ZHEN AN

FERROSILICON MAGNESIUM TECHNICAL DOCUMENTATION

Composition Design | Manufacturing Process | Nodularization Metallurgy | Quality Control | Safety

For ductile iron foundries, compacted graphite iron producers, cored-wire manufacturers and industrial raw-material buyers

Compiled from public standards information, supplier technical documents, process literature, academic research and user-provided internal research notes.

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This document is a technical research and procurement reference. It does not replace a product standard, batch COA, SDS or transport assessment.

Document Scope and Use Limitations

This document covers rare earth ferrosilicon magnesium alloy, commonly abbreviated as **FeSiMg** or **MgFeSi**. It is an Fe-Si-based alloy containing Mg and, depending on the grade, Ca and rare earth elements (RE). In foundry applications, it is primarily used as a nodulizer for ductile iron or, with a specifically designed chemistry and treatment window, as a vermicularizer for compacted graphite iron (CGI).

Information is separated into three categories: (1) facts supported by an identified public standard or original research; (2) supplier-specific product or SDS statements; and (3) engineering guidance or procurement recommendations compiled from the internal research notes. These categories must not be treated as interchangeable.

Important limitation: FeSiMg chemistry, particle size, rare-earth system, impurity limits and hazard classification vary by producer and grade. Any chemical range, MgO limit, Mg-uniformity target, transport classification or operating instruction must be confirmed against the actual product, batch test results, current SDS, applicable standard and agreed technical specification.

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01 | Executive Summary and Key Conclusions

FeSiMg is a functional intermediate alloy used to treat molten iron. Its value is not defined by magnesium percentage alone. It lies in introducing highly reactive magnesium into molten iron in a controllable alloy form, while the combination of Mg, Si, Ca and rare earth elements helps foundries obtain the required graphite morphology and a stable treatment response.

From the producer's perspective, the main challenge is that Mg has a high vapour pressure at elevated temperatures and can volatilize, oxidize or react violently. From the foundry's perspective, the key variables include Mg recovery, residual Mg, fading, sulphur and oxygen levels in the base iron, particle size and treatment practice. From the buyer's perspective, the principal risks are inconsistent batch chemistry, particle-size deviation, excessive fines, moisture exposure and SDS/transport documents that do not match the actual product.

Dimension	Key technical point	Implication for production or procurement
Material identity	Fe-Si matrix containing Mg and potentially Ca/RE.	Do not confuse it with aluminium-industry Mg-Si master alloy, ordinary FeSi or Pidgeon-process reductant.
Manufacturing	Mg addition, reaction heat, oxidation protection, casting/cooling and screening are critical.	Final Mg alone cannot demonstrate process stability.
Foundry performance	Treatment depends on base-iron chemistry, temperature, addition method, particle size and pouring sequence.	FeSiMg alone cannot guarantee nodularity or casting properties.
Quality documents	A batch COA should link grade, particle size, batch number, test method and packaging identification.	A sample report cannot replace batch inspection.
Safety	The hazards of lumps may differ from those of dust or fines.	Use the SDS and transport assessment for the actual grade and particle size.

Five Conclusions to Remember

- **Mg content is not the only quality indicator.** Mg distribution, oxidation condition, particle size and treatment practice also matter.
- **Magnesium reaction control is central to manufacturing.** Mg vapour pressure and oxidation at high temperature constrain process design.
- **Two Mg-recovery concepts must be separated.** Mg recovery during alloy production is not the same as Mg absorption during molten-iron treatment.
- **A commercial grade code is not automatically a national-standard grade.** Codes such as 3-8 or 5-8 must be checked against the supplier's definition, formal grade and complete COA.
- **An SDS cannot be transferred from one supplier to another.** Different chemistries and particle sizes may require different hazard and transport assessments.

02 | Product Definition, Nomenclature and Boundaries

2.1 Correct Product Name

The Chinese national standard GB/T 4138-2024 is titled *Rare Earth Magnesium Ferrosilicon Alloy* (稀土镁硅铁合金). The official standards information platform identifies it as current, published on April 25, 2024 and effective from November 1, 2024, replacing GB/T 4138-2015 in full. [6]

Name	Typical context	Explanation
Rare earth ferrosilicon magnesium alloy	Contracts, technical agreements, inspection and standards	Recommended formal English product name.
FeSiMg / MgFeSi	Engineering communication and tables	Common abbreviations; define at first use.
Nodulizer / Nodularizing agent	Ductile iron treatment	Application name, not a complete chemical identity.
Vermicularizer	CGI treatment	The chemistry and control target should be distinguished from a conventional nodulizer.
Silicon magnesium alloy	General web searches	Ambiguous; may refer to Mg-Si master alloys used in aluminium systems.

2.2 Materials That Should Not Be Confused

Material	Main composition or use	Difference from FeSiMg
FeSiMg nodulizer	Fe-Si matrix, Mg and potentially Ca/RE	The material covered by this document.
Ferrosilicon 75	High-silicon iron alloy, mainly a silicon source	May be a raw material for FeSiMg, but is not itself a nodulizer.
Mg-Si master alloy	Magnesium-silicon intermediate alloy, often used in aluminium alloys	Not an appropriate substitute for the FeSiMg product name.
Ferrosilicon for the Pidgeon process	Reductant used in magnesium production	Used to reduce MgO; not for graphite nodularization.
Ferrosilicon inoculant	Silicon-based inoculating material	Should not be equated with a higher-Mg nodulizing alloy.

Recommended wording: At first mention in English documents, use “Rare earth ferrosilicon magnesium alloy (FeSiMg), used as a nodulizer for ductile iron.” Avoid using only “silicon magnesium alloy,” which can be interpreted as an aluminium-industry Mg-Si master alloy.

2.3 Standard Scope

The official GB/T 4138-2024 information page confirms the standard title, current status and effective date. The user-provided internal research notes describe its scope as covering rare-earth magnesium ferrosilicon alloys produced by the melting/blending route for use as nodulizers and vermicularizers, including light-rare-earth and yttrium-based heavy-rare-earth systems. The full official technical tables were not available for line-by-line verification during preparation of this document. Buyers should therefore consult the official standard text and the agreed technical specification before setting acceptance limits.



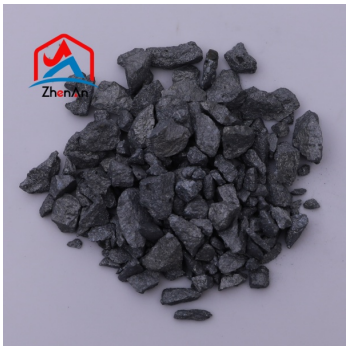


Figure 1. FeSiMg product appearance.

Lump and granular samples supplied by ZhenAn. Appearance alone does not identify Mg/RE chemistry or a standard grade; confirm the batch COA.

03 | Chemical Composition and Element Functions

The basic FeSiMg structure consists of an Fe-Si alloy matrix containing Mg, with Ca and rare earth elements added according to the intended application. Fe and Si form the alloy matrix; Mg is the principal nodularizing element; Ca and RE can influence reaction behaviour, element recovery and the treatment window. Residual elements such as Al, Ti, Mn, P, S and C should be controlled according to the grade and the requirements of the final casting.

3.1 Representative Compositions: Different Sources, Different Specifications

Source / sample	Si (%)	Mg (%)	Ca (%)	RE (%)	Interpretation
Atabaş SDS: FeSiMg 6/8	44–48	5.5–9.0	1.0–2.0	0.5–1.5	Supplier-specific SDS coverage. [1]
Hongshun process article	40–45	5–10	1–3	0.5–2	Typical ranges stated on the webpage. [4]
2025 research target	40–46	9–11	1–1.5	1.25–1.5	Experimental charge-design target; RE mainly Ce/La. [5]
User-provided COA sample	43.83	10.17	1.72	1.64	Single sample; grade and other test items are incomplete.

Table 3-1. Values come from different sources, products and experimental conditions. They are comparative examples, not a unified grade specification.

3.2 Functions of Main Elements

Element	Main function	Quality issues to monitor
Fe	Forms the iron-based alloy body and carries/dilutes active elements.	Mass balance and direct assay; do not infer measured Fe solely by difference.
Si	Forms the Fe-Si matrix and affects alloy phases and silicon input to iron.	Measured Si and matching to the target grade.
Mg	Principal nodularizing element; participates in desulphurization/deoxidation and changes graphite formation conditions.	Actual content, segregation, oxidation loss and residual-Mg control.
Ca	Participates in alloy-phase formation and may moderate Mg reaction behaviour and affect Mg recovery.	Ca content and its combination with Mg/Si.
RE	Supports nodularization and may modify the effects of certain trace elements.	Total RE, individual elements and light-RE/yttrium-based system.
Al, Ti, Mn	Associated or residual elements requiring application-specific control.	End-user limits; no single universal threshold applies to all castings.
P, S, C	Can affect molten iron and casting performance; may originate from raw materials and processing.	Whether included in the COA, test method and agreed acceptance limits.

3.3 The Rare-Earth System Must Be Identified

A COA that reports only “RE 1.64%” does not show which rare-earth elements are present. It is insufficient to determine whether the alloy is mainly a Ce/La light-rare-earth system or a yttrium-based system. Where required by the grade or end-user, the technical COA may report total RE and selected individual elements such as Ce, La and Y. The elements to be reported should be agreed according to the product chemistry, customer requirements and applicable export-compliance review.

Mass-balance caution: If a COA lists only Si, Mg, RE, Ca and Al, the remainder must not automatically be reported as measured Fe. The difference may include unreported elements, oxides, impurities and analytical error. If Fe is an acceptance item, it should be measured directly or determined using an agreed method.

04 | Magnesium: Physical Chemistry and Alloy Phases

4.1 Why Magnesium Is the Main Manufacturing Challenge

Magnesium has a boiling point of approximately 1,107°C (commonly reported in the approximate range of 1,090–1,110°C). FeSiMg alloying is generally carried out at temperatures above this range. Magnesium therefore has a high vapour pressure in the melt and can volatilize rapidly, with possible oxidation, fume generation and vigorous reactions. The 2025 research paper notes that direct addition of pure Mg to molten FeSi can cause intense reaction, Mg loss and MgO fume. [5]

The process objective is not simply to melt magnesium into the alloy. It is to control the contact rate, reaction interface, temperature and protective conditions so that as much Mg as practicable enters the alloy rather than escaping as vapour or oxide.

4.2 Magnesium-Bearing Phases in the Alloy

X-ray diffraction (XRD) analysis in the 2025 paper identified Mg_2Si, $FeSi_2$, FeSi, Si, Ca-Mg-Si-related phases and small amounts of $CeSi_2$ and $LaSi_2$ in the experimental alloy. This indicates that FeSiMg is a multiphase alloy rather than a simple mechanical mixture of elemental constituents. [5]

Phase / structure	Significance in the study	Interpretation boundary
Mg_2Si	An Mg-bearing silicide phase identified in the experimental sample.	Its presence does not establish the phase fraction in every commercial grade.
FeSi / $FeSi_2$	Phases associated with the Fe-Si matrix.	Phase composition depends on Si content and solidification conditions.
Ca-Mg-Si phases	Ca-Mg-Si-related phases were identified in the paper.	The effect of Ca must be considered with the actual chemistry and process.
$CeSi_2$ / $LaSi_2$	Rare-earth silicides identified in the experimental sample.	Not all rare-earth systems necessarily form the same phases.

4.3 Define the Mg Recovery Stage

Alloying-stage Mg recovery can be expressed as:

Mass of Mg retained in the finished alloy ÷ Mass of Mg charged × 100%

This measures the proportion of charged magnesium retained in the FeSiMg alloy during manufacture. It is different from Mg absorption or residual-Mg yield when FeSiMg is used to treat molten iron. The two indicators belong to different process stages and must not be compared as if they were the same metric.

05 | FeSiMg Manufacturing Process and Critical Controls

The official scope information for GB/T 4138-2024 identifies the melting/blending route for rare-earth magnesium ferrosilicon alloy. Supplier process literature and academic research describe different magnesium-addition and protection methods. The following is a process overview, not a mandatory equipment layout, addition sequence or temperature schedule for every producer.

01 Raw materials FeSi, Mg, CaSi and RE feedstocks; inspect batches and moisture.	**02 FeSi melting** Form a stable Fe-Si melt; control temperature and melt condition.	**03 Mg alloying** Control contact rate, coating or other protection to reduce volatilization and oxidation.	**04 Ca / RE adjustment** Adjust chemistry to the target composition and homogenize.	**05 Casting & cooling** Cast into ingots or another form; control solidification and cooling.	**06 Crushing & screening** Crush, screen, classify, sample and package.

5.1 Raw-Material Preparation

- Check actual Si, Al, Ca, C, P and S in the FeSi feedstock instead of relying only on its nominal grade.
- Magnesium ingot surface condition, dimensions and oxide layer can affect addition behaviour.
- CaSi and rare-earth feedstocks should have traceable batches and chemical analyses.
- Keep feedstocks and equipment dry. Moisture control is relevant to both melting safety and finished-product storage.

5.2 Melting and Magnesium Addition

The Hongshun process article describes a typical route in which FeSi is melted first, Mg is then added progressively, and RE and Ca are introduced according to the product design. It also emphasizes Mg volatility and temperature control. [4] The 1,450–1,550°C range stated on that webpage is a process example from that source, not a universal set point. The actual operating window depends on furnace type, melt chemistry, Mg-addition method, protection conditions and equipment capability.

5.3 Casting, Cooling, Crushing and Screening

Cooling after casting can affect microstructure, cracking tendency and subsequent crushing behaviour. Crushing and screening determine the delivered particle-size distribution and fines content. The Hongshun webpage gives examples such as 0.5–5 mm, 3–8 mm and 5–15 mm; the 2025 paper reports a crushed and screened experimental product in the 5–50 mm range. [4][5] These are source-specific examples, not interchangeable standard grades.

5.4 Process Records and Potential Failure Modes

Stage	Recommended process records	Potential consequence if uncontrolled
Raw-material acceptance	Batch number, chemistry, moisture/surface condition	Target chemistry deviation and batch variation.
Melting	Furnace/heat number, temperature, melting time, charge ratio	Unstable melt condition or non-uniform chemistry.
Mg addition	Mg batch, addition method/time, protective conditions	Mg burn-off, fume, segregation or vigorous reaction.
Ca / RE addition	Feedstock batch, addition sequence, target and measured values	Variable RE recovery and composition.
Casting/cooling	Casting temperature, ingot dimensions, cooling conditions	Cracking, structural variation and excessive fines.
Crushing/screening	Screen sizes, screening time, yield by size fraction	Oversize, excessive fines or inconsistent particle size.

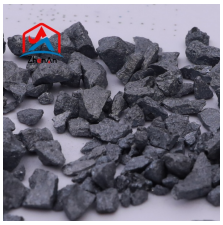


Figure 2. Crushed FeSiMg product - close-up.

Illustrates the finished material discussed in Section 5.3, rather than operating equipment. Verify delivered size distribution by sieve analysis.

06 | Research Case: Protective-Coating Magnesium Addition

Eissa et al. published the 2025 paper *An Innovative Safe Process for Producing Magnesium–Ferro–Silicon (MgFeSi) Alloy Containing Calcium and Rare Earth Elements* in the *International Journal of Metalcasting*. The study investigated a protective-coating method intended to control the reaction between magnesium ingots and molten FeSi. [5]

6.1 Experimental Design

The experimental setup used FeSi, steel scrap, Mg ingots, calcium-silicon alloy, rare-earth elements and protective/flux materials including FeSi fines, dolomite, talc and boric acid. By coating the magnesium ingot surface, the researchers sought to moderate the immediate contact reaction and reduce Mg volatilization and oxidation. [5]

6.2 Key Experimental Results

Experimental condition	Mg recovery	RE recovery	Notes
Uncoated Mg ingot	69.49%	88.70%	Reference heat in the paper.
FeSi-fines coating	84.96%	96.35%	One of the protective-coating conditions.
Best composite-coating test	87.35%	99.59%	Highest values reported in the study.

How to quote 87.35% correctly: “Under the specific experimental conditions used by Eissa et al., the protective-coating magnesium-addition method achieved a maximum alloying-stage Mg recovery of 87.35%.” It is not an industry-standard recovery rate and must not be presented as a guaranteed result for any production line.

6.3 Proposed Mechanisms

- Coating most of the Mg ingot surface limits the instantaneous contact area between Mg and molten FeSi.
- Melting/reaction of materials such as FeSi fines can absorb heat and reduce local reaction intensity.
- The composite cover formed by dolomite, talc and boric acid can help limit air access and Mg oxidation.
- The protective layer may slow Mg vapour escape and provide more opportunity for Mg to react with Si and Ca to form silicide phases.

6.4 What Must Be Revalidated Before Industrial Scale-Up

The study used experimental heats and specific raw materials, coating coverage and formulations. Industrial scale-up requires renewed validation of melt capacity, heat balance, coating stability, compatibility with furnace lining and protective materials, fume extraction and occupational safety, heat-to-heat repeatability, and final product chemistry. The paper's formulation should not be adopted as an operating procedure without engineering review.

07 | Nodularization and Vermicularization Metallurgy

7.1 Graphite Morphology in Ductile Iron

Graphite in grey iron is generally flake-shaped. The sharp ends of flakes can act as local stress concentrators. Ductile iron treatment aims to form spheroidal graphite, which can provide improved strength, ductility and overall mechanical performance. FeSiMg introduces Mg into molten iron; Mg reacts with sulphur, oxygen and other surface-active elements and changes the conditions under which graphite forms. The 2025 paper identifies MgFeSi as an important additive in ductile iron production and discusses the relationship between spheroidal graphite and improved ductility and strength. [5]

7.2 Combined Effects of Mg, RE and Ca

Component	Engineering interpretation	Variables that must also be considered
Mg	Principal nodularizing element; participates in desulphurization/deoxidation and changes graphite growth conditions.	Base-iron S/O, temperature, Mg-addition method, holding and pouring time.
RE	Supports nodularization and may neutralize the effects of certain anti-nodularizing trace elements; effect depends on the RE system.	Ce/La/Y composition, interfering elements such as Ti/Pb/As, casting section thickness.
Ca	Forms Ca-Mg-Si-related phases in the alloy and may influence reaction behaviour and Mg recovery.	Ca/Mg/Si ratio, manufacturing route and final molten-iron chemistry.

7.3 Residual Mg Is a Molten-Iron Process Parameter

The user-provided internal research notes list 0.035–0.055% as a commonly discussed residual-Mg reference window. This range should be treated only as a starting point for process discussion, not as a universal target for all ductile iron grades. The final residual-Mg target must be determined by the casting specification, base-iron sulphur, section thickness, nodularity, fading behaviour, matrix structure and customer quality requirements.

7.4 Nodularization Treatment and Fading

After Mg treatment, molten-iron conditions continue to change with time, temperature and ongoing reactions. Excessive delay between treatment and pouring may lead to reduced nodularizing effectiveness or changes in graphite morphology. The allowable time is not a universal fixed number of minutes; it must be validated against the foundry's chemistry, ladle, temperature loss, holding practice, treatment quantity and pouring sequence.

7.5 CGI Vermicularization Is Not the Same as Ductile-Iron Nodularization

Compacted Graphite Iron (CGI) requires worm-like graphite morphology between flakes and spheroids. Its treatment window is generally narrower than that of conventional ductile iron and requires more precise control of Mg, RE and potentially inhibiting/interfering elements. A conventional nodulizer grade and addition practice should not automatically be transferred to CGI production.

08 | Grades, Particle Size and Process Matching

8.1 Commercial Codes Versus Standard Grades

Commercial codes such as 3-8, 5-8 and 7-8 are often used to indicate approximate RE and Mg targets, but suppliers may use different naming conventions. These codes do not automatically replace the formal grades in GB/T 4138-2024. A purchase contract should state the formal standard grade or, where no direct correspondence is established, define a mutually agreed grade with a complete chemical specification.

Commercial example	Common market interpretation	What must be verified
3-8	Often interpreted as approximately 3% RE and 8% Mg.	Whether RE means total RE or a specific system; measured Mg.
5-8	Often interpreted as approximately 5% RE and 8% Mg.	Formal standard grade or contractual grade definition.
7-8	Often interpreted as approximately 7% RE and 8% Mg.	Rare-earth composition and compliance identification.
High-Mg / low-RE	Descriptive commercial wording.	Exact numerical limits; the label alone is not an acceptance specification.

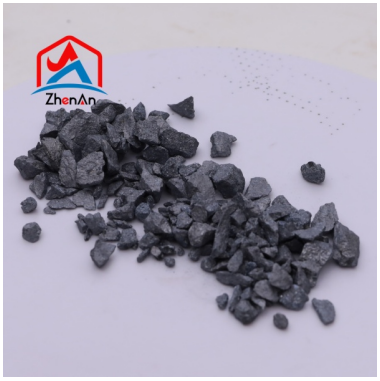
8.2 Particle Size Must Match the Addition Method

Particle-size example	Potential application context	Important note
0.5–5 mm	Fine fraction or specific in-mould/powder applications.	Dust, oxidation, fines and transport risks require separate assessment.
1–5 mm	Fine fraction or cored-wire core material discussions.	Check compatibility with the cored-wire line, steel strip and filling density.
3–8 mm	Steel-ladle addition example on the Hongshun webpage.	Not a universal recommendation for all ladles.
5–15 mm	Ladle-addition example on Hongshun; also listed as a common lump-size range in the internal notes.	Match to ladle capacity, treatment method and reaction rate.
5–25 / 5–30 / 8–40 mm	Common lump-size ranges compiled in the internal research notes.	Verify exact limits against the full GB/T 4138-2024 text or agreement.
5–50 mm	Crushed and screened experimental product reported in the 2025 paper.	A research-sample range, not a standard grade.

8.3 Why “5–25 mm” Is Not a Complete Particle-Size Specification

Nominal particle size gives only the lower and upper limits; it does not describe the actual size distribution. Two batches both labelled 5–25 mm may have very different proportions in the 5–8 mm, 8–15 mm and 15–25 mm fractions. Fines, oversize, screening method and sampling method all affect batch consistency. Buyers should request screening results rather than accepting only the particle-size label on the package.

Particle-size acceptance recommendation: State the target size range, screening method, allowable undersize/fines, allowable oversize, sampling method, retest rule and disposition of nonconforming batches in the technical agreement. Numerical tolerances must come from the applicable standard or a mutually agreed specification.



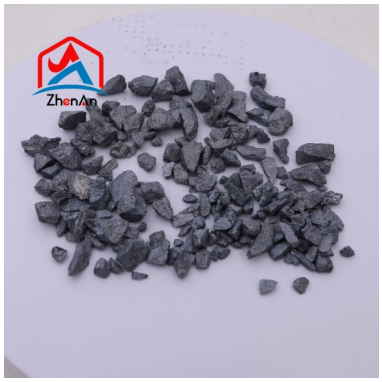


Figure 3. Granular product views.

Photographs show particle shape and visual variation. No scale is provided; size limits, fines and oversize require a batch screening report.

09 | COA, Inspection and Batch Quality Control

9.1 COA and SDS Serve Different Purposes

Document	Main question answered	What it cannot replace
COA / Certificate of Analysis	What chemistry, particle size and test results were measured for this batch?	Cannot replace an SDS, transport assessment or full process validation.
SDS / Safety Data Sheet	What are the hazards and the required handling, storage, first-aid, firefighting and transport precautions?	Cannot prove batch chemistry or particle-size compliance.
TDS / Technical Data Sheet	What are the typical product specifications, uses and technical characteristics?	Cannot replace a batch COA.
Transport assessment	How is this product classified under specific form and transport conditions?	Cannot be replaced by an assessment for another grade or particle size.

9.2 Recommended COA Contents for Industrial Procurement

Information group	Recommended items	Purpose
Identity and traceability	Manufacturer, full product name, standard/agreed grade, batch number, production date, report date	Confirm that the report belongs to the supplied goods.
Main chemistry	Si, Mg, Ca, RE and Fe if required	Verify the main constituents against the grade.
Rare-earth details	Total RE; selected individual elements such as Ce, La and Y as agreed	Identify the actual rare-earth system.
Impurities	Al, Ti, Mn, P, S, C as required by the product specification	Match end-user casting requirements.
Enhanced testing	Separate MgO result, multi-point Mg results, moisture/fines information if agreed	Help assess oxidation, segregation and transport risks.
Particle size	Screening curve, fines percentage, oversize percentage and test method	Verify delivered size and batch consistency.
Methods and authorization	Test method, sampling rule, laboratory, authorized signature and conclusion	Make the result traceable and reviewable.

9.3 Multi-Point Mg Testing and the 0.30 Percentage-Point Target

The user-provided research notes recommend multi-point sampling and identify an Mg range spread of no more than 0.30 percentage points as a target for consideration. This may be used as a candidate enhanced-quality agreement, but the accessible public sources reviewed for this document do not establish it as a universal mandatory limit under GB/T 4138-2024. If included in a contract, the number and location of sampling points, individual or composite analysis, test method, repeatability and decision rule must also be defined.

9.4 The Value and Limits of Separate MgO Testing

MgO is not the same measurement as metallic/alloyed Mg. Reporting MgO separately may help a buyer understand oxidation-related quality risks. However, the laboratory method, result expression, detection limit and sample preparation must be stated. An XRF total-element result must not automatically be treated as an MgO phase measurement, and a universal MgO acceptance limit should not be invented without a method and product basis.

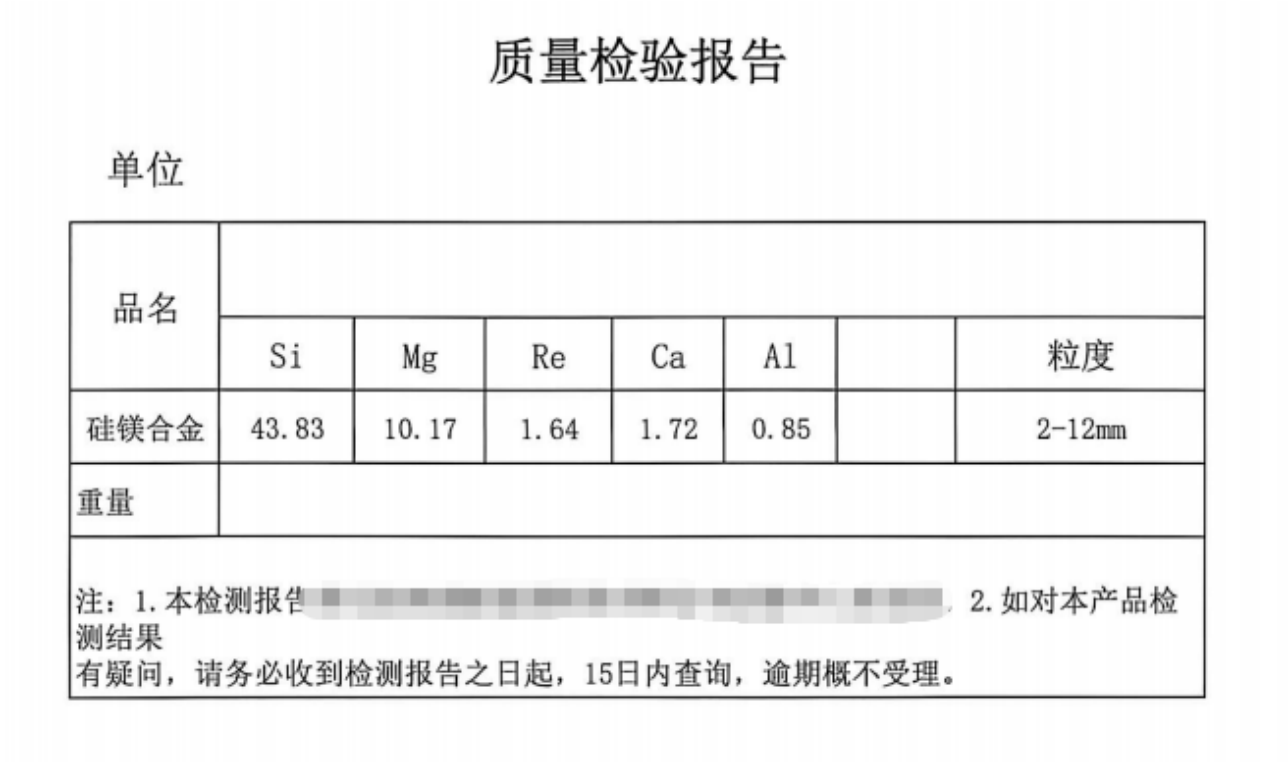
9.5 Batch and Sample Consistency

- Identify the heat, batch, particle size and sampling date on each sample.
- Issue COAs by agreed production batch; do not use one sample COA to cover multiple heats without an agreed basis.
- For third-party testing, agree in advance on sampling location, sealing, test items and cost allocation.
- Define representativeness, sample preservation, laboratory and arbitration procedures for destination-port retesting.
- Ensure the product name, batch number and weight are consistent across COA, package marks, packing list and bill of lading.

09 | COA, Inspection and Batch Quality Control

9.6 Sample COA: Original Test Report

The user-supplied FeSiMg test report below illustrates the sample data discussed in Sections 3.1 and 13.3. The original image is reproduced as provided.



质量检验报告

单位

品名							
	Si	Mg	Re	Ca	Al		粒度
硅镁合金	43.83	10.17	1.64	1.72	0.85		2-12mm
重量							

注：1.本检测报告 [redacted] 2.如对本产品检测结果
有疑问，请务必收到检测报告之日起，15日内查询，逾期概不受理。

Figure 5. User-provided FeSiMg COA sample (original Chinese test report; supplied redaction retained).

Reported values: Si 43.83, Mg 10.17, RE 1.64, Ca 1.72 and Al 0.85; particle size: 2-12 mm.

Read this as a sample report, rather than a universal grade specification or evidence for every supplied batch. The visible image does not provide a complete grade, batch identity, test method, rare-earth breakdown or separate MgO result. Refer to Sections 9.2 and 13.3 for the additional information needed for procurement review.

10 | Common Quality Issues and Troubleshooting

FeSiMg performance is determined by both alloy quality and foundry practice. When nodularity, inclusions or late-stage fading become problematic, the cause should not immediately be attributed to insufficient Mg or an incorrect grade. Review the raw materials, base iron, addition method, reaction, inoculation, holding time and pouring sequence systematically.

Observed symptom	Potential factors	Recommended investigation sequence
Low nodularity / graphite degeneration	Insufficient residual Mg; high S/O in base iron; Mg segregation; unstable addition or recovery; unsuitable treatment temperature.	Measure base-iron S and residual Mg first; then review batch COA, addition quantity, temperature and treatment method.
Variable results with the same product	Batch non-uniformity; unrepresentative sampling; different size distribution; sample not representative of bulk goods.	Check batch/heat traceability, multi-point Mg, screening curve and sealed sample records.
Slag or oxide-related defects	Oxide inclusions; elevated MgO/fines; insufficient slag removal or unsuitable treatment practice.	Review MgO method, fines, slag handling and pouring practice.
Chill tendency or difficult machining	Excess residual Mg/RE; cooling conditions; chemistry and inoculation not matched.	Check final iron chemistry, cooling conditions, metallography and customer casting specification.
Nodularity fading late in the ladle	Excessive delay after treatment; temperature loss; Mg loss or changing iron condition.	Record treatment-to-pour time, temperature curve, ladle type and pouring sequence.
Lumps break down and fines increase	Cooling stress; brittle structure; moisture exposure or handling impact.	Review production cooling, packaging seal, warehouse conditions and transport handling.

10.1 Recommended Troubleshooting Sequence

A. Verify base iron S, temperature, iron weight and base chemistry.	**B. Verify the alloy** Batch COA, Mg/RE/Ca, MgO and particle size.	**C. Review treatment** Addition quantity/method, reaction time, slag removal and inoculation.	**D. Examine castings** Nodularity, graphite morphology, matrix structure and defect location.

Diagnostic principle: A compliant FeSiMg COA does not guarantee a compliant casting. A casting defect does not prove that FeSiMg is the cause. Link alloy batch data to treatment records, metallography and pouring records before assigning responsibility.

11 | Storage, Packaging, Occupational Safety and Transport

11.1 SDS Information Is Product-Specific

The Atabaş Global FeSiMg SDS (Document No. ATB-SDS-FEALLOY-FESIMG-2026-001, Rev.00, dated October 26, 2026) covers FeSiMg 6 and FeSiMg 8. Under the GHS/CLP conditions stated in that document, the lump form is not classified as hazardous, while dust/fines under the specified particle-size conditions are listed with H228 (Flammable solid) and H261 (In contact with water releases flammable gas). [1]

Do not generalize: The “UN Not regulated” conclusion in the Atabaş SDS applies only to the supplier, grades and transport conditions covered by that document. Other suppliers, different chemistries, powders or other particle sizes require their own SDS and valid transport assessment.

11.2 Moisture and Wet-Material Risks

The SDS warns that contact with moisture or acids may generate hydrogen and may involve trace phosphine and arsine. In enclosed spaces such as ship holds, containers and silos, gas accumulation can create flammable, toxic or oxygen-deficient atmospheres. Wet material entering molten metal or slag may also cause violent steam explosions and metal splashing. [1]

11.3 Handling and Storage Recommendations

- Provide local exhaust ventilation and dust collection at crushing, screening and transfer points.
- Keep the product dry and store it in a dry, sheltered and ventilated area; avoid condensation and standing water.
- Keep packages sealed. Fine material should be stored in suitable closed containers.
- Avoid contact with water, acids, strong oxidizers and other incompatible materials.
- Confirm that material is dry before addition to molten iron. Wet material must not be charged into molten metal.
- Before entering containers, ship holds or silos, follow site procedures for ventilation and atmosphere testing, including oxygen and relevant gases. Do not enter without authorization.

11.4 PPE and Firefighting

The Atabaş SDS recommends suitable particulate respiratory protection where dust is generated, together with eye/face protection, appropriate gloves and protective clothing for the work environment. For burning fines, the SDS identifies dry sand, dry graphite powder or Class D metal-fire extinguishing powder as suitable media; it advises against using water, foam or carbon dioxide on burning metal fines. Actual firefighting arrangements must follow site risk assessment and local regulations. [1]

11.5 Packaging and Long-Distance Transport

The Hongshun webpage refers to moisture-resistant packaging. The Atabaş SDS emphasizes keeping the product dry, preventing rainwater or seawater ingress, and ventilating cargo spaces/containers and testing the atmosphere before entry. [1][4] For exported lumps, the technical agreement may specify inner liners, outer packaging, sealing, batch number, net/gross weight and moisture-protection marks. Fine products require a separate review of sealing, dust control, ignition sources and transport conditions. Packaging does not replace transport classification.



Figure 4. Product sample in a presentation container.

This is a sample display, not a shipping-package specification. Confirm liners, closures, labels and moisture protection for the actual shipment (Section 11.5).

12 | Applications and Product Selection

Application	Main concerns	Selection and validation focus
Ductile iron pipes and fittings	Stable nodularity, production volume, treatment efficiency and cost.	Base-iron S, residual Mg, ladle practice, particle size and batch consistency.
Automotive castings	Mechanical properties, metallurgical consistency, machinability and defect rate.	Al/Ti impurity control, residual Mg, metallography and customer acceptance specification.
Wind-power castings / heavy sections	Graphite morphology in thick sections, fading and pouring sequence.	RE system, Mg/RE balance, pouring time and section-specific trials.
Pumps, valves and industrial castings	Consistent treatment across different wall thicknesses and complex shapes.	Treatment quantity, particle size, addition method and inoculation pairing.
Compacted Graphite Iron (CGI)	Narrow vermicularization window and graphite morphology control.	Dedicated vermicularizer chemistry, Mg and inhibiting elements, real-time iron testing.
Cored-wire manufacturing	Core particle size, flowability, chemical uniformity and stable feeding.	Fine-material COA, screening, moisture and product-specific transport assessment.

12.1 Six Questions Before Selecting a Grade

- Is the final product ductile iron or CGI? What graphite morphology is required?
- Will treatment use sandwich, cored-wire, tundish-cover or in-mould methods?
- What are the base-iron sulphur level, temperature, treatment mass and pouring sequence?
- Which customer specification defines residual Mg, RE system and impurity limits?
- Will the product be used as lumps or as cored-wire core material? What particle size and fines limit are required?
- Are third-party COA, separate MgO analysis, RE breakdown, SDS and transport assessment required?

12.2 Sample and Production Validation

Supplier sample evaluation should use the same grade, particle size and production route as the intended commercial supply wherever possible. Record sample batch number, COA, base-iron chemistry, temperature, addition quantity, treatment method, residual Mg, nodularity, metallography and casting defects. If the sample and bulk order come from different heats or particle sizes, sample-trial results cannot automatically represent the commercial batch.

13 | Supplier Qualification and Procurement Checklist

13.1 Document Review Checklist

Review item	Evidence to request	Assessment criteria
Product identity	Formal name, standard grade or agreed contractual grade	Name, grade, chemistry system and use are clear.
Standard compliance	GB/T 4138-2024 declaration and relevant clauses/test records	Do not substitute an old edition or draft for the current standard.
Batch quality	Recent batch COAs, batch numbers and production records	Samples and bulk goods are traceable.
Chemical analysis	Si, Mg, Ca, RE, impurities and Fe if required	Methods, units, detection limits and acceptance basis are clear.
RE breakdown	Total RE and agreed individual-element results	The actual RE system can be identified.
Particle size	Screening report, fines and oversize percentages	Matches the order and foundry process.
Safety documents	SDS for the exact product and particle size	Current version; composition matches the product.
Transport documents	Applicable transport assessment / carrier requirements	No borrowed classification from another product.
Packaging and storage	Package photographs, labels and storage instructions	Moisture protection, traceability and handling are clear.
Third-party inspection	Recognized laboratory report or sampling agreement	Sampling and arbitration are agreed in advance.

13.2 Recommended Technical Contract Appendix

- Formal product name, standard/agreed grade and intended application.
- Complete chemistry table covering main elements, RE system and agreed impurities.
- Particle-size range, screening method, fines and oversize limits.
- Sampling rules, Mg multi-point test method and batch acceptance procedure.
- Required COA, SDS, TDS, inspection report and shipping documents.
- Packaging, storage, transport conditions and procedures for moisture exposure or damaged packaging.
- Third-party retesting, sealed samples, arbitration laboratory, claim period and allocation of responsibility.
- Sample-to-production batch consistency requirements.

13.3 Example Review of a COA Sample

A FeSiMg test sample supplied in the internal research material lists Si 43.83%, Mg 10.17%, RE 1.64%, Ca 1.72%, Al 0.85% and a particle size of 2–12 mm. This can be used to demonstrate COA review. However, the complete grade, RE breakdown, MgO, Ti, Mn, directly measured Fe, batch number and analytical methods are not fully provided. These figures alone are therefore insufficient to confirm compliance with a specific formal grade under GB/T 4138-2024.

Sample item	Information provided	Review comment
Si / Mg / Ca / RE	Numerical results available	Compare each result with the formal grade or agreed range.
RE breakdown	Total RE only	Cannot identify the RE system or individual-element content.
MgO / Ti / Mn / Fe	Not fully provided	Request additional tests if required by the buyer.
Particle size	2–12 mm	May be a contractual size range; request a full screening curve.
Batch traceability	Incomplete sample information	Add batch number, production date, sampling and test details.

14 | Competitor-Source Review and Research Limitations

Source	Coverage	Strength	Limitations and treatment in this document
Atabaş SDS [1]	GHS hazards, composition ranges, first aid, firefighting, storage, PPE and transport	Structured safety document; distinguishes lump from fines.	Applies only to its stated grades and conditions; UN classification is not generalized.
PatSnap Eureka [2]	Composition, thermodynamics, process routes and phases	Broad materials-research perspective.	Some content mixes ordinary FeSi, low-Mg inoculant materials and higher-Mg nodulizers; scope is restricted when used.
CIA PDF [3]	Not readable during this review	Original CIA document link was supplied.	Access resulted in a redirect error; title and body were not verified, so no technical conclusion is attributed to it.
Hongshun [4]	Raw materials, melting, casting, crushing, screening and packaging	Clear process structure, useful for outlining the manufacturing chapter.	No complete factory test dataset or clause-by-clause standard comparison; parameters remain webpage examples.
Eissa et al. [5]	Protective-coating Mg addition, Mg/RE recovery and XRD phase analysis	Experimental design, result tables and references are available.	Experimental results are not industrial guarantees; scale-up requires validation.
GB/T 4138-2024 [6]	Official standard title, status, publication and effective dates	Official national standards information platform.	The complete official technical tables were not available for verification.

14.1 Caution When Using the PatSnap Page

The PatSnap page discusses a broad category of ferrosilicon-magnesium alloys and also refers to ordinary FeSi, low-Mg inoculant materials, MgO reduction for magnesium production and Mg-bearing silicon alloys. Its references to 0.3–5% Mg or 0.5–3% Mg should not be treated as universal specifications for high-Mg FeSiMg nodulizers. The page is used as a research lead only; mixed categories are not converted into product acceptance ranges. [2]

14.2 Areas Not Fully Covered by This Review

- The full text of GB/T 4138-2024, including every chemical-composition table and inspection rule, was not available for complete verification; a full standard-grade limit table is therefore not reproduced.
- The supplied CIA PDF could not be read, so no inference is made about its title, historical data or conclusions.
- No complete factory process records, heat logs, third-party test reports or long-term quality statistics from a specific producer were independently reviewed.
- No independent laboratory test or transport hazard assessment was conducted on any specific FeSiMg product.

15 | Conclusions, Glossary and References

15.1 Conclusions

FeSiMg is a functional alloy used to introduce magnesium into molten iron. Its performance and value depend on the combination of the Fe-Si matrix, Mg, Ca and rare earth elements, as well as on the manufacturing control of Mg volatilization, oxidation, segregation, solidification and particle size. For foundries, correct selection requires matching alloy chemistry with base-iron conditions, treatment method and casting requirements. For procurement teams, reliable supplier evidence consists of traceable batch COAs, complete screening data, an applicable SDS, a clearly defined standard/contract grade and workable retesting provisions—not a general claim of “high quality.”

Three common mistakes should be avoided: treating commercial shorthand as a formal standard grade; treating alloy-production Mg recovery as molten-iron treatment recovery; and applying one supplier's SDS hazard classification to all FeSiMg lumps and fines.

15.2 Glossary

English term	Meaning	Explanation
FeSiMg / MgFeSi	Ferrosilicon magnesium alloy	Common abbreviation for rare earth ferrosilicon magnesium alloy.
Nodulizer / Nodularizing agent	Graphite nodularizing agent	Used for ductile iron nodularization.
Vermicularizer	CGI treatment agent	Used for CGI treatment.
Ductile iron / SG iron	Spheroidal graphite cast iron	Cast iron with predominantly spheroidal graphite.
Compacted Graphite Iron (CGI)	Compacted graphite cast iron	Cast iron with compacted/vermicular graphite.
Residual Mg	Magnesium remaining in iron	Mg remaining in molten iron after treatment.
Mg recovery	Magnesium recovery rate	Must specify alloy-manufacturing stage or molten-iron treatment stage.
Sieve analysis	Particle-size screening	Used to report particle-size distribution and fines.
COA	Certificate of analysis	Reports measured results for a specific batch.
SDS / MSDS	Safety data sheet	Describes hazards, handling, storage and transport safety.

15.3 References and Source Materials

[1] ATABAŞ GLOBAL. *Safety Data Sheet (MSDS) — Ferro Silicon Magnesium (FeSiMg)*. Document No. ATB-SDS-FEALLOY-FESIMG-2026-001, Rev.00, October 26, 2026, 7 pp. Original PDF.

[2] PatSnap Eureka. *Ferrosilicon Magnesium Ferrosilicon Alloy: Comprehensive Analysis of Composition, Production, and Industrial Applications*. May 26, 2026. Webpage.

[3] Central Intelligence Agency. CIA-RDP62-00328A000200050082-0.pdf. User-supplied link; access redirected during this review and the document title, body and page references could not be verified. It is therefore not used as technical evidence. Original link.

[4] Hongshun. *Ferro Silicon Magnesium Alloy Production Process: A Complete Guide*. May 27, 2025. Webpage.

[5] Eissa, M., El-Faramawy, H., Ahmed, A., Ghali, S., Halfa, H., El-Fawkhry, M., Kotb, E., and Nasr, M. *An Innovative Safe Process for Producing Magnesium–Ferro–Silicon (MgFeSi) Alloy Containing Calcium and Rare Earth Elements*. *International Journal of Metalcasting*, 2025. DOI: 10.1007/s40962-025-01614-7. Open access, CC BY 4.0.

[6] State Administration for Market Regulation / Standardization Administration of China. GB/T 4138-2024, *Rare Earth Magnesium Ferrosilicon Alloy*. Published April 25, 2024; effective November 1, 2024; current status. Official standards information platform.

[7] User-provided internal document: *Ferrosilicon Magnesium Systematic Research Report (Reset / Unified Terminology Edition)*, dated November 9, 2026. Used as an internal research basis. Items requiring confirmation against the full standard, actual batch COA or official regulations are identified as engineering references or verification items in this document.

Disclaimer: This document is intended for technical learning, supplier communication and procurement evaluation. It is not a product quality guarantee, operating procedure, SDS, dangerous-goods transport assessment or legal opinion. Actual production and transport decisions must be confirmed by qualified technical, safety, laboratory and compliance personnel against the specific product and applicable local regulations.