AZTERLAN

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

[r e] THINKING
METALLURGY

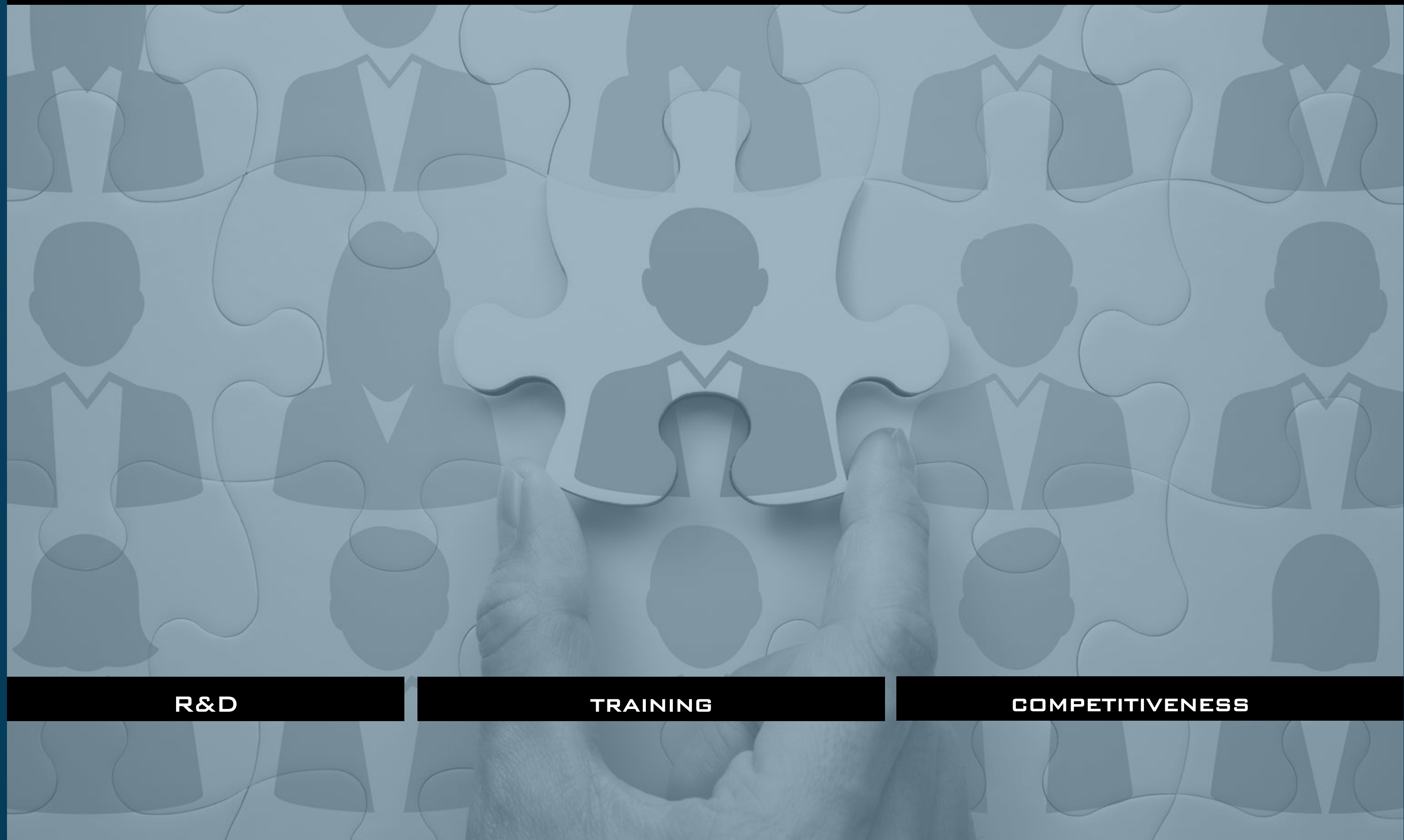
AZTERLAN METALLURGY RESEARCH CENTRE
Aliendalde Auzunea nº6, E- 48200 Durango - Bizkaia (SPAIN)
www.azterlan.es · (+34) 946 215 470

AZTERLAN

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

ON-LINE TRAINING

INTRODUCTION TO IRON FOUNDRY



[re]THINKING METALLURGY

A new glance at IRON FOUNDRY

By the side of an advancing process industry.

AZTERLAN is a technology center focused on metallurgy and metallic transformation processes.

We rethink metallurgy to help companies that manufacture and apply metallic materials and components optimize the quality and performance of their products, as well as to build more efficient and sustainable manufacturing processes.

We develop disruptive technological solutions, such as materials, technologies, methodologies and software, to help metal-mechanic companies keep a leadership position in their markets and create new application fields for their materials and products.

Knowledge transfer is a key aspect of our activity, and, within this field, we understand that **training the technical staff of companies is of great significance to build more robust and stable processes.**

On-line course

Introduction to Iron Foundry

13 learning nuggets

Independent didactic units regarding each phase of the foundry process.

Self led experience

Each user or job position can consume the topics that consider fit better to their needs.

Assessment activity with every didactic unit

Every nugget (didactic video content) has their own assessment activity.

Know your employees' activity

Companies can get the most relevant data regarding the activity of their staff inside the platform.

AZTERLAN Training platform

On-line platform built on *Moodle*, one of the most widespread on-line training technologies.

AZTERLAN Foundry experts' support

Additionally, depending on the number of staff-members registered, groups are provided with limited consulting sessions with iron casting experts from the AZTERLAN team.

Through 13 learning nuggets (thematic units consisting of videos between 15 and 40 minutes long) focused on the main phases of the iron casting process, this on-line training activity is designed for professionals from foundry companies and aims to offer an overview of this leading manufacturing process to the different job profiles (technical and non-technical) within the organization.

Course objectives:

- To understand the phases

of iron casting process and their integration into it.

- To review/understand the key concepts and terms of iron casting.
- To highlight the importance of proper control and performance of activities in each phase to reduce rejection and quality problems.

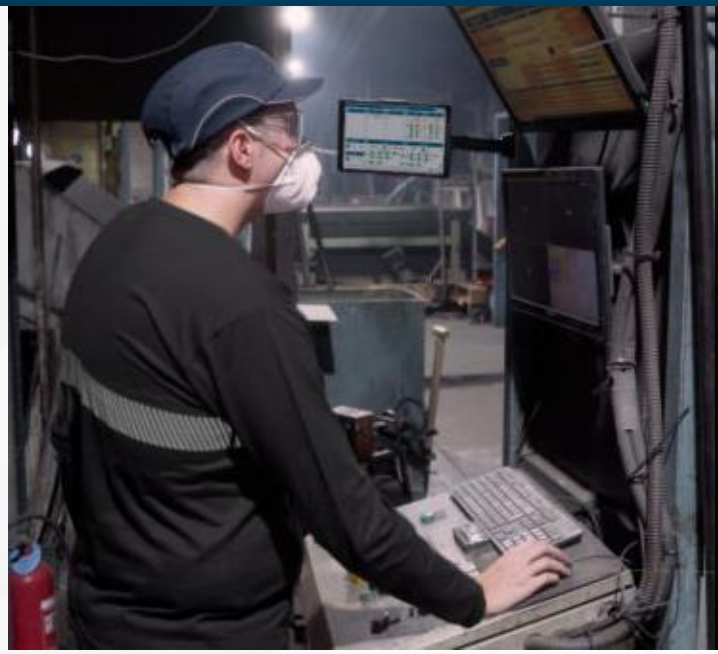
Target audience:

- Technical and non-technical staff of iron casting companies.
- New hires.
- Continuing education for established professionals.

Topics

- ❑ Melting
- ❑ Liquid metal treatments
- ❑ Molding sands
- ❑ Sand testing
- ❑ Molding
- ❑ Core-making
- ❑ Filling and feeding systems
- ❑ Metallurgy
- ❑ Metallurgical Quality
- ❑ Solidification
- ❑ Metallography
- ❑ Sand-Associated Defects
- ❑ Metallurgical Defects

MELTING



FORMAT:
Learning nugget

DURATION:
30 min

SUMMARY:
The process of preparing the base metal, i.e., a proper melting process, is essential to produce high-quality castings. The metallurgical quality of the resulting melt will depend on the raw materials used and the melting method employed. The main melting equipment are: the cupola, the induction furnace, the arc furnace, and the rotary furnace. Regarding the charge materials, chemical composition, energy required for melting, safety, productivity, metallurgical quality, availability, and contamination must be considered..

INDEX:
1. RAW MATERIAL CLASSIFICATION
2. CASTING MEANS
3. REFRACTORIES
4. CONTROL MEANS

TREATMENTS OF MOLTEN METAL

FORMAT:
Learning nugget

DURATION:
20 min

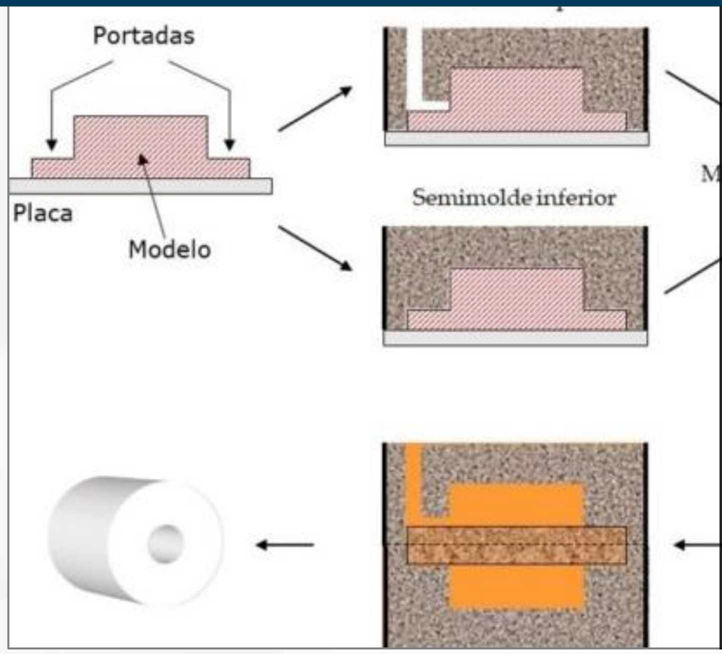
SUMMARY:
Liquid metal treatment is the addition of specific products to the melt to guide its evolution during the solidification process.

In iron casting, the most common treatments performed on the molten metal are: desulfurization, deoxidation, and deslagging. This are followed by recarburization, which consists of adjusting the carbon content in the metal's chemical composition by adding graphite or another type of recarburizing agent. Subsequently, an inoculation treatment is also performed, which increases the metal's nucleation power and increases the number and distribution of graphites, positively affecting the material's properties. Finally, and as a specific case in the manufacture of spheroidal or compact cast iron, a spheroidization or nodulization treatment is performed.

These treatments carried on the metal during its molten state are fundamental and define the characteristics of the material. When applying one or the other, the desired chemical composition, the way the graphite will precipitate, and the final metallurgical quality of the metal must be taken into account.

INDEX:
1. INTRODUCTION
2. MELTING AREA
3. SPHEROIDIZATION TREATMENT AREA
4. POURING UNIT
5. MOLDS FILLING

MOLDING SANDS



FORMAT:
Learning nugget

DURATION:
15 min

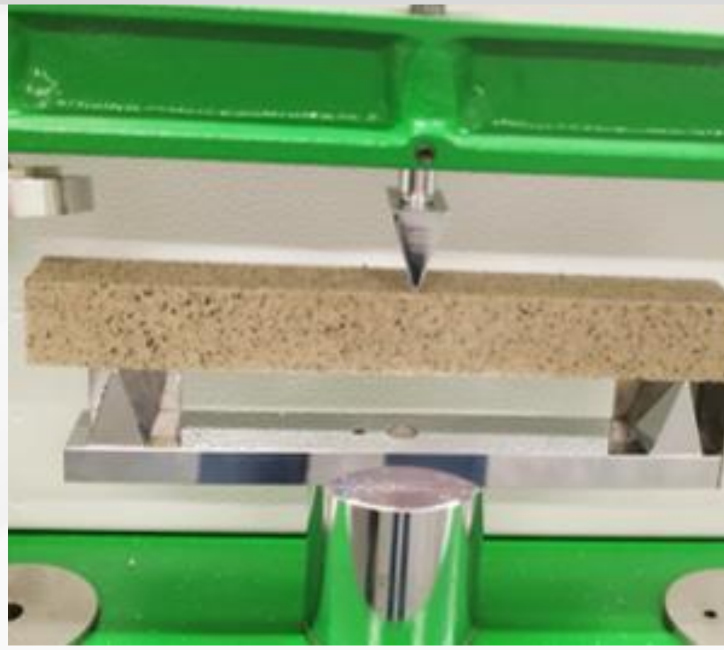
SUMMARY:
Proper sand mill management requires knowledge of green molding sand and the other elements that make up the sand circuit, the functions of each of these elements, effective maintenance of these functions, the ability to reuse spent sand, avoiding losses of this material, considering sand as a valuable process tool, and considering the sand mill circuit an important step in the manufacturing process.

It is of great significance to study the sand mill's capacity, that is, to determine the number and capacity of the sand mixture-producing elements, to understand the elements that consume these prepared sand mixtures, to compare the sand consumption capacity, that is, the production speed of the lines versus the sand production of the mixers, to determine the nominal and maximum capacity of the sand mill, and to understand its margins.

This will ensure the continuous production of sand mixtures with the appropriate properties, assuming variability in line with the quality requirements of the parts and the resources available at the plant itself. It will also preserve and maintain the appropriate properties of the manufactured molds and cores before and after the casting process, and compensate for variations inherent to the manufacturing process, minimizing their effects on the mixture properties.

INDEX:
1. MANUFACTURING PROCESSES
2. GREEN MOLDING SAND
3. CONSTITUENTS
4. MIX PREPARATION
5. CONTROL TESTS
6. COMPACTION SYSTEMS
7. SAND MILL MANAGEMENT

MOLDING SANDS TESTING



FORMAT:
Learning nugget

DURATION:
10 min

SUMMARY:
The preparation of sand mixtures with suitable molding characteristics is of great importance in the manufacture of castings. Maintaining and monitoring the sand system requires a series of tests, the results of which allow for appropriate corrective measures. Variations in sand properties are usually small, requiring relatively long periods of time to correct any deviations detected. Deviations in sand properties can be one of the most significant sources of defects in castings. Tests on sand must be performed according to standardized procedures and using properly calibrated equipment.

INDEX:
1. SAMPLING
2. CONTROL TESTS ON RAW MATERIALS
3. CONTROL TESTS ON PREPARED SAND MIXTURES

MOLDING

FORMAT:
Learning nugget

DURATION:
40 min

SUMMARY:
The objective of molding is to achieve molds with sufficient strength to withstand the ferrostatic pressure of the casting and the subsequent cooling of the metal inside. There are several types of molding, the most important of which are sand molding, either chemical or green sand, shell molding, lost-wax molding, and metal shell molding.

Focusing on green sand molding, the most used method in iron foundries, mold manufacturing can be done manually or using machinery. Foundries used manual molding, but its low productivity, repeatability, and the numerous problems it caused have led to its gradual replacement by mechanical molding, which is currently the most widely used method.

The patterns used to manufacture molds can be constructed from various materials, depending on their application. Manual molding techniques used single patterns, while mechanical molding processes commonly use pattern plates, which can be made of wood, metal, and/or resins.

There are several types of molding machines with varying configurations and production capacities. In general, mechanical molding techniques can be classified into two broad groups: low-pressure and high-pressure molding..

INDEX :

1. BASIC CONCEPTS
2. TYPES OF MOLDING
3. CHEMICAL MOLDING
4. GREEN SAND MOLDING

CORE-MAKING

FORMAT:
Learning nugget

DURATION:
20 min

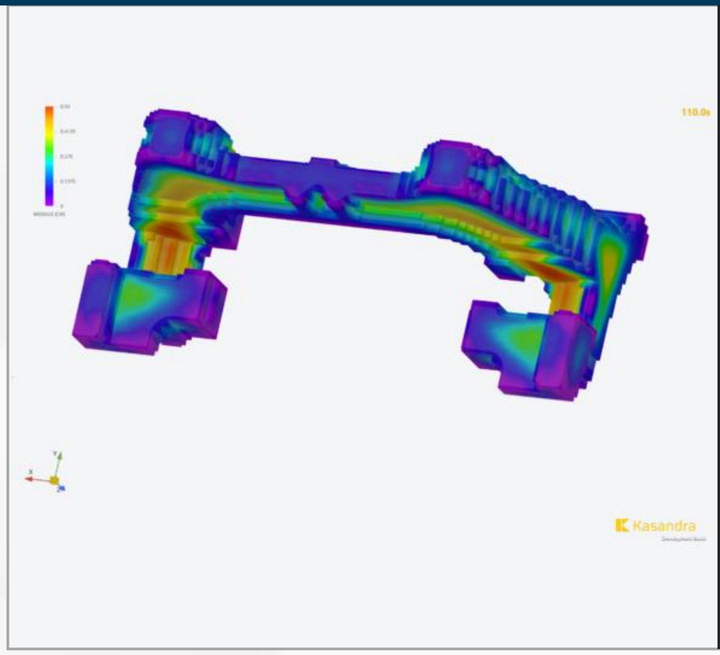
SUMMARY:
The mass production of cores is a very important stage because, like the parts themselves, they must meet the highest quality standards. The cores are placed inside sand molds to accurately define both the internal and external shapes of the part.

Sand core manufacturing can use several processes with different characteristics and raw materials associated with each process. It is essential to identify the process controls necessary to manufacture cores that meet the required quality standards and do not impact the final quality of the part or component to be manufactured.

INDEX :

1. INTRODUCTION
2. MANUFACTURING PROCESS
3. AMINE-HARDENED COLD BOX PROCESS
4. RAW MATERIALS
5. PROCESS CONTROL

FILLING AND FEEDING SYSTEMS



FORMAT:
Learning nugget

DURATION:
30 min

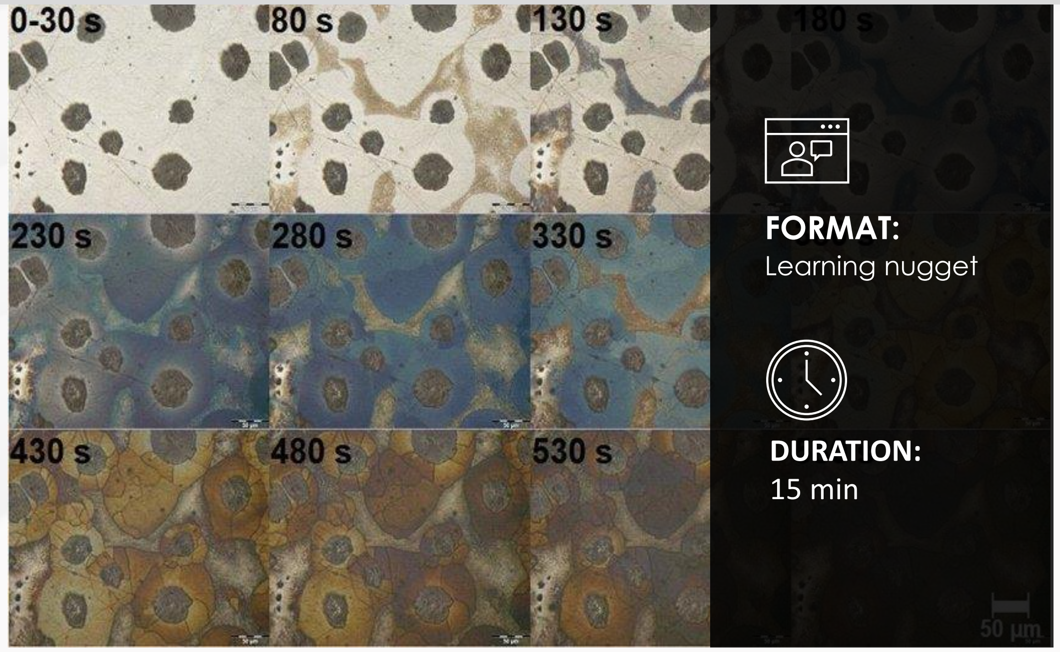
SUMMARY:
Industry demands the production of low-cost components, which, in the case of castings, entails a series of challenges and demands, such as high productivity. The availability of machines capable of mass-producing sand molds at high speeds means that filling these molds with liquid metal cannot be a limiting factor in manufacturing. Therefore, the proper design of filling systems, which optimizes filling times without increasing the speed at which the liquid metal enters the mold, is essential for maintaining manufacturing speeds.

Likewise, system performance—the ratio of the weight of the parts produced in a mold to the total weight of the system—is also a key factor for competitiveness. The goal must be to increase this performance, either by increasing the number of parts per mold or reducing the volume of the filling and feeding systems. Understanding the metal solidification processes inside the part will minimize the need for liquid metal fill to avoid shrinkage defects by adjusting the size and number of feeder elements.

Simulation tools make it possible to validate previously calculated systems, verifying their correct sizing and minimizing the possibility of part shrinkage defects. This reduces the number of tests required when industrializing new references and significantly reduces industrialization costs..

INDEX:

METALLURGY



FORMAT:
Learning nugget

DURATION:
15 min

SUMMARY:
Metallurgy is the science that studies the structure and properties of metals and establishes the relationship between their chemical composition, structural organization, and characteristics. Iron-based materials are part of the metal family and can exist as a pure element or as part of alloys. From an industrial perspective, pure metals do not have a significant field of application; pure iron is rare in industrial applications, which is why we always refer to them as ferrous alloys.

Ferrous alloys are defined as those in which iron is the main element, with carbon occupying a prominent secondary position in the chemical composition. Ferrous materials are classified into two large groups: steels and cast irons. It is precisely the carbon content that forms the barrier between steels and cast irons.

All cast irons and steels on the market contain, in addition to carbon, other chemical elements that give them their characteristics. The presence or absence of graphite in iron castings and their morphology determine the material’s structure and characteristics, allowing them to be classified..

INDEX:

METALLURGICAL QUALITY

FORMAT:
Learning nugget

DURATION:
20 min

SUMMARY:
Metallurgical quality is an indication of a metal's nucleation potential, that is, the ease with which carbon precipitates in the form of graphite throughout the solidification process. To determine a metal's metallurgical quality, solidification and cooling curves are used, obtained through thermal analysis, plotting the metal's temperature against time. Thermal analysis studies the metal's behavior throughout the solidification process and their subsequent cooling to room temperature. During solidification, iron castings undergo structural changes, including graphite nucleation, subsequent growth, and changes in the microstructure of the metal matrix. These changes occur throughout the solidification and cooling process and are reflected in the thermal analysis curve.

INDEX:
1. INTRODUCTION TO THERMAL ANALYSIS
2. FE-C DIAGRAM
3. MAIN COMPONENTS OF THERMAL ANALYSIS
4. TYPES OF TESTS
5. TEST CONDUCT AND PRESERVATION

SOLIDIFICATION

FORMAT:
Learning nugget

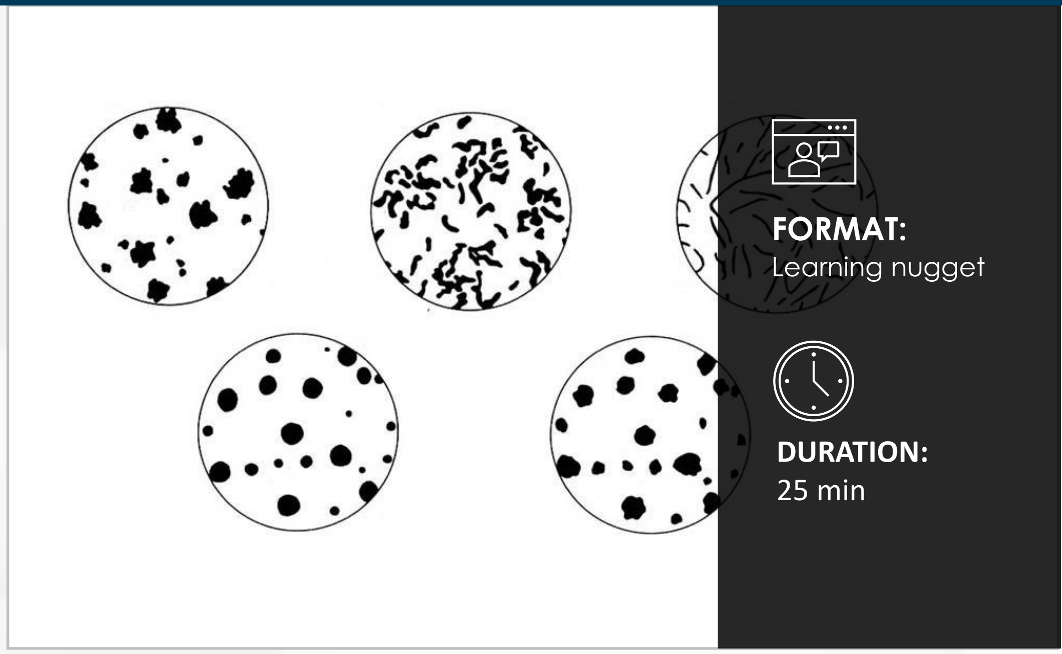
DURATION:
40 min

SUMMARY:
The solidification process largely determines the structure, both at the macro and micro levels, of the consolidated material and, consequently, its mechanical properties.

This session presents a classification of ferrous materials, briefly mentioning their characteristics and applications. Afterwards, focuses on how solidification occurs, both at the macroscopic and microscopic levels, for steels and cast irons. Finally, it describes, through cooling curves, the different stages into which solidification is divided: initiation, eutectic and final palier, and analyzes their influence on the manufactured castings.

INDEX:
1. CLASSIFICATION OF FERROUS MATERIALS
2. SOLIDIFICATION OF FERROUS MATERIALS
3. STAGES OF SOLIDIFICATION

METALLOGRAPHY



SUMMARY:
Metallography is the branch of metallurgy that studies the internal structure of metals and alloys through the observation and analysis of their microstructure. This discipline is an indispensable tool for the manufacturing and production of materials. Metallography is useful for the research and development of new materials, as well as for solving quality problems such as preventing failures and defects during use.

Proper sample preparation is essential for the observation and analysis of the microstructure of metals and alloys. The sample preparation process involves several stages, including cutting, grinding, polishing, etching, and cleaning.

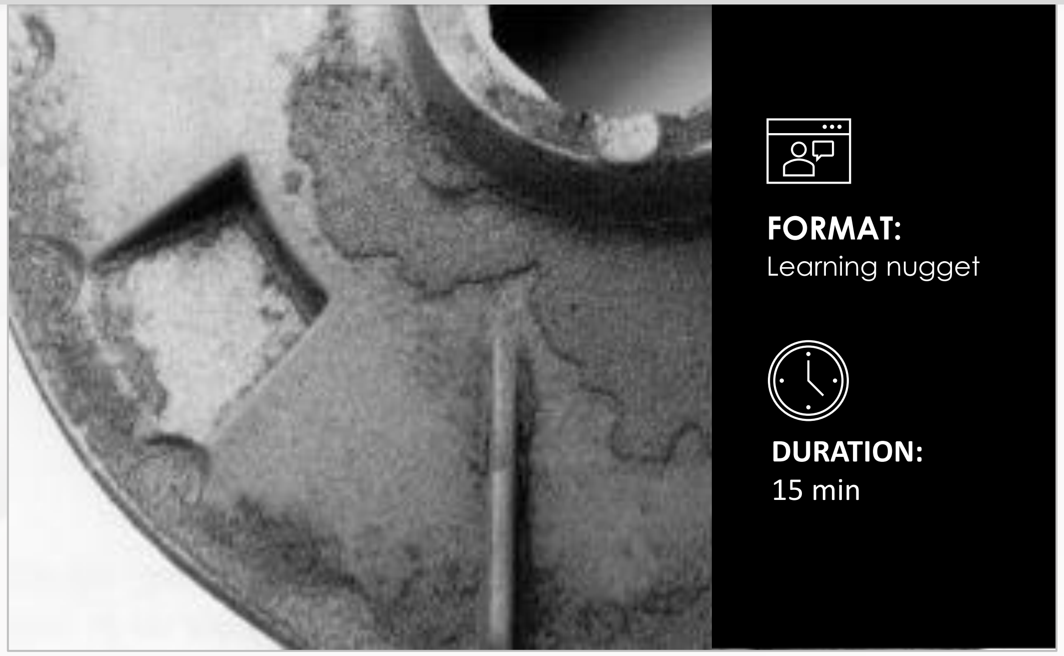
Once the samples are prepared, the microstructure of metals and alloys is studied using observation and analysis techniques in optical and electron microscopes. These techniques allow the internal structure of materials to be visualized and analyzed.

Optical microscopy is the mostly used technique; electron microscopy is a more advanced technique. There are two types of electron microscopes: the scanning electron microscope (SEM) and the transmission electron microscope (TEM).

Microstructure analysis allows the determination of the mechanical and physical properties of materials. This analysis includes observing the morphology of the microstructure, determining the quantity and distribution of phases, measuring phase dimensions, and determining their chemical composition..

INDEX:
1. METALLOGRAPHIC PREPARATION
2. PHASE IDENTIFICATION
3. ANALYSIS MEDIA

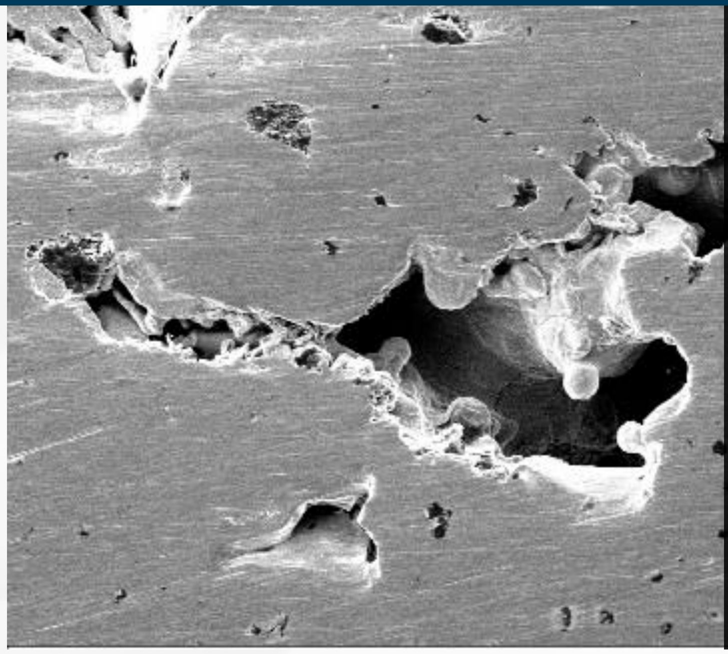
SAND-RELATED DEFECTS



SUMMARY:
Casting defects are deviations, imperfections, or deficiencies in parts relative to the quality specifications established by the service requirement and design. Most of these defects originate from process deviations. Sand-related defects can be grouped into four main types: surface defects, defects due to sand expansion, mold-related defects, and defects related to the mold-metal reaction. Although virtually all sand-related defects can be avoided with proper sand mill management, studying them and understanding their origin is considered extremely useful for detecting their presence and taking the necessary corrective actions to eliminate them without incurring high process costs.

INDEX:
1. INTRODUCTION
2. SURFACE DEFECTS
3. SAND EXPANSION DEFECTS
4. MOLD-RELATED DEFECTS
5. MOLD-METAL REACTION

METALLURGICAL DEFECTS



FORMAT:
Learning nugget

DURATION:
25 min

SUMMARY:

Casting defects are deviations, imperfections, or deficiencies in parts relative to the quality specifications established by the service requirement and the design. Most of these defects originate from process deviations. The causes that promote metallurgical defects are implicitly related to inadequate metallurgical quality of the metal and affect the entire manufacturing process.

The appearance of these types of defects may be related to the chemical composition of the metal, an inadequate melting procedure, nodulization treatment, inoculation, and metal casting. Defects of metallurgical origin can be classified into four categories: defects related to the morphology and/or distribution of graphite; defects related to the matrix structure; defects related to the internal soundness of the parts, i.e., the presence of shrinkage defects and/or porosities; and, finally, defects derived from the production process that have their origin in metallurgical quality.

INDEX:

Frequently Asked Questions

Is it mandatory to complete the entire training course (13 modules)?

Although the full course is purchased as package (13 modules at a time), each module is designed as a standalone unit that can be studied independently. Participants—either by personal choice or at the recommendation of their company or designated supervisor—can decide to complete the entire course or focus only on the modules most relevant to their professional needs.

Is there an evaluation system?

Yes. After viewing the content of the thematic module (a 15–40-minute video), the student must complete the assessment activity to consider the training activity has been completed.

Will my employees receive proof of completion of the course?

Upon completion of each module (learning nugget) and passing the evaluation questionnaire, the user/learner will be able to generate a certificate certifying that they have completed and passed the training activity.

As a company, will I be able to access information about my employees' performance on the platform?

AZTERLAN can provide the company with relevant data regarding its users' activity inside the platform:

- Time spent on the platform and dedicated to each training activity
- Modules (learning nuggets) completed
- Results obtained in the assessment activities

Can someone take the course without being part of a foundry company's staff?

Currently, this activity is aimed at foundry companies as a way to strengthen continuous training among their professional teams.

For more information about this type of activities, please contact Dr. Susana Méndez (smendez@azterlan.es)