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SAULT COLLEGE

of APPLIED ALTS and TECEftOLOG

Sault Ste. I-rarIe

COURSE OUILILL

METALLURGY

MET 251-2

(NOTE: Same as MET 200-5)

revised November, 1976

Metallurgy & KelcJing

KET *Qo£^.-___*

TEXT:

.Sidney H. Avner

"Introduction to Physical Metallurgy"

(McGraw-Hill Book Company)

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Metallurgy & Welding

MET ^ 7 - a

Topic Nunber	Suggested Periods	Topic Description	Reference
		Introduction to Metallurgy - Definition of the Science -• Breakdown into Extractive; Physical £nd Mechanical Metallurgy The Raw Materials - Iron Ores, Ease Metal Ores - Composition of Ores and Occurances Mineral Dressing . - Crushing and Grinding Metnods - Separation Processes: Magnetic Separation Gravity Separation Flotation Agglomeration Processes " Sintering - Pelletizing The Blast Furnace Process - The Burden Materials - The Chemistry of the Blast Furnace Process - Material Balance - The Operation of the Furnace Steelmaking Processes - Bessenes Process - Open Hearth Process - Basic Oxygen Process Classification of Steels Uses of various types of plain carbon steels	
8	1	Cooling and Solidification of Metals	
9	8	The Iron-Carbide-Equilibrium Diagram - The Critical Temperature Lines - Products of equilibrium and non equilibrium cooling conditions	

Topic Number	Suggested Periods	Topic Description	Reference
10		Heat Treating Methods - Softening Processes - Hardening Processes - Hardenability, mass effect and ruling section - Quenching Medias	
11		Surface Hardening Methods - Flame Hardening - Induction Hardening - Pack Carburizing, Gas Carburizing - Cyaniding - Nitriding	
12		Alloy Steels - Effect and Classification of alloying elements	
13		Aluminum, Brass and Bronze - Composition - Eeat creating characteristics	
14		Cast Iron - Composition and properties ~ TYPes of cast irons	

METALLURGY

MET -^Si-3L

TEXT:

Avner, S.H. — Introduction to Physical Metallurgy

-GEN.-iRAL:

The student should be able to describe the processes wir.ch lead-to the production of steel from the rav; materials. Ee should be able to cescrioe the properties of sled by using the Iron-Carbon-Diacram and be able to use the information to Keat Treat steejL samples of varying carbon content.

The changes during Heat Treatment will be tested by using Hardness and Impact testers. Processes of Case-Hardening are discussed and applied to steel samples.

The student should have *e.z* understanding of the effects of alloying metals on the properties of steel.

He should also be able to describe the properties and Heat Treating Characteristics of Aluminum, Brass and Bronze.

METALLURGY

MET _^3V :_S.

'SPECIFIC OBJECTIVES

The student should be able to describe the processes which lead to the production of steel from the raw materials.

The stiident should be able to give a definition of Metallurgy in writing.

He should be able to outline, in writing, the subjects dealt-with in Extractive, Physical, and Mechanical Metallurgy.

He should be able to write a definition of Mineral Dressing.

He should be able to name 4 types of iron ore and write their chemical composition.

He should be able to describe processes used to liberate minerals before separation and be able to give a sketch of the operation of Crushers, Autogenous Grinding Kills and Rod and Ball Mills.

He should be able to produce a sketch outlining the following separation processes : Magnetic Sf>oarati on
Heavy Media Separation
Humphrey Spiral Separation
Flotation

He should be able to describe the Sintering process, name the raw materials, describe their, functions in the process and be able to produce a sketch of a sinter strand, showing and naming the major components.

The student should be able to name the raw materials used in the pellelising process, name their function, describe the pellelizing machines with the aid of sketches, and name the fuel used in the process and the temperatures obtained.

The student should be able to produce a sketch of a coke oven and be able to name the major components.

The student should be able to name the raw materials changed in the Blast furnace and explain their functions in the process.

The student should be able to give a sketch of a blast furnace and be able to name the major components.

The student should be able to write the main chemical reactions of the Blast furnace process.

The student should be able to write the material balance for the Elast furnace process.

He should be able to write the approximate composition of Pig Iron.

The student should be able to name the raw materials used in the Open Hearth process.

•He ^should be able to produce a sketch of the Open Hearth and be able to name the major parts.

The student should be able to describe the Open Hearth Steel-Making process.

The student should be able to name the raw materials used in the Easic-Oxygen-Process.

He should be able to give a sketch of the steelnaking equipment and name the major components.

The student should be able to describe the steellmaking process with the Easic-Gxygen-Vessel.

The student should have cet'eloped an understanding of the Iron-Carbon-Diagram and be able to apply this knowledge to the Heat - Treatment of various Carbon Steels.

The student should be able to produce a polished and etched steel sample suitable for microscopic examination by using cutting 'and polishing equipment.

He should be able to identify under the microscope the following components of steel: Ferrite, Pearlite, Martensite.

The student should be able to write the composition of Ferrite and Pearlite.

He should be able to explain the relationship between Ferrite, Pearlite and the Carbon Content of Steel.

He should be able to explain the transformations taking place in steel when the steel is heated.

He should be able to explain on the Iron Carbon Diagram the meaning of the critical temperature lines.

He should be able to explain the meaning of the eutectic and the eutectoit point, and name the respective carbon content.

He should be able to name the types of quenching media.

He should be able to describe the effect of various quenching medias on the hardness of steel.

Be able to determine the hardness of steel by using the Rockwell Tester and the Shore Scleroscope.

Be able to describe the measuring principle employed by Rockwell, Brinell and Vickers Testers.

Be able to explain the relationship between hardness and toughness of steel and the importance of the Blue Brittle Ranee.

Be able to Treasure the hardness by using the Charpy Impact tester.

To explain the objectives of the following heat treatment .processes: Annealing, formalizing, Tempering. .

To be able to describe the procedures used in each one of the following heat treatment processes: Annesaling, Normalizing, and Tempering.

To be able to 'describe the procedures used in the following Case hardening processes: Pack and Gas Carburi^ing, Cyaniding, Kitriding, Induction and Flame Hardening.

Be able to name the changes taking place on the surface of the steel when subjected to the different case hardening processes.

The student should know which effects additions of other metals have on the properties of steel.

The student should be able to name 5 properties of steel which can be altered by addition of alloying metals.

He should be able to name the changes in the properties of steel which take place when Nickel, Chrome,-Manganese, Molybdenite, Vanadium, Cobalt and Tungsten are added.

He should be able to indicate the approximate quantities of alloying metals added to the steel.

The student should be able to describe properties and Eeat treating characteristics of Aluminum, Brass and Bronze.

The student should be able to name the composition of Duraluminum, Brass and Bronze.

Ke should be able to name the differences of these alloys in respect of heat treatment characteristics in comparison to Carbon Steel.

MECHANICAL TECHNICIAN

Welding

MAJOI. TOPICS:

	Lab	Theory
Oxy-Acetylene"Welding	4	2
Electric Arc Welding	5	2
Fabri cation (Projects)	5	2
Argon Arc Welding .(Tig)	1	i
Gas Metal Arc Welding (Mig)	1	1
Weld/ng Metallurgy		A
	16	12

MAJOR REFERENCE MATERIAL (available to students)

"The Science and Practice of Welding" - Patton
"The Procedure Handbook of Arc Welding" - 12th Ed. Lincoln
Oxy-Acetylene Welding Handbook" - Linde
"Welding Fundamental Principles & Practices" - C.W.B
"Welding Metallurgy" Volume 1 & 2 - Linnert

FILMS

"Shielded Arc Welding I & II" - Miller
"Electric Arc Welding Processes" - Miller
"Electrode Manufacture & Selection" - Hobart

PLANNED FIELD TRIPS:

"Adams Welded Products" (C.W.B. approved - Fabricator)
"Dominion Bridge" (Subarc Welding of WF Beams)

PREAMBLE:

This welding course will introduce the student to a "hands-on" learning experience of common oxy-acetylene and electric arc welding methols, practices and related activities. Selected exercises, films, and field trips will give the student a good understanding of the uses and merits of each listed weling process, in addition to safe work habits and proper welding and cutting skills. Emphasis is placed on demonstration and practice.

Investigative procedures are adopted wherever possible, for example: (in approximate order)

- Heat Concentration and Tip Selection
- Effect of Flame Type on Liquid Puddle
- Tip Size and Pressure in relation to base thickness
- Pressures in relation to make up torch
- Explosi\^e range of Acetylene (in air and oxygen)
- Arc characteristics of major electrodes
  (xx 10, 11, 13, 24, 14, 16, 18, 28)
- Effect of quenching on ductiliy of selected rods
- Selection of polarity and current
- Volt-ampere relation (measurement)
- Voltage drop (measurements)
- M^gietic effect on current and arc stream
- Advantages of non-fusion welding
- Heat input effects on distortion
- Heat conductivity in metals
- Carbon precipitation in stainless steels
- CO? + Argon mixtures affecting metal transfer
- Selection of Welding Process in relation to heat input and width of H.A.Z.

Oxy-Acetylene Welding

SCOPE

- fusion welding
- non-fusion welding
- hardfacing
- spray facing
- cutting

EQUIPMENT

- types of torches, tips, accessories, maintenance
- filler metals
- personal and shop safety
- tank construction
- storage (bulk and manifolds)

GASES

- characteristics and properties of oxygen and acetylene
- fuel mixtures used industrially

PROJECTS

Fusion Weld

- 14 ga. metal using edge joint, corner joint, butt joint, tee joint
- Cast-iron-bracket, Aluminum Strip (2S) , Stainless Steel strip (304)

Brazeweld

- tee joint (mild steel)
- castiron to steel
- al. strip (aluminweld, 33s)

Brazing and Soldering

- copper tubing (50-50 solder, silpfos , silversolder
- al. strip (35S)

Hardfacing

^^F - Stellite rod; Cast Borium

Sprayfacing

- Eutalloy torch

Cutting

- manual, semi-automatic, circle cutting, piercing, ' structural shapes cutting,
- cutting of containers

ELECTRIC ARC WELDING

Electrodes

classification of mild steel, low-alloy rods, stainless steel, al, nickel, copper, hardfacing, and tocl steel electrodes
selection

Machines

- characteristics of stick-electrode machines: *of\(t* arc voltage, V/A curve investigation, duty cycle calculations
- current and polarity selection
- accessories and maintenance
- personal and shop safety

PROJECTS

Bead and Weave

- flat and position 6010/11

Fillet Welds

- 7024, 7018, 28 on 3/8" plates
- 1/8 6013 - 14 ga. strip downhand

Groove Weld

- with back-up plate (C.W.B. Code)
- without back-plate (pressure code) (6011-7018)

Hardfacing

"jstoody electrodes, patterns used

• Repaid Welding

- using 309-16, Aluminum weld, N irod, Phosphor Bronze on appropriate applications

Carbon Arc Gouging

. —. demo, and practice

Ressistance Spot Welding

- demo, and .practice

FABRICATION

Equipment

- use of Ironworker, stationary and portable grinder, hand tools

PROJECTS

- layovt and weld angle, iron f r?™^
- lay out, cut and weld 90° pipejoint on 4" pipe
- cut plate to fabricate I-beam (distortion)
- forge and heat treat chisel, chipping hammer

Weld Symbols

- interpretation, measurement of fillets

Distortion

- causes and prevention

ARGON ARC WELDING

- set up of machines, accessories, solenoids
- Tig^arc characteristics
- Demonstration and practice running beads on steel (pipe - root pass), stainless steel, al, copper strip

CjAS METAL ARC WELDING

Demonstration and practice fillet welds with the following equipment:

- „.....-'.Innershield" Sam 400 - LN-22 Wire feeder with C^{T}' and variable inductance control (Lincoln)
- Liivde (Sigma) Gasshield and Fluxcore .-* system
- Hobart Microwire and CC ~ (hardwire)
- »___-„Aixco -Miget Gun for AI and stainless steel application

SUBARC WELDING

-iset up of portable equipment with #10 Radiagraph as ^carriage

WELDI11G METALLURGY

- Weld faults, sizes, terminology
- Weldability versus Hardenability, Weldability tests
- Fluxes, shielding gases, Hydrogen diffussion in welds
- H.A.F. related to I.I.C^ Equilibrium Diagram
- Calculations of Admixture in welds, carbon equivalent, " preheat and post heat requirements, heat input in joules/inch
- Selection of Welding processes
- Weldability of Cast Irons, Aluminum Alloys, Stainless Steels, Tool Steels
- Welding of Q. and T. steels TIG Plate
- Destructive Testing (Nickbreak, Guided Bend Test)
- Identification of Metals (Spark, Flame and Chem. Solution)
- Magna flux
- X-Ray Inspection

WELDING METALLURGY

Proposed Course Outline

It is intended that the following course outline will be taught to continuous intake students who will be issued the following texts.

"**Arcweld** Electrode Pocket Guide". . . . cost $ 2.00

"Metals and How to Weld Them". . . . . • cost $ *k.95*

OUTLINE

SECTION	CHAPTERS	OUTLINE
1.	1*2,3**f»	!• Stoat It<s All About 2. Mechanical Properties of Metals 3» Toughness and Other Properties *km* The Metals We Use
2«	7,8,	7. Fundamentals of Metallurgy 8. Metallurgy and Heat Treating
3*	**9,10,11,13**	9. Metallurgy and Welding **10,** Welding Low Carbon Steels **11.** Welding Medium Carbon Steels **13.** Welding Alloy Steels
*k**	*Ik* '	1^* Metallurgy of Cast Irons **Welding** Cast Irons
5.	15	15. Satinless Steels & High Chrome Alloys
6*	21	21. Good Welds and **How** to Make Them

Tfeere are basically five blocks to the outline, and they are set up so that students may enter ANY given block and thru the aid of his **text,** catch up .to the rest of the class. For his part, the instructor **must** be organized and capable of relating the two texts with this **outline.**