CATALOGUE

MATERIALS FOR LADLE TREATMENT OF MOLTEN METAL TO PRODUCE CAST IRON AND STEEL

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MULTICOMPONENT MICROCRYSTALLINE MODIFIERS (MKMS). GENERAL

Our company has developed a technology for manufacturing Fe-Si based **multicomponent microcrystalline modifiers (MKMs)** used for treatment of steels and irons in ladles in order to produce castings with improved mechanical and performance properties. Their large-scale commercial production and supply began in 1998.

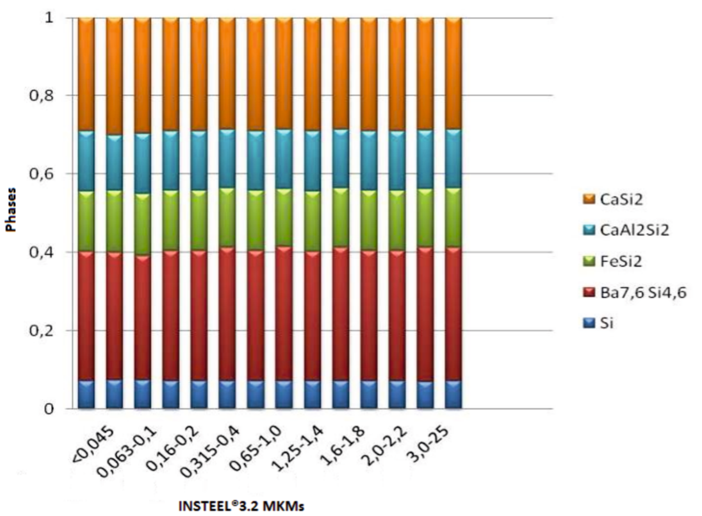
MKMs are produced by cooling liquid multicomponent alloys containing a number fo components in high concentrations, such as Mg (magnesium), Ca (calcium), Ba (barium), Sr (strontium), Ce (cerium), La (lanthanum), Zr (zirconium), Ti (titanium), etc. This process is known as "chips process".

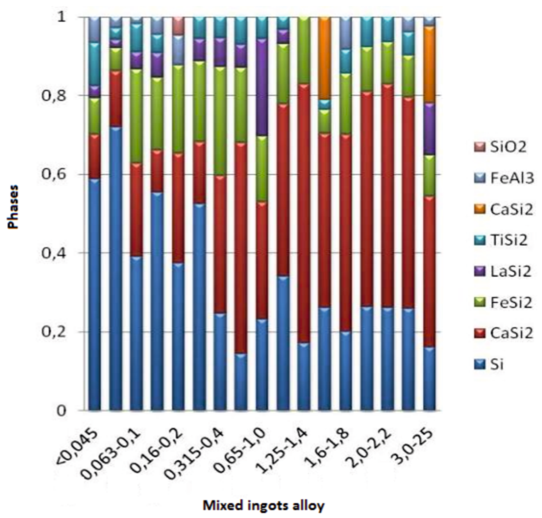
These liquid alloys are poured continuously using special-purpose, unique equipment. This equipment makes it possible to produce thin plates up to 5 mm thick, or chips, having a microcrystalline structure and uniform distribution of the active components. The chips have hardened surfaces and are not subject to segregation problems, which minimize their contact with atmospheric moisture and oxidization of the active components during storage.

The cooling rates (700-1,000 C/sec.) of the liquid alloys poured continuously are higher than those of the liquid alloys poured into molds where they solidify. As a result, their phases are 5-10 times smaller. The high cooling rates also promote the compacted structure of chips.

Rapid cooling also minimizes segregation of magnesium, calcium, and other light components, significantly increases the homogeneity of the chemical composition of the MKMs (Figure 1), and minimizes the content of the gases dissolved in them.

Chips have non-equilibrium structures and enlarged reactive surfaces. As a result, they are dissolved at higher rates when used for treating steels and irons, and the recovery of their easily fusible components increases.





Phases of active components and their distribution in INSTEEL® MKM and modifier in ingot form

Research undertaken by Metals Institute (Federal State Budgetary Scientific Institution) of Urals Branch of Russian Academy of Sciences in Yekaterinburg.

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USE OF MKMS INSTEAD OF MODIFIERS IN INGOT FORM MAKES IT POSSIBLE TO:

- increase the duration of the modification effect
- increase the recovery of easily oxidized components during treatment of steels under the same conditions of introduction of both MKMs and modifiers in ingot form
- reduce flare during modification of irons by modifiers high in magnesium content in open-type ladles
- reduce consumption of modifiers
- minimize contamination of high-quality steels by gases during extra-furnace steel processing.

MKM chips following melting

Crushed MKMs

The correct choice of modifiers will enable you to minimize the expenses you incur to produce quality castings with maximum product yield.

If you are still insufficiently experienced in choosing and using modifiers or lack the necessary experience altogether, turn for help to our company's specialists!

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MODIFICATION AS A DETERMINANT OF PROPERTIES OF STEEL INGOTS AND CASTINGS

The reliability, durability and other performance properties of parts made from products of steel casting for machines and other equipment **can be improved subject to successful removal from the melt of detrimental impurities** (oxygen, hydrogen, sulfur, phosphorus, non-ferrous metals, etc.), **alteration of the morphology of remaining non-metallic inclusions** (NMI) and minimizing their negative impact on the quality of metal products.

Cast steels differ from steels undergoing deformation (rolling, stamping or forging) in that all the peculiarities and shortcomings of the casting and pouring processes are reflected in the properties of finished cast products. All things being equal, the performance reliability of cast products depends more on the methods of casting and pouring than that of steels undergoing deformation.

Cast steels are distinguished by having noticeable initial traces of damage such as microscopic pores, cavities and cracks. Intercrystalline membranes of oxides, sulfides and nitrides may form on the boundaries of initial large grains. Among other things, cracks may spread along them more easily than across the base metal.

Cast steels have larger primary grains and their refinement constitutes a difficult task. Cast steels also have more pronounced inequigranular structure. Heat treatment of castings using normal modes does not fully eliminate the structural peculiarities of cast steels. To lessen chemical heterogeneity, it is advisable to perform high-temperature homogenization followed by normalization. However, it is not always possible to carry out such operations. It is difficult to quench and temper large castings weighing over 0.5 tons to improve their properties. The same is true of mass-produced castings. So their heat treatment is limited to normalization.

When cast steels are tested, it has been observed that their failure characteristics are spread over a wide range. Thus, during cyclic loading cast steel samples may have both higher and lower durability. Lower durability may be attributed to increased crack growth rates.

In the iron and steelmaking industry characterized by the utilization of multi-tonnage facilities, a wide range of products is used to improve the quality of molten metals poured. This improvement process is known as treatment of molten metals in the ladle. The methods of treatment include treatment by slag mixtures, argon blowing, degassing, deoxidization and modification.

Steel foundries normally do not have special-purpose equipment for treating steels outside the furnace. In light of this, the only and, as experience has shown, efficient method for improving the quality of steels is using **special-purpose multicomponent alloying modifiers** for treating the melt in ladles.

Modification (and inoculation as its variation) of molten metals is a fundamental process that involves active influencing the state of molten metals before their crystallization by means of introduction into them of small quantities of substances (modifiers, inoculants) leading to the alteration of the morphology of their non-metallic inclusions (their size, shape and pattern of their distribution. Addition of modifiers changes the energetic state of the melt, lessens the contamination of the boundaries of the grains of the metal matrix, and results in better mechanical and technological properties of steel castings.

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Modifiers influence the rate of solidification and undercooling. Besides, they contribute to the removal of the impurities of such non-metals as oxygen, sulfur, nitrogen and phosphorus and form high-melting compounds with the impurities of non-ferrous metals.

Until recently, the steelmaking and foundry industries have been using largely a calcium-based modifier, **either fused silicocalcium, a binary alloy mixed by fusion**, or blended ferrocalcium.

Using calcium-containing modifiers for treating steels outside the furnace such as silicocalcium and ferrocalcium makes it possible to transform aluminum oxides into calcium aluminates that can rapidly leave the molten metal. This results in a significantly lower degree of contamination of the melt with NMI, better mechanical properties and higher crack resistance. However, due to calcium's peculiar properties, viz., high vapor elasticity and low solubility in iron, its positive influence on the metal is not sufficient and consistent (its recovery in the melt ranges between 7% and 40%).

A solution to the problem may be the use of multicomponent modifiers containing, besides calcium, other alkaline-earth metals (AEM) like barium, magnesium, as well as rare-earth metals (REM) like cerium, lanthanum. They could increase the effect of calcium.

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ENGINEERING SUPPORT

NPP Group's Engineering Support personnel boast many years of practical experience in fine-tuning a variety of modification processes used in the iron and steel foundry industry. They have provided consulting services for more than 400 companies within the foundry and metallurgy sectors of the Russian Federation, Commonwealth of Independent States and European Union, which made it possible for them to achieve the desired results. Based on a foundry's technology-related tasks, NPP Group's Engineering Support personnel can readily select the most efficient products: modification agents, master alloys, refining briquettes, in the mold inoculant blocks, etc. and develop appropriate modification methods.

PP Group provides the following types of engineering support:
- process audits
- development of steel and iron modification methods

Engineering support from NPP Group comes in two forms:
- Consultation by correspondence based on the source data provided by customers about the foundry processes employed by them.
- On-the-spot support involving visits by NPP Group's Engineering Support personnel to customers, adjusting or rectifying their foundry processes and performing tests under laboratory conditions and on the shop floor.

* NPP Group provides engineering support services to its clients free of charge.
To discuss terms and conditions call 8 (351) 210 37 37.

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INSTEEL®
SERIES OF MULTICOMPONENT MODIFIERS FOR EXTRA-FURNACE STEEL PROCESSING

Our company produces **INSTEEL®** multicomponent modifiers used for extra-furnace steel processing. They contain such chemically active components as **Ca, Sr, Ba, Ti, Zr, Ce, La**, etc. Their combination and quantitative content in particular grades depend on the specific conditions of their application and challenges faced by a particular foundry plant working to meet quality requirements.

INSTEEL® modifiers are produced by using a proprietary technology called "chips process". The modifiers produced by using this technology have characteristically dense, highly dispersed structures and low gas saturation.

All INSTEEL® multicomponent modifiers significantly increase steel fluidity. High fluidity ensures good castability and thus proper feeding of thin-section castings, They also make it possible to lower pouring temperatures and solve the problem of shrinkage defects.

Besides, each **INSTEEL®** series **modifier** additional particular properties.

1. INSTEEL®1.3, INSTEEL®1.5 and INSTEEL®6.1 modifiers
are the grades of modifiers used predominantly to solve problems caused by the significant contamination of carbon, low- and medium-alloy steels by non-metallic inclusions resulting in low fluidity of steel and structural defects of castings.

They contain such chemically active components as **Ca** and **Ba** in various proportions, have different degrees of efficiency, which makes it possible to vary their use depending on the degree of initial contamination of the melt and possible limitations on silicon in it. **Calcium** contained in these modifiers has low solubility in iron, reacts actively with oxygen, sulfur, hydrogen and other elements, purifies the boundaries of grains of carbonitrides, sulfides that make steels brittle. Calcium promotes modification of the products of aluminum deoxidization leading to the formation of readily removable globular NMI.As a result, **the pliability and impact strength of steels increases**. Calcium vapors are highly resilient, which significantly decreases its recovery in steel in the absence of barium.

Barium (Ba) does not easily dissolve in iron but, unlike calcium, it has a low pressure of vapors in the zone where its modifier dissolves (5.2 kPa at 1,600C).As the melting point of barium is relatively low (710C), it reacts earlier and more efficiently with oxygen and sulfur, and its high surface tension (wettability) promotes rapid and complete removal of reaction products.

The presence in one modifier (alloy) of calcium and barium which are fully reciprocally soluble, when liquid, lowers the elasticity of their vapors in steel. Due to a slower rate of evaporation of the elements the period of reaction of calcium with the melt increases. As a result, its purification of oxygen and sulfur progresses more efficiently and the degree of calcium recovery increases due to the modification of a larger amount of NMI.

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2. INSTEEL®11 modifier contains zirconium **Zr** in addition to its main components **Ca** and **Ba**. **Zirconium** is a multi-functional element as it acts as a deoxidizer, desulfurizer and denitrizer. It prevents other elements (vanadium and boron) from interacting with oxygen and nitrogen. Additions of zirconium as well as titanium to the melt result in the formation of carbosulfides.

Zirconium also combines with other elements to form Zr(N,C), ZrSx or Zr4S2C2.Due to its significant affinity to nitrogen, zirconium can force nitrogen out of aluminum nitrides. Interaction of ZrN with (Zr,Mn)S results in the formation of inclusions having the shape of angular crystals. Zirconium carbonitrides also form as thin layers around sulfides.

Zirconium is used as a microalloying element to increase the strength, toughness, wear- and corrosion resistance, hardenability, weldability and workability of steels.

The INSTEEL®11 modifier has shown high efficiency when used for producing heavy-duty cast products utilized for the manufacturing of rolling stock for the Russian Railways (railway carriage frames and beams). It increased the impact strength of steels at low temperatures (KCV-60).

3. INSTEEL®3.2, INSTEEL®3.3 and INSTEEL ®10.1 modifiers, besides such main elements as **Ca** and **Ba,** also contain REM, predominantly **cerium (Ce)** and/or **lanthanum (La)** in various concentrations.

The effects of REM on steels are diverse. Their use not only results in efficient globularization of non-metallic inclusions but also makes it possible to change conditions under which castings solidify.

Formation of REM hydrides **promotes high corrosion resistance of steels.** REM, in their turn, are capable of forming high-melting and hard intermetallic compounds (intermetallics) with non-ferrous metals, which eliminates intercrystalline low- and high-temperature brittleness thus increasing the plastic properties of steels.

REM significantly influence conditions under which steels solidify modifying the macro- and microstructure of ingots and castings. REM oxides, sulfides and nitrides as well as intermetallics **produce a modification effect on the structure of steels,** contributing to their strength. Additions of REM decrease the segregation of liquating elements (carbon, sulfur and phosphorus), reduce the value of the columnar zone, the size of equiaxed crystals and the distance between dendritic branches. This deeper impact on the structure of steels **significantly improves the crack resistance of ingots undergoing subsequent forging.**

4. The INSTEEL®5.1 and INSTEEL®5.2 modifiers also contain **Ca, Ba and RE,** but higher concentrations thereof, which significantly increases their efficiency when solving special problems. For example, ladle treatment of steels used for underground and underwater pipelines, which are continuously exposed to factors causing corrosion, makes it possible to significantly increase their service life. These modifiers are also quite efficient for ladle treatment of steels used for manufacturing **corrosion resistant shut-off valves.**

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5. The INSTEEL®4.4 and INSTEEL®7 modifiers, in addition to **Ca, Ba and RE**, contain **titanium (Ti).** **Titanium** is a strong deoxidizer. It efficiently impacts the phase composition and morphology of non-metallic inclusions by additionally deoxidizing steel, increases the solubility of hydrogen in steel thus preventing pinholes from appearing in castings.

Titanium is a strong deoxidizer. It efficiently impacts the phase composition and morphology of non-metallic inclusions by additionally deoxidizing steel, increases the solubility of hydrogen in steel thus preventing pinholes from appearing in castings.

Depending on its concentration in steels and their chemical composition, titanium form carbides (TiC), sulfides (TiS), carbosulfides (Ti4C2S2) and nitrides (TiN).Carbides increase the hardness of steels to a greater degree. Titanium injected into molten steel forms TiNs forms nitrides as early as during the pre-crystallization and crystallization periods. By binding sulfur and nitrogen and forming infusible particles, titanium not only produces a modifying influence on the process of crystallization but also performs a barrier function as a refiner of austenite grains during processes of heat treatment.

Titanium is used to prevent intercrystalline corrosion **when manufacturing corrosion-resistant ferritic and austenitic steels.**

Injection of microadditions of titanium into steel promotes fine-grained structure and reduces the tendency of steel towards the formation of hot cracks.

Titanium increases the wear resistance of steels as they resist increasingly the development of plastic deformation at its initial stage and their hardness increases. It also impacts their mechanical properties by not only refining austenite grains but also by reinforcing them and strengthening intergranular bonds.

6. The INSTEEL®9.3 and INSTEEL®9.4 modifiers, in addition to **Ca, Ba,** also contain **Sr.** Strontium and other AEM contained in multicomponent alloys enhances the impact of calcium and barium on the various properties of steels: their flowability and mechanical properties.

The use of this modifier makes it possible to obtain a high degree of calcium recovery and highest impact strengths at temperatures below freezing.

Based on the obtained results with regard to modification, it is safe to assume that strontium, as compared to barium, more efficiently protects calcium from oxidization and transforms it into a microalloying element, making the dendrite structure of steel castings more refined and improving steel properties.

7. INSTEEL® modifiers can be manufactured to have such chemical compositions as to meet individual customers' requirements. They may also contain boron and vanadium.

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BARSI-CA
MULTICOMPONENT SLAG DEOXIDIZER

BARSI-Ca is a mixture of chemical compounds containing Ba, Si and Ca.
They have the ability to deoxidize and refine the slag in electric arc furnaces that have acid lining.

BARSI-Ca is added to the slag in a furnace 3-5 minutes before the melt is tapped immediately after ferromanganese is introduced. **BARSI-Ca,** being a multicomponent deoxidizer, creates conditions for the diffusion deoxidization of steel and makes it possible to significantly save ferroalloys. Injection of **BARSI-Ca** into a ladle during tapping promotes refinement of steel, increases its fluidity, which, in its turn, makes it possible to decrease the temperature of steel pouring by 10-20°C.

The use of **BARSI-Ca** makes it possible to decrease consumption of the standard deoxidizers used to manufacture various grades of steel, viz: FeSi up to 16%, FeMn up to 8% and Al up to 50% respectively.

Its use for deoxidization of steel prior to its treatment in a ladle by **INSTEEL**® modifiers increases significantly their efficiency.

The average consumption of this multicomponent is 7.5 kg/t.

The BARSI-Ca deoxidizer is delivered in PE-lined big bags with capacities of 0.5 and 1.0 tons, in paper bags with capacities between 5 and 25 kg and cored wires.

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SKB REFINERS

SKB-2M and **SKB-20У** refiners serve to refine the molten metal in ladles to further produce cast iron and steel. These refiners are mixtures of carbonates of the alkaline-earth metals, which are strontium, calcium and barium, in powder form. The mixtures have optimized chemical compositions.

These refiners are used:
- to improve the fluidity of molten metals;
- to improve the mechanical properties and performance of castings;
- to improve the plasticity of castings and ingots;
- to reduce the tendency of castings to crack
- to improve the micro- and macrostructure of castings

Applications:
A refiner is placed on the bottom of a preheated ladle in a ratio from 0.2 to 0.5% of the weight of the metal being treated. Base iron of correct composition is then teemed on to it. Subsequently, the base iron is held for 5-10 minutes for the relevant reaction to come to an end and a scum to form on the surface of the melt. It is then skimmed off and the melt is poured out.

Following refinement, the melt is to be poured out of the ladle within 15-20 minutes.

Sizes:
To facilitate introduction of refiners into the melt, they are supplied in size 0-40 mm and in size 0-3 mm in palletized and powder form respectively.

Packaging:
Paper bags with capacities of 5, 10, 15, 25 kg.

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ALCAR® MULTICOMPONENT FE- AND NI-BASESILICON-FREE MASTER ALLOYS

These multicomponent silicon-free master alloys are used to produce ingots of heat resistant and low-silicon steels.

1. **ALCAR®Fe** multicomponent silicon-free master alloys are used to treat carbon, low-, medium- and high-alloy steels and alloys.

2. **ALCAR®Ni** multicomponent silicon-free master alloys are used to treat low-, medium- and high-alloy steels and alloys.

Fe- and Ni-based master alloys contain such elements **Ca, Al, Nb (niobium), Ti, B (boron), V (vanadium) and REM.**

Nickel imparts corrosion resistance, high strength and ductility to steel, increases its hardenability, and makes an impact on the coefficient of thermal expansion.

Vanadium increases the hardness and strength of steel and contributes to grain refinement. It also increases the density of steel because it is an efficient deoxidizer.

The influence of vanadium in low-alloy steels is determined, to a considerable degree, by their carbonitride strengthening including:
- dispersion strengthening
- grain refinement
- formation of the perfect grain microstructure

Vanadium carbonitrides serve as nucleating centers when new austenite grains are formed during the process of heating above critical points and promote formation of more refined austenite grains.

Niobium is a strong carbide forming element. It slightly lowers the value of impact strength but induces a significant decrease in the ductile-to-brittle transition temperature evaluated on the basis of a ductile constituent percentage in the fracture of impact-test specimens. As compared to vanadium, niobium is more efficient carbide for thermally strengthened steels. It influences more significantly the stability of austenite by means of suppressing the processes of ferrite formation.

A niobium addition promotes significant refinement of the structure and increases stability against austenite grain growth. It improves the quality of steels in three ways:
- by refining austenite and ferrite grains and impeding the recrystallization and growth of grains
- by suppressing the nucleation of polygonal ferrite as a result of increased hardenability
- by increasing the strength due to separation of niobium carbonitrides during the process of cooling of steel or subsequent aging

Boron microalloying is used:
- when producing carbon steels: for increasing hardenability
- when producing low-alloy steels: for reducing to a lesser extent their alloying by using expensive and critical elements (molybdenum, nickel) without compromising their mechanical and performance properties. Concurrently, such operational characteristics they have as cuttability, weldability and cold working property improve

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INOCULANTS FOR GRAPHITIZING TREATMENT OF IRONS

Graphitizing treatment of irons involves introducing chemically active elements into them when they are liquid, which contributes to the formation of additional centers of graphite crystallization.

This treatment makes it possible, among other things, to achieve the following objectives:
- to prevent formation of cementite in the structure of irons
- to reduce the likelihood of appearance of gas- and shrinkage-related porosity defects
- to improve the mechanical properties of irons
- to make the structure of irons more uniform in sections of castings having uneven wall thicknesses

Our company offers the following grades of efficient inoculants with microcrystalline structures for graphitizing treatment of gray and ductile irons:
SIBAR®, R-GRAPH®, Z-GRAPH®, Si-extra®, ZIRCALLOY®, INOCSIL®

Depending on the method of introducing inoculants into liquid irons the sizes of inoculant particles may range between 0.2 and 20 mm.

Inoculants are supplied in PE-lined big bags with capacities of 0.5 and 1.0 tons and, at the customer's option, in paper bags with capacities between 5 and 25 kg or PE bags with capacities between 1 and 3 kg, cored wires.

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SIBAR® INOCULANT FOR GRAPHITIZING TREATMENT

The grades of this inoculant are as follows:
SIBAR®2, SIBAR®4, SIBAR®4M, SIBAR®7, SIBAR®7M, SIBAR®12, SIBAR®22

Each grade contains a range of chemically active elements such as **Ca, Al, Ba, Mn** and **Si** in optimum proportions. Each subsequent grade is more efficient than the preceding one with their consumptions being equal. The efficiency of inoculants and the duration of their inoculating effect increase with increases in contents of barium in them in combination with high contents of silicon and specified amounts of calcium and aluminum. However, an addition of manganese makes the duration of the inoculating effect grow longer with the content of barium being relatively low. The most efficient inoculants of these grades in terms of their effect duration make it possible for graphite inclusions remain in irons in large quantities for thirty minutes following their treatment.

Each of these inoculants can be used for graphitizing treatment of both gray and ductile irons. The choice of the grade depends on the technical and economic expediency of its application for solving particular production tasks.

Treatment of irons with SIBAR® inoculants makes it possible to achieve the following objectives:
- to prevent formation of cementite inside the portions of castings whose cross sections are thin and on the surface of castings
- to make the structure of castings having complicated cross sections more uniform
- to improve the mechanical properties of irons

Standard sizes of inoculant particles:
- 0.8-3 mm for inoculants introduced into the molten metal as it enters a ladle
- 1-10 mm for inoculants placed at the bottom of a ladle
- 0.2-0.8 mm for inoculants introduced into the molten metal as it enters a mold
- Cored wires

In the case when molten metal is poured into a ladle, 1.0-3.0 kg of inoculants is consumed per 1 t of iron. In the case when molten metal is poured into a mold (delayed modification), twice as small an amount of inoculants may be consumed.

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Select the correct size of modifiers. Large particles of a modifier do not have sufficient time to dissolve and float. As a result, the final stages of reactions occur on the surface of molten metal leaving part of it untreated.

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R-GRAPH® INOCULANTS FOR GRAPHITIZING TREATMENT

The main component of the **R-GRAPH®** inoculant is **cerium (Ce).** It is a rare earth metal. Combining with small amounts of calcium and aluminum it impacts significantly the structure of the cast iron being treated and binds tightly oxygen to sulfur and the traces of non-ferrous metals present in the cast irons produced in EA furnaces. Thus, it creates a large amount of additional graphite crystallization centers and the strength properties of resultant castings significantly improve.

As cerium has high density, the compounds it forms with non-metallic inclusions and non-ferrous metals are not prone to liquation and can stay in the melt for a long time **thus extending the inoculating effect.** This asset is particularly important when large amounts of molten iron are poured for long periods of time.

The **R-GRAPH®** inoculant can dissolve in liquid irons at relatively low temperatures. Due to this, it can **efficiently treat "cold" cupola melted irons at temperatures as low as 1,200°C.**

Standard sizes of inoculant particles:

- 0.8-3 mm for inoculants introduced into the molten metal as it enters a ladle
- 1-10 mm for inoculants placed in the bottom of a ladle
- 0.2-0.8 mm for inoculants introduced into the molten metal as it enters a mold
- Cored wires

In the case when molten metal is poured into a ladle, 2-3 kg of inoculants is consumed per 1 t of iron. In the case when molten metal is poured into a mold, twice as small an amount of inoculants may be consumed.

! It is important to know that fading of a modifier should be kept track of from the moment modification is completed not from the moment the ladle with molten mold is about to be emptied into molds.

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Z-GRAPH® INOCULANT FOR GRAPHITIZING TREATMENT

The grades of this inoculant are as follows:
Z-GRAPH®, Z-GRAPH®TM, Z-GRAPH® TP and Z-GRAPH®R

When graphite flake cast iron produced in EA furnaces is used for making castings, particular problems may arise. Often they are caused by local superheating, high casting speeds, and a large amount of scrap and various carburizers in charged materials. In addition, it increases the chilling tendency for cast irons, and the likelihood of appearance of gas- and shrinkage-related porosity defects. It also worsens their workability.

To solve the abovementioned problems, our company has developed a line of inoculants under the trademark **Z-GRAPH®** for treating irons produced in electric-arc furnaces.

The graphitizers contain different concentrations of **Ba, Mn, Ca, Zr.** The **Z-GRAPH®R** graphitizer contains **cerium (Ce)** and **lanthanum (La)** instead of barium.

The chemically active elements contained in the inoculants affect cast irons by refining their graphite inclusions on the one hand, and increasing their amount on the other. As a result, the mechanical properties of cast-iron castings improve in all their cross-sections. The presence of Zr and Ba in the first three inoculants makes it possible to produce thin-walled castings free of chilling defects, neutralize the harmful influence of nitrogen that leads to the formation of gas- and shrinkage-related porosity defects.

The inoculants are used to efficiently treat cast irons having low carbon equivalent values.

Use of the**Z-GRAPH®TP** inoculant for many years has proved efficient in treating cast irons used for manufacturing high-pressure equipment (hydraulic distribution valves and high-pressure pumps). This inoculant increases the density of cast irons thus improving the leakproofness of parts and components made from them.

The **Z-GRAPH®R** inoculant has an optimum combination of REM and zirconium.
It has **the unique property** of influencing the formation of favorable finely dispersed carbide phases **during the crystallization of special-purpose wear resistant cast irons.** Its use for ladle treatment of irons that are used **for manufacturing parts and components for mining equipment makes it possible to essentially improve their performance characteristics.** The final product of such treatment is wear-resistant chrome iron.

Standard sizes of inoculant particles:
- 0.3-2 mm for inoculants introduced into the molten metal as it enters a ladle
- 2-6 mm or 1-10 mm for inoculants placed at the bottom of a ladle
- 0.2 -0.8 mm for inoculants introduced into the molten metal as it enters a mold
- Cored wires

In the case when molten metal is poured into a ladle, 1-3 kg of inoculants is consumed per 1 t of iron. In the case when molten metal is poured into a mold, twice as small an amount of inoculants may be consumed.

! Calculate precisely the amount of a modifier to be added. The amount depends on the treatment process to be used. Saving on modifiers may lead to inconsistent of treatment process.

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SI-EXTRA® INOCULANT

The grades of this inoculant are as follows:
Si-extra® B, Si-extra® S, Si-extra® Z and Si-extra® Z-S

These highly efficient graphitizing inoculants are used for the production of grey irons with high and medium content of sulfur.

Such chemically active components as **Ba, Zr, Sr** and **RE** in small concentrations in combination with high-concentration silicon (up to 80%) produce a powerful graphitizing effect when the inoculants of these grades are added to the melt during the period of its precrystallization even in small quantities.

Treatment of irons with these inoculants makes it possible to solve the following objectives:
- prevent appearance of chilling defects in thin-walled castings when cooling occurs at high speeds
- promote uniform distribution of type A graphite in the structure of the melt
- neutralize the harmful influence of nitrogen that leads to the formation of gas- and shrinkage-related porosity defects
- enhance the mechanical properties of cast iron

Si-extra® inoculants are used successfully to treat irons utilized for manufacturing by chill casting piston rings for internal combustion engines and fittings for high-voltage electric networks.

Standard sizes of inoculant particles:
- 0.5-3 mm for inoculants introduced into the molten metal as it enters a ladle
- 3-10 mm for inoculants placed at the bottom of a ladle
- 0.2-0.8 mm for inoculants introduced into the molten metal as it enters a mold
- Cored wires

In the case when molten metal is poured into a ladle, 0.5-2 kg of inoculants is consumed per 1 t of iron.

In the case when molten metal is poured into a mold, twice as small an amount of inoculants may be consumed.

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Arrange for modifiers to be kept under conditions of proper storage. Modifiers contain chemically active elements, part of which may absorb moisture from the environment.

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ZIRCALLOY® AND ZIRCALLOY® SUPER INOCULANTS FOR GRAPHITIZING TREATMENT

Such chemically active components as **Al, Ca** and **Zr** in combination with high-concentration silicon make it possible to efficiently treat molten iron for further production of ductile cast irons with low content of sulfur.

Treatment of molten iron makes it possible to:
- prevent appearance of chilling defects in thin-walled castings
- promote uniform distribution of graphite in the structure of the melt
- enhance the mechanical properties of cast iron
- neutralize the harmful influence of nitrogen that leads to the formation of gas- and shrinkage-related porosity defects.

Addition of manganese to the ZIRCALLOY® Super inoculant makes it possible to slow down the weakening of the spheroidizing effect during long periods of pouring large amounts of molten metal into pouring ladles.

Standard sizes of inoculant particles:
- 0.5-6 mm for inoculants introduced into the molten metal as it enters a ladle
- 0.2-0.8 mm for inoculants introduced into the molten metal as it enters a mold
- Cored wires

In the case when molten metal is poured into a ladle, 1-3 kg of inoculants is consumed per 1 t of iron. In the case when molten metal is poured into a mold, twice as small an amount of inoculants may be consumed.

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INOCSIL INOCULANT®
FOR GRAPHITIZING TREATMENT

The grades of this inoculant are as follows: INOCSIL®1 - INOCSIL®6

The inoculant contains **Al, Ca, Ba** and **REM** with **silicon** content being about 75%.

These efficient and quick dissolving inoculants serve to treat molten metal to produce ductile iron. They decrease formation of carbides in thin-walled castings. The chemically active components of these inoculants combine to make the inoculating effect more extended as compared to the standard FeSi75 inoculant.

The **INOCSIL®1** and **INOCSIL®2** inoculants are used when producing ductile iron castings from GGG40 cast iron. They promote ferritization of the metal matrix of irons thus significantly enhancing their ductility.

When large amounts of molten metal are to be poured during long periods of time, the **INOCSIL®3** inoculant is quite efficient when introduced into pouring ladles.

The **INOCSIL®6** inoculant is highly efficient for producing **SG** iron grades. It makes it possible to prevent graphite degeneration in massive castings.

Standard sizes of inoculant particles:
- 0.5-6 mm for inoculants introduced into the molten metal as it enters a ladle
- 0.2-0.8 mm for inoculants introduced into the molten metal as it enters a mold
- 0.2-2 mm for filling powders in cored wires

In the case when molten metal is poured into a ladle, 1-3 kg of inoculants is consumed per 1 t of iron. In the case when molten metal is poured into a mold, twice as small an amount of inoculants may be consumed.

! When pouring molten metal from a furnace, both the molten metal and the modifier being added to it should be stirred turbulently.

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INOCSIL®F AND Z-GRAPH®F INOCULATING ELEMENTS FOR IN-MOLD MELT TREATMENT

These efficient inoculating elements are used for in-mold melt treatment to produce grey and ductile irons. They are introduced into the gating system of a mold. The **Z-GRAPH®F** inoculating element is used when castings have chilling tendency.

Using these inoculants for in-mold melt treatment makes it possible to solve the following objectives:
- to formation of cementite in the structure of iron castings
- to improve the mechanical properties of irons
- to make the structure of irons more uniform in sections of castings having uneven wall thicknesses
- to form additional centers of crystallization

These inoculating elements have the following distinctive features:
- active dissolution in irons at low temperatures due to their chemical composition
- user-friendly as they have fixed weights and dimensions adapted to customers' gating systems
- the method used for their manufacture makes it possible to ensure the required concentrations of active elements
- consumed much more economically as compared to inoculants in crushed form used for ladle treatment

Inoculating elements

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SIBAR®4F
INOCULANT FOR LATE INOCULATION

Our company is ready to offer an inoculant for late graphitizing treatment of molten metals in pouring basins to produce grey and ductile irons. Candy bar shaped inoculants are added to molten metals in pouring basins or ladles favoring formation of additional crystallization centers.

Late inoculation makes it possible to achieve the following objectives:
- to prevent formation of cementite in the structure of irons
- to improve the mechanical properties of irons
- to make the structure of irons more uniform in sections of castings having uneven wall thicknesses

The SIBAR®4F inoculant has the following distinctive features:
- Its structure makes it possible for it to fully dissolve in irons at low temperatures
- Bars are easy to measure out as they have fixed weights and can be readily split into several portions by weight
- Bars are easy to transport due to their shape
- The inoculant is not subject to crumbling and does not give off powder residue
- The method of the inoculant's manufacture makes it possible to ensure the required proportions of chemically active elements in it

SIBAR®4F inoculant

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INOCSIL®S
INOCULANT FOR LATE INOCULATION

The **INOCSIL®S** inoculant comes in the form of **cast inserts** used for late inoculation of molten metal in a pouring basin or sprue to produce medium- or large-sized castings. The inserts have fixed weights, dimensions and chemical compositions.

INOCSIL®S inserts are placed in molds or at the bottom of pouring basins. Late inoculation makes it possible to significantly reduce consumption of this graphitizing inoculant. The chemical composition of the inoculant is determined depending whether it is going to be used for production of grey or ductile irons.

Use of the **INOCSIL®S** inoculant yields maximally consistent results as its weight and physical properties remain unchanged from one casting operation to another. The inoculating effect occurring when **INOCSIL®S** inserts are used lasts longer than that when crushed inoculants are used. The optimum temperatures for casting iron are 1350-1450°C.

Standard forms of delivery:
- Cast inserts weighing between 2 and 60 kg with required dimensions

Consumption:
- 0.8-1.4 kg per 1 t of iron when placed in pouring basin

Packaging:
- steel bucket and drums
- pallets

INOCSIL®S inserts

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SPHEROIDIZERS

There is quite a variety of casting technologies as well as that of physical, mechanical and performance properties castings are expected to conform to. Worldwide production of high-quality ductile iron castings (as well as other high-quality castings) has shown that there is no single all-purpose modifier making it possible for them to conform to these properties. This is the reason why our company produces a wide variety of analytical grades of modifiers. This enables foundry experts to select application-specific modifiers with the required composition and concentration of active components that makes it possible to produce castings possessing the requisite properties under specific casting conditions.

Spheromag®, Spheromax®, SIMAG® and **VERMILOY®** multicomponent spheroidizers with microcrystalline structure (MKMs) produced by our company contain various concentrations of magnesium, calcium, barium and REM. Using a variety of spheroidization methods and techniques makes it possible to produce ductile and compacted iron castings on a consistent basis.

The cooling rates (700-1,000°C/sec.) of liquid MKMs are higher than those of liquid ispheroidizers cast into molds where they crystallize and solidify. As a result, their phases are 5-10 times smaller.

The high cooling rates also promote compacted, highly dispersed structure of the MKMs (chips) and uniform distribution of phases within them.

Liquid iron in ladles is treated by MKMs more uniformly. For example, microcrystalline spheroidizing modifiers, or spheroidizers, have small magnesium-containing phases (10-20 m). As a result, the magnesium vapor bubbles are also small, and subsequently, the surface and time of its contact with the liquid iron are maximally optimum. This factor increases its residual content in the iron.

Liquid MKMs have fine grains and their density increases as they crystallize. Rapid crystallization promotes more homogeneous phase composition and more uniform distribution of the active components of the MKMs such as AEM and REM. Besides, AEM and REM do not accumulate locally and MKMs do not disintegrate with time, which is typical of magnesium-containing spheroidizers in ingot form.

!

Take the temperature of molten metal into consideration when treating it with Mg.
High temperatures result in a low degree of magnesium recovery.

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SPHEROMAG® AND SPHEROMAX® SPHEROIDIZERS

These spheroidizing modifiers are used for treating iron in ladles and molds.

1. SPHEROMAG® 611, 711, 621, 721, 631, 731 spheroidizers are predominantly used to treat iron in the ladle when producing castings having pearlite and pearlite-ferrite structures by means of the sandwich process. These castings are in high demand by the machine-building industry where they are used in critical assemblies

The choice of spheroidizers and their consumption depends on the quality of molten metal, viz: the content in it of such detrimental impurities as sulfur and phosphorus as well as carbide-forming and deglobularizing impurities such as chromium, vanadium, titanium, etc., the saturation of the molten metal with dissolved gases such as oxygen, nitrogen and hydrogen. The more impurities the molten metal contains, the more active components the spheroidizer in question should contain. In fact, the numerical grade designations of spheroidizers indicate the average percentage contents of magnesium, calcium and REM.

When selecting the grade, it is also necessary to consider the temperature of the molten metal when it is poured from the furnace into a treatment ladle. The higher the temperature, the higher percentage content of calcium should be. Calcium significantly reduces losses of magnesium as it combines with the latter to form an intermetalide whose dissociation temperature is higher than that of magnesium silicide. Calcium contained in spheroidizers not only reduces magnesium losses caused by flare but also reacts with some of the oxygen and sulfur contained in the molten metal, and as a result they exit the melt as slag.

All spheroidizer grades contain REM whose content does not exceed 1%. They slow down the growth rate of globules, which makes the microstructure of the melt more refined. They also promote binding of non-metallic inclusions thus forming additional graphite crystallization centers, and the strength properties of resultant castings significantly improve.

Spheromag® 611, sizes 1-6 mm

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2. SPHEROMAG5212, 7103, 7223, 6509 and **6529 spheroidizers** have been developed by our company to treat molten metal to produce ductile iron castings. Ductile iron has a ferrite matrix. Such castings are used to manufacture large-sized items subjected to heavy mechanical loads while in operation. These grades contain barium so the grade designations have four digits. Barium encourages formation of graphite crystallization centers and discourages formation of cementite.

The optimum combination of such chemically active elements as magnesium, calcium, barium, cerium and lanthanum favors formation of a ferrite structure with a high degree of graphite spheroidization (up to 98%) and a large amount of graphite globules (up to 200 pieces per 1 mm2 of the microsection area). These globules are small (20-300 m), which contributes to the ductility and strength of the castings.

3. SPHEROMAG500, 600 and **700 spheroidizers** are used **for in-mold treatment of molten metal to subsequently produce spheroidal graphite iron castings.**

These spheroidizers make it possible to obtain consistent results at their minimum consumption rates (0.7-1.0% of the total weight of the melt) as compared to other melt treatment methods. They are used to produce spheroidal graphite cast irons with predominantly ferrite and pearlite-ferrite matrices (GGG40, GGG45, GGG50). Besides, **SPHEROMAG®500, 600 and 700** spheroidizers contain lanthanum, and when they are used for in-mold treatment of cast iron melts, the degree of undercooling of the molten metal as it crystallizes is higher than when it is treated by an ordinary spheroidizer, FeSiMg5-7. **SPHEROMAG®500, 600 and 700 spheroidizers also favor formation of graphite globules with regular geometric shapes and reduce the likelihood of formation of gas- and shrinkage-related porosity defects in castings.**

The sizes of spheroidizers used for the in-mold treatment process vary within a narrow range (0.8-4.0; 1.0-4.0; 1.0-5.0 and 0.5-3.0 mm) and depend on the types of casting equipment used by customers. Our company also produces these spheroidizer grades in ingot form with its subsequent crushing and sizing.

4. Spheromax923, Spheromax9104, Spheromax915 spheroidizers are used to treat melts in covered ladles to produce spheroidal graphite cast irons having a pearlitic matrix (GGG60 and GGG70) from which castings are made. These cast irons have low silicon contents and high magnesium and barium contents. This combination makes it possible to obtain consistent globular graphite form over the entire cross section of castings. Barium also promotes formation of additional crystallization centers. When treating melts in covered ladles by means of the sandwich process, magnesium is recovered to the greatest possible degree and the spheroidizing effect lasts as long as necessary.

All **Spheromax®** spheroidizers can dissociate in irons at low temperatures, which makes it possible to modify cupola irons with sulfur content up to 0.12% without prior desulfuration and to produce spheroidal graphite cast irons having a pearlitic matrix and spheroidal graphite cast irons having ferritic and pearlitic matrices from which castings are made.

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MgPro 100
COVER MATERIAL

MgPro 100 serves to provide protective cover for spheroidizers used for ladle treatment by means of the sandwich process. Traditionally, iron chips and steel shavings have been used for this purpose.

MgPro 100 is a powder whose color ranges from grey to black. When used, it does not generate fume and does not affect negatively molten iron. It is not hazardous for personnel.

A batch of a spheroidizer is fed into a ladle, it is then covered with a uniform layer of **MgPro 100,** after which molten metal is poured into the ladle.

The cover material makes it possible to:
- reduce metal heat losses from the melt in the ladle, which will make it possible to lower energy consumption
- optimize consumption of the spheroidizer being used as it allows the modification process to proceed calmly
- improve the iron foundry environment as it reduces generation of flame and fume that accompany interaction of molten metal and magnesium.

Consumption depends on the capacity of the treatment ladle and the size of the spheroidizer being used and may be between 4 and 7 kg per 1 ton of molten iron.

Packaging:
- polymer bags with capacities of 1.5-5 kg packed into big bags
- paper bags with capacities of 5-25 kg packed into big bags.

MgPro 200
DESULFURIZER

The **MgPro 200** desulfurizer serves to remove some of the sulfur contained in irons in electric arc and induction furnaces and in pouring ladles.

The MgPro 200 desulfurizer comes in sizes up to 10 mm. It is filled into individually portioned tight polymer bags. It is not hazardous for personnel, and it does not affect negatively molten iron.

Application:
After the charge materials are melted in the furnace and the slag that formed is tapped, the **MgPro 200** desulfurizer is placed on top of the molten iron. As the iron is being treated by the desulfurizer, its temperature should be maintained between 1500 and 1550°C for the duration of 3-5 minutes. After this, the newly formed slag is tapped. f necessary, the iron should be treated additionally by the **MgPro 200** desulfurizer in a ladle.

Consumption: 8-12 kg/t

Packaging:
- polymer bags with capacities of 2-5 kg packed into big bags

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SIMAG® SPHEROIDIZER

This efficient multicomponent spheroidizer is high in magnesium content. It is used for spheroidizing cast irons produced by various methods. It is also used as a filling material for cored wires fed into ladles by means of pinch-roller systems.

The chemical composition of this spheroidizer makes it possible to treat cast irons in such a way that the degree of magnesium recovery is high and flare and fume are insignificant. Consumption of this spheroidizer is twice as little as that of spheroidizers used for in-mold treatment (4-6 kg per ton).

SIMAG® is supplied as a filling material for cored wires 10, 13, 14 and 15 mm in diameter with the standard sizes of their particles being 0.2-2 mm. One meter of a cored wire 13 mm in diameter contains between 180 and 200 g of spheroidizers.

Consumption of the SIMAG® spheroidizer used for ladle treatment is 4-6 kg per 1 ton of molten metals with sulfur contents being 0.015-0.020%.

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Cored wires in coils with maximum **850 mm** in height and with maximum outer and inner diameters being **1,300 mm and 600 mm** respectively. **Coils are between 500 and 1,500 kg** in weight. Coils are fastened securely on wooden pallets and wrapped in two layers of PE film. Coils are packed and shipped **vertically or horizontally; decoilers/dereelers** are optional.

SIMAG®

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VERMILOY® SPHEROIDIZER

Compacted graphite iron (CGI) also known as **vermicular graphite iron** is a unique construction material. In terms of physical, mechanical and casting properties, it falls between spheroidal graphite iron (SGI) and lamellar graphite iron (LGI).Its casting properties, shock-absorbing capacity and thermal conductivity are almost the same as those of LGI, and its strength properties are commensurate with those of individual SGI grades.

CGI castings are used successfully for manufacturing metallurgical equipment (ingot molds, chill molds, stools, etc.) and for construction of diesel engines.

When producing CGI castings, such a method should be utilized that ensures the vermicular graphite structure consistently meet relevant requirements. Ordinary multicomponent spheroidizers like FeSiMg have low REM contents (0.3-1.0%).This does not make it possible to ensure consistent compacted (vermicular) graphite structures because the required range of residual magnesium is rather narrow (0.015-0.028%).

To ensure consistent compacted graphite structures, our company has developed a spheroidizer, **VERMILOY®**.

The combination of active components, their quantitative ratio and the special method of production of the **VERMILOY®** spheroidizer make it highly efficient and its spheroidizing effect may last up to 35 minutes. This ensures a high degree of its recovery in liquid irons whose temperatures may exceed 1,250°C

When liquid irons are treated with the **VERMILOY®** spheroidizer in open-topped ladles, the resultant flare and fumes are insignificant. This testifies to the fact that the degree of its recovery is high. As a rule, the weight of a spheroidizer introduced into a ladle does not exceed 1% of that of the melt.

Standard sizes: 0.2-1 mm, 1-10 mm, 1-20 mm

Consumption of this spheroidizer is 8-12 kg per 1 t of the melt depending on its chemical composition, method of its introduction and the chemical composition of the melt.

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Paper bags with capacities between 5 and 25 kg
- Cored wires

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MEXMAPK® (MEKHMARK) MASTER ALLOY FOR CAST IRONS

The grades of this master alloy are as follows:
MEXMAPK®45, MEXMAPK®50, MEXMAPK®60, MEXMAPK®60M

These products are used for treatment of base irons in ladles. Their use makes it possible to produce castings having a uniform pearlitic matrix and increased hardness. Microalloying of irons with **copper and tin** improves the mechanical properties of irons and makes their pearlite and graphite more refined.

Standard sizes: 0-10 mm, 0-20 mm

Consumption of master alloys introduced into molten metal as it enters a ladle depends on what mechanical properties are required.

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Paper bags with capacities between 5 and 25 kg
- Cored wires

ALL-PURPOSE REFESIL® MASTER ALLOYS WITH REM

Fe-Si-based **master alloys with REM** are used for ladle treatment of irons and steels.

Their use makes it possible to:
- obtain a vermicular graphite structure of iron
- treat steel
- treat grey iron:
  - carry out graphitization
  - carry out deep desulphurization of iron
  - remove detrimental impurities from melts

Sizes: 1-20 mm

Consumption of master alloys to be introduced into the melt depends on the degree of its contamination with such elements as S (sulfur), P (phosphorus), Sb (stibium), Cr (chromium), V (vanadium).

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Paper bags with capacities between 5 and 25 kg

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NI-BASED SPHEROMAG®N MASTER ALLOY

The grades of this master alloy are as follows:
Spheromag®5FN, Spheromag®5FNR, Spheromag ®16N

Ni-based heavy master alloys with magnesium and REM are used for alloying irons with **nickel** and modifying them with **magnesium.** Their distinctive feature is that their density exceeds that of liquid iron. So they are easy to use, the **degree of recovery of the magnesium contained in them is high and the results of modification they perform are consistent.**

The compositions of the master alloys being produced are **Ni-Mg, Ni-Fe-Mg, Ni-Cu-Mg** with or without **REM**. The exact composition of a master alloy is determined by customer needs and the conditions under which they are going to be used.

Standard delivery forms:
- MKMs in 1-50 mm sizes
- weighted ingots within 0.5 and 2 kg
- 0-100 mm (for Ni-Mg master alloys)

Packaging:
- PE-lined big bags with a capacity of one ton
- steel buckets and drums

Weighted ingots of Spheromag®5FN master alloy

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COATING POWDER FOR CHILL MOLDS

This powder is used to **protect chill molds** and increase their life span. It also prevents formation of cementite in the surface layer of castings.

The powder may also be used for the **graphitizing treatment** of grey and ductile irons and also to improve the surface quality of castings when they are produced using the chill mold casting process.

Standard sizes: 0.1-0.4 mm

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Paper bags with capacities between 5 and 25 kg

Coating powder

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REFLOY® AND REFLOY®FM BRIQUETTED REFINERS AND DESULPHURISERS

Purpose
This is a new product developed by NPP. It may be used in the making of steel and iron as a silicon-containing charge material instead of the ferrosilicon FeSi45 grade.

REFLOY® and REFLOY®FM are produced in the form of briquettes up to 60 mm in size.

Applications
In addition to using **REFLOY®** ferrosilicon for alloying irons with silicon, it is also used as a refiner due to its effect on the melt that contributes to the partial removal of dissolved sulfur. This can be accounted for by the fact that it contains chemically active AEM and REM.

The **REFLOY®FM** product has a higher content of active Mg as compared to its **REFLOY®** counterpart, and as a result it has a stronger desulphurizing effect.

Both the **REFLOY®** and **REFLOY®FM** products make it possible to reduce the costs of desulphurization and graphitization as deleterious impurities can be removed from molten metal during the melting process.

REFLOY®F briquettes

!

Take into account the sulphur content in metall before its modifeir treatment! The high sulphur content in metall leads to neutralization of magnisium in modifier.

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BATCHING MATERIALS INTO PLASTIC BAGS

NPP has the necessary capability to supply its products in plastic bags to its customers when requested.

The advantages of batching materials into plastic bags include the following:
- portioning out batches into bags is determined by consumption rates of modifiers
- human errors can be eliminated as much as possible (there is no manual portioning and weighing)
- no segregation of materials during transportation
- materials do not give off dust when handled
- materials are protected against moisture during storage

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons
- steel buckets and drums

Modifier in plastic bag

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CORED WIRES
AND FILLER MATERIALS

One of the major achievements in the present-day steelmaking and foundry industries is the development of a cored wire injection method for modification of steels and irons in ladles and its industrial application.

Currently, NPP supplies cored wires with various filler materials **10, 13, 14 and 15 mm in diameter.** The filler materials may be single- or multi-component, fused or blended.

Cored wire coils

The cored wires with the following filler materials are supplied by NPP on a commercial basis: Likely fillers of mass-produced cored wires

Description*	Application
DM®1 and SIMAG® spheroidizers	Desulfurization and spheroidization of cast iron
INSTEEL® modifiers	Refining and modification of steel
Calcium silicon	Deoxidization and modification of steel
Ferrotitanium Ferromolybdenum Ferrovanadium Titanium sponge	Alloying and micro-alloying
Customer's material	

* Subject to customer approval, other materials, including blended ones, may be used as filler materials. Customers' materials may also be used.

Packaging:
Cored wires are supplied in coils with maximum 850 mm in height and with maximum outer and inner diameters being 1,300 and 600 mm respectively. Coils are fastened securely on wooden pallets and wrapped in two layers of PE film. Cored wire coils of non-standard dimensions can also be supplied.

At the customer's option, coils may be fastened on wooden pallets vertically or horizontally and supplied to customers. Pallets may have supports.

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CARBAMAX® CARBURIZERS

Our company can supply quality solid carburizers with low sulfur content.

Our products' advantages are listed below:

- low moisture and gas content
- low sulfur content
- high carbon content
- high dissolution rate
- cost effectiveness
- high nucleation rate
- high purity (low ash content)

Carburizers are used for the purpose of adjusting the content of carbon in the composition of synthetic iron and steel. To improve carbon recovery, it is recommended to introduce a carburizer into the furnace along with the charge materials. This method favors more uniform distribution of the carburizer throughout the furnace space.

The **CARBAMAX®70** carburizer contains up to 30% ash. It is a metal-oxide and its chemical composition is made up of elements such as **Si, Mg, Ca and REM.**

Physical and chemical properties of carburizers offered for supply:

Carburizers	Carbon content, %, no less than	Sulfur content, %, no more than	Ash content and volatile gases, %	Standard sizes, mm
CARBAMAX®98	98	0.07	no more than 0,9	0.1 - 4 (80%)
CARBAMAX®97	97	0.07	no more than 3,0	1 - 5 (90%)
CARBAMAX®70	70	0.5	no more than 30 / volatile gases no more than 3,0	0.5-20; 0-100

Carburizers are supplied in:

- PE-lined big bags with capacities of 0.5 and 1.0 tons
- Paper bags with capacities between 5 and 25 kg

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FERROALLOYS FOR PRODUCTION OF STEEL AND IRON

Ferroalloys are various alloys of iron with other elements (silicon, chromium, etc.). Ferroalloys are used for alloying and deoxidizing steel, for binding liquid impurities and imparting required structures and properties to molten metals.

We offer the following ferroalloys necessary for production of steel and iron:
- **Ferrosiliconzirconium**
- **Ferromanganese**
- **Ferrosilicon**
- **Ferrochromium**
- **Silicocalcium**

At the customer's option, we can make up a set of various ferroalloys and arrange consolidated shipment.

Packaging:
- PE-lined big bags with capacities of 0.5 and 1.0 tons

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Since 1996

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