced at any industrial melting unit in the ladle with slag and of obtaining steel quality of an equally high level. Naturally this possibility may be realised, provided a technology has been worked out to carry on the process of melting in the furnace, which would take care of the required preparation of the metal for its refining with synthetic slag.

Vigorous intermixing of the metal with synthetic slag in the ladle opens up an additional opportunity for removing non-metallic inclusions from steel on account of their assimilation by synthetic slag; this can also be used, provided a technology has been developed for deoxidising the metal bath, which permits to obtain non-metallic inclusions with required properties.

The slags melted in a separate melting unit and used for treating steel in the ladle have been termed synthetic slags and the method based on their application has been called the refining method or treatment of steel in the ladle with liquid synthetic slag. The method does not involve considerable capital expenditure and, as shown by experience, can be put into effect in a short time at the existing steel plants.

The above advantages of the method of refining steel with synthetic slag allow to regard it as the most accessible, reliable and effective means to improve the quality of mass-scale produced metal.

Originally the method of treating steel with liquid synthetic slag in the ladle was first suggested by [illegible], a Soviet engineer. In the following years, it was repeatedly tested in a number of countries, including the Soviet Union, using highly basic acid and lime-ferruginous slags. Beginning with 1930, the aluminous slag for refining steel found a rather limited application and the analysis of numerous publications devoted to the method of refining steel with synthetic slags has shown that practically none of the principal features of the process was studied with sufficient thoroughness. The designing and technological implementation of the process outside the USSR is at a low level. Namely, one-phase electric arc furnaces used in France [illegible] are of imperfect design, and the technology of deoxidizing the metal before its treatment with synthetic slag is the same for all the grades of steel. The latter is in contradiction of principle, since the chemical composition and properties of non-metallic inclusions depend on the content of oxygen in the metal, which is dissimilar for steel of different grades.

In this connection the introduction of the process of refining steel with synthetic slag at the works of the Soviet Union had to be preceded by a complex investigation aimed at revealing the basic regularities of the process and at finding its optimal parameters. A study was made of the properties of synthetic slags; of the regularities of the chemical composition of the metal and slag which influence the redistribution of sulphur between them; of the processes of formation and removal of non-metallic inclusions when steel is refined with synthetic slag; of the hydrodynamics of the process of slag emulsification in metal; and of many other points. On this basis the kinds of raw materials suitable for the production of slag were determined, and the technology elaborated for the process of steel refining with synthetic slag in general, including the technology of its preparation, of deoxidizing steel, etc.

A special slag-melting furnace, the first in the world, of a fundamentally new design was developed and put into operation. The life of the furnace lining was eight times higher than that of the old-design furnace [illegible] lining, as a result of which the cost of synthetic slag was reduced by 30%.

A study of the distribution of sulphur in the system metal-lime-aluminous slag with various additives has shown that the formerly used slag has a sufficiently great desulphurizing capacity. Considering, however, that the Soviet Union possesses vast reserves of alumina-containing raw materials with a high content of silica, it was of no little interest to discover the possible use of these raw materials for the preparation of synthetic slag. The investigations were crowned with success and new cheaper synthetic slags were developed with a higher content of silica whose harmful effect is neutralized by additions of magnesium oxide. This slag likewise possesses a great desulphurizing capacity and can be successfully applied in those cases when desulphurization of steel is the chief object of treating steel with synthetic slag.

Most serious attention was given to elaborating technological measures providing for a low content of inclusions in steel when it is refined with synthetic slag. Testing of the technology of deoxidizing metal, applied in France and envisaging an addition of ferrosilicon in the furnace, has shown that such a technology does not warrant a low content of globular inclusions in ball-bearing steel.

For this reason experiments were carried out under industrial conditions in 10, 20 and 40-ton electric arc-furnaces and under laboratory conditions so as to study the influence of the chemical composition of non-metallic inclusions on their behaviour during the refining of steel with synthetic slag, to reveal the role of synthetic slag in the processes of deoxidizing metal and to work out slag composition, or the technology of [illegible] practice, which would provide for a low content of inclusions of all kinds.

A great number of variants of the technology of steel making were tested in 10 and 20-ton electric furnaces, changing the chemical composition of slag in the period of refining and during the deoxidation of the metal when melting ball-bearing and alloyed structural steel. The greatest number of variants were tested in melting ball-bearing steel. The content of ferric oxide in the final slag varied then from 0.[illegible] to 12%, which permitted to control within a certain range the level of oxidation [illegible] in the [illegible] when it was deoxidized with silicon, and treated with synthetic slag, and to change the content of ferric and manganese oxides in the composition of the resultant primary inclusions.

All the experimental variants of melting can be classified into four groups: heats with diffusive deoxidation of [illegible] [illegible] heats with sedimentation deoxidation; those with moderate additions of [illegible] [illegible] and those with [illegible] additions of ore during the finishing.

It has been found in examining the grade of metal that in the tested variants of melting ball-bearing steel refined with synthetic slag in the ladle it was possible to have its pollution through banded [illegible] (sulphide, oxide and silicate) at a lower level than that of the same steel melted in accordance with conventional technology. Quite the contrary, pollution through globular inclusions, corresponding to smaller pollution of standard steel is achieved only upon melting in an electric arc-furnace according to a fixed technology. In case melting is done with diffusion or sedimentation deoxidation of metal in the furnace, pollution of steel refined with synthetic slag exceeds that of ordinary steel. It is only oxidation of the metal up to the very tapping with additions of ore in the furnace which allows to have the content of globular inclusions in steel of the same content as in ordinary steel, and with [illegible] oxidation of the metal, even at a lower level. The content of oxide inclusions proved to be at a minimum in heats with diffusive deoxidation of metal in the furnace and its subsequent treatment with synthetic slag.

The content of globular inclusions in structural steel was [illegible] that in ball-bearing steel, diminishing with a decrease in carbon content in the steel.

The content of banded oxide inclusions in structural steel, quite the contrary, dropped with a rise in the carbon content in the metal.

If aluminium was added to the metal in the course of its treatment with synthetic slag, the pollution of steel with banded inclusions of corundum and spinel sharply increased.

The increase in the amount of aluminium added to the metal for final deoxidation led to a rise in the content of banded oxide inclusions and to a decrease in globular oxide inclusions.

The results of full-scale heats permitted to draw definite conclusions regarding the nature of non-metallic inclusions of different kinds in steel refined with synthetic slag as well as to which inclusions are most readily assimilated by synthetic slag. To check these conclusions, heats were also carried out under laboratory conditions.

The experimental laboratory heats were carried out with finely-dispersed silicon and manganese powders added to carbonyl iron powder, and then synthetic slag powder in some heats. In the process of melting the resultant mixtures in Tamman furnace, there was interaction between the oxygen of the iron and the deoxidizers and synthetic slag as well as with the slag of the resultant primary inclusions.

The results of determining the amount and chemical composition of non-metallic inclusions separated by the electrolytic method from the metal are given in Table 1.

Table 1

Results of analysing non-metallic inclusions in steel deoxidised with silicon and manganese

Amount of added deoxidisers, pct		Variant of melting	Amount of the inclusions, pct	Chemical composition of non-metallic inclusions, pct							
				SiO_2		Al_2O_3		FeO		MnO	
Si	Mn			of the remnant	of the metal	of the remnant	of the metal	of the remnant	of the metal	of the remnant	of the metal
0.25	0.25	Without slag	[illegible]	[illegible]	[illegible]	14.8	[illegible]	[illegible]	0.0007	9.4	0.0007
0.25	0.25	With slag	[illegible]	40.0	0.0008	[illegible]	0.0008	20.0	[illegible]	–	–
0.50	0.50	Without slag	[illegible]	95.7	[illegible]	1.8	0.0007	[illegible]	0.0007	0.7	0.0003
0.50	0.50	With slag	[illegible]	[illegible]	0.0130	[illegible]	0.0006	[illegible]	[illegible]	0.8	0.0001
1.00	1.00	Without slag	[illegible]	90.9	0.0251	4.7	0.0013	1.1	0.0005	3.3	0.0009
1.00	1.00	With slag	[illegible]	91.7	0.0156	[illegible]	0.0005	2.9	0.0005	2.5	0.0004

Interaction between the metal and the droplets of synthetic slag floating from it to the surface resulted in a decrease in the content of non-metallic inclusions in the small ingots so produced. However, the degree of the decrease in their content differed, depending on the amount of the deoxidizers added to the metal and, consequently, on the chemical composition of the inclusions.

As the amount of the added silicon and manganese increased and, correspondingly, the content of silica in the composition of the inclusions rose, the degree of their removal from the metal diminished, the decrease in the amount of inclusions being proportional to the drop in the content of silica in them in relation to the metal.

Analysis of the results led to the conclusion that the inclusions enriched with silica and having a higher melting point and viscosity as well as solid corundum and spinel inclusions are more difficult to be assimilated by slag than inclusions of non-viscous iron-manganese silicates. The transfer of oxygen from metal to slag according to the law of distribution helps, on the one hand, to obtain a lower content of oxygen dissolved in the metal after treatment with synthetic slag; on the other hand, it contributes to a rise in the silica content in the composition of primary inclusions and to a deterioration of the conditions under which they are assimilated by slag. The globular inclusions found in finished metal are the remaining inclusions non-assimilated by slag, formed when steel was deoxidised by silicon and manganese. After the treatment with slag has been completed in the course of teeming the metal and cooling it in the moulds, such inclusions continue to increase in size owing to the separation of a new non-metallic phase during the cooling of the metal and are enriched with alumina on account of interaction of aluminium added to the metal and reduced from the slag. The oxide banded inclusions are products of interaction of the remaining oxygen dissolved in the metal after treatment with slag and aluminium. The dimensions of the oxide bands and nodules will differ, depending on the amount of aluminium added for deoxidation. With an increase in the amount of the added aluminium, more

more corundum and spinels are formed, but the possibilities of further growth of globules, due to the silicate phase separating from the metal, are limited.

Unlike the quiescent of the slag-metal emulsion during its turbulent motion, the forced coalescence of non-metallic inclusions in the slag droplets is induced, above all, by the low viscosity of the [illegible], and not by [illegible] inter[illegible] at the boundary with the metal.

The results of [illegible] at present technology of making steel of [illegible] technology [illegible] production of finished metal but [illegible] metal [illegible]

The technology [illegible] of refining steel and the time of adding to it various [illegible] carbon in the metal so that [illegible] are formed in the process of refining with synthetic slag. For this purpose [illegible] steel the metal is oxidized till the very tapping [illegible]. In every case the metal is deoxidized with aluminium after being treated with synthetic slag.

The research devoted to setting up and [illegible] technology [illegible] the equipment used for the implementation [illegible] for extensive application of this technology in the steelmaking industry.

Between [illegible] and [illegible], the technology of [illegible] steel with its refining in the ladle with liquid synthetic slag was introduced at five electric arc furnace and open hearth steelmaking shops of four iron and steel works.

By the end of [illegible], it was applied for making over one and a half million tons of steel intended for most diverse [illegible], carbon and alloyed structural steel, tool, carbon and alloyed steel for pipe billets, carbon and low-alloy steel for large diameter pipes, etc.

The metal produced according to the new technology was comprehensively investigated at iron and steel plants and machine-building works as well as at specialized machine-building institutes.

As a result of these investigations, the following principal advantages of steel refined with synthetic slag have been established.

When melted in electric arc-furnaces, the sulphur content in the steel is lower 1.5-2 times (Table [illegible]), and oxygen content by 30-50% than in ordinary steel. Open-hearth steel refined with synthetic slag contains from four to five times less sulphur than ordinary open-hearth steel.

The reduction in the content of sulphur in the metal provided a substantial decrease in its pollution with sulphide inclusions. The participation of synthetic slag in the processes of deoxidation of metal, when oxide non-metallic inclusions with required properties are obtained, has made it possible to reduce considerably the pollution of metal with oxide inclusions as well.

In the final analysis, the total content of non-metallic inclusions in steel refined with synthetic slag, when appraised by the method of calculating the polluted fields of vision, is five to ten times lower than in steel of the same grade melted according to standard technology.

The decrease in the content of sulphur and non-metallic inclusions in steel is not an end in itself. This tends to change in the way of improvement many properties of steel and to better the behaviour of steel when in operation.

Non-metallic inclusions have the most pronounced effect on the operating characteristics of ball-bearing steel. The coarse inclusions on the working surface of rolling bearing parts or near it gradually crumble upon cyclic loading, being more friable in comparison with the metal. A site of destruction of the metal originated, and the bearing is put out of operation. There are many publications in which direct connection has been established between the content of coarse inclusions in the metal and the durability of bearings. There was therefore every reason to believe that steel refined with synthetic slag, containing as it does a smaller amount of inclusions, will possess greater fatigue resistance. The stand tests carried out on a great number of bearings have fully confirmed this assumption. The resistance of bearings made of steel refined with synthetic slag on the average exceeded by [illegible]% that of bearings of steel melted in the same furnaces according to standard technology.

The level of ductility at a preset strength and the uniformity of such properties is of considerable importance for structural steel of different destination, which is basic material in the manufacture of machines and mechanisms of every kinds. The high level of ductility enables steel products to withstand better dynamic loads and overloading and increases the resistance of steel to brittle rupture. The level of ductility is characterized by the values of elongation, necking and impact strength. In steel containing large amounts of various detrimental impurities, the latter are driven out upon crystallization to the boundaries of the grains and then their agglomerations stretch along the direction of rolling. As a result, the metal becomes weaker in the direction transverse to rolling and there appears an anisotropy of its properties. As the direction in which the efforts applied to steel products may greatly differ under operating conditions, the magnitude of anisotropy of the steel properties is, naturally enough, one of its major characteristics on which the durability of the products will depend to a considerable extent.

Table 2

Comparative content of sulphur in steel refined with synthetic slag and in steel melted according to standard technology

Grade of steel	Capacity of furnace, tons	Technology of melting	Number of heats	Number of heats with sulphur content of 0.006 pct or less, pct	Average content of sulphur, pct
ШХ15	100	Standard	100	38	0.008
		SSH	100	73	0.005
40ХНМА	40	Standard	14	21	0.008
	100	SSH	20	65	0.006
30ХГСА	40	Standard	16	12	0.009
	100	SSH	20	100	0.004
30ХГСНА	40	Standard	20	35	0.007
	100	SSH	18	95	0.004
18Х2Н4ВА	40	Standard	20	20	0.008
	100	SSH	20	85	0.005

Owing to smaller pollution with various detrimental impurities, steel refined with synthetic slag possesses a higher level of ductility across the direction of rolling, their greater uniformity, a smaller anisotropy of the properties and higher resistance to cold. Notably, the impact strength across the fibre in alloyed structural steel increases 1.5-2 times at room temperature and 1.5 times at low temperatures.

The index anisotropy of the properties of steel likewise increases 1.5-2 times.

In parts with a complex configuration there are practically always ready sites of destruction and concentration points of stresses in the shape of different slots, grooves, etc. For this reason a highly important feature of steel is its capacity for plastic deformation before destruction in a volume-stressed state and under conditions of concentration of stresses, and particularly at reduced temperatures. This feature was studied in tests of bending samples with a notch at different temperatures. The capacity of steel refined with synthetic slag for plastic deformation considerably exceeds that of steel melted according to standard technology.

The result is that the energy to be used for destroying steel refined with synthetic slag across the direction of the fibre exceeds on the average by [illegible] that of destruction of steel melted according to standard technology.

The great durability reserve of steel was also manifested at a number of machine building works in the reduction of rejected parts in cold stamping and upsetting. For instance, rejected nuts on account of cracks, quite considerable before, was completely eliminated at one of the automobile works.

The low level of pollution of steel refined with synthetic slag with detrimental impurities and, above all, with sulphur also guarantees a substantial improvement of its ductility at temperatures of hot deformation. For example, in torsional tests at a temperature of 1200°C, samples of chrome-silicon-manganese steel refined with synthetic slag were destroyed after approximately 100 twists, while samples of the same steel melted according to standard technology withstood only 50 twists. This highly important fact attests that steel refined with synthetic slag can be subjected to hot deformation with a greater degree of reduction in one passage than ordinary steel, without forming fissures and cracks.

It is well known that with a predetermined content of carbon in steel, its weldability deteriorates and its propensity increases to form crystallization cracks in the course of welding as the content of sulphur rises. That is why steel refined with synthetic slag, with a low content of sulphur, possesses considerably better weldability and a lesser propensity to form crystallization cracks. Such steel allows higher rates of welding and it can be applied within a wider range of highly-productive electroslag welding. Examination of the seam zone of welded joints of steel refined with synthetic slag has shown that metal with a lower content of sulphur is less friable in this zone in the course of the welding cycle. This is of great significance in the Soviet Union, since wide application of steel refined with synthetic slag for welded structures in the Far North areas will permit to raise substantially their reliability and prolong their service.

The use of steel refined with synthetic slag also entails considerable reserve of reducing the weight of welded structures. Special investigations have shown that with the sulphur content in the metal ranging from 0.006 to 0.0[illegible] pct, the carbon content in the metal may be raised by 0.[illegible]-0.03 pct without deteriorating weldability. The strength of the metal correspondingly increases and a possibility opens up for a proportional reduction in the thickness of the products to be welded. Investigations have been started at present, aimed at making practical use of the advantages of steel refined with synthetic slag as far as its weldability is concerned.

The list of the advantages of steel refined with synthetic slag, far from complete, unquestionably testifies to the great structural reliability and strength of such steel. These advantages became manifest, above all, in reducing the scrap of steel at iron and steel works and machine-building plants with regard to non-metallic inclusions, the occurrence of fine cracks, exfoliation, the discrepancy between the mechanical properties and the requirements, the deficiencies of welding, cracks upon sagging of parts, etc.

The reduction in scrap of steel is the first but not the most important consequence of introducing the new technology. The main effect is attained as a result of increasing the life of steel products.

life of steel products.

The cost of treating a ton of steel with synthetic slag amounts at present to about 4% of the cost of steel. The expenditure on treating steel with synthetic slag is only partly compensated by the reduction [illegible] spoilage at iron and steel works, while in the electric furnace making there [illegible] an additional economy of approximately [illegible]%, achieved through a shorter heat time. Furthermore, melting of alloying steel according to the new technology is economically advantageous owing to the decrease in rejected parts at machine-building works and, chiefly, to longer service of the [illegible]. Calculations indicate that an increase achieved only by increasing the resistance of [illegible] [illegible]% should completely make up for the expenses involved in treating with slag all the steel melted at present according to the new technology.

The prospects for improving the quality of steel intended for diverse application by refining it with liquid synthetic slag in the ladle are considered as being high in the Soviet Union. It is envisaged not only to extend in the next few years the application of this technology in melting alloyed steel, but also to embark on its introduction on making low-alloy and carbon steel for welded structures. This will be aimed both at improving the grade of the metal [illegible] of welded structures and at utilizing the possible increase in the strength of steel by raising the carbon content in it.

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