ИНОСТРАННЫЙ ЯЗЫК В ВУЗЕ

Владимирский государственный университет

Т.А. НАЗАРОВА В.Н. ШАРШИН

FOUNDRY
ЛИТЕЙНЫЕ МАШИНЫ И ПРОИЗВОДСТВО

Учебное пособие по английскому языку

Владимир 2002

Министерство образования Российской Федерации
Владимирский государственный университет

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Учебное пособие включает пять разделов. Каждый раздел представляет собой цикл, состоящий из заданий-шагов, выполнение которых позволит овладеть навыками чтения научно-технической литературы по специальности, разговорной речью и письмом. Материалы учебного пособия основаны на оригинальных англо-американских текстах, содержащих иллюстрации, элементы ролевой игры и задания творческого характера.

Предназначено для студентов высших учебных заведений специальностей 110400 – литейное производство черных и цветных металлов и 120300 – машины и технология литейного производства очной и заочной форм обучения, а также соискателей и аспирантов специальности 05.16.04 – литейное производство при изучении английского языка.

Табл. 1. Ил. 24.

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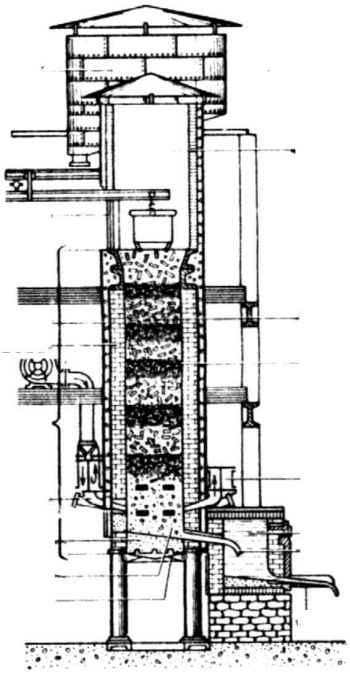
Unit I

CUPOLAS

Step 1

Look at the drawing of the cupola, study the names of the parts and match the names with the parts in the drawing.



1. Spark arrester
2. Stack
3. Charging door
4. Shell
5. Iron charge, metal charge
6. Lining
7. Coke charge
8. Cupola body, cupola shaft
9. Tuyere
10. Wind box
11. Sand bottom
12. Forehearth
13. Spout
14. Coke bed
15. Door
16. Tap hole

Step 2

Put the questions about construction of the cupola and ask your partner.

1. In what part of the cupola is a spark arrester?
2. Where are tuyeres?
3.
4.
5.

Step 3

Describe the construction of the cupola in the drawing.

Step 4

4.1. Read the text and find out :

1. How can the cupolas vary in size? 2. What are the main parts of a conventional cupola? 3. What processes take part in the cupola? 4. In what way is the cupola charged? 5. In what way is the metal drained out?

A Conventional Cupola

Cupolas can vary in size, from ones that melt 1 ton of cast iron per hour to ones that melt 50 tons per hour. Conventional cupolas consist of a cupola shaft, a stack with a spark arrester, a set of tuyres, a hearth and a forehearth.

The cupola shaft is the main part of the cupola. It is based on the sand bottom plate and the props. The charging door for charging the cupola with the mixture of raw materials is in the upper part of the shaft, the lower part of the cupola shaft from the sand bottom to the first row of the tuyres is called a hearth. The cupola shaft of the conventional cupolas from the sand bottom up to the charging door is lined inside with two layers of fireclay bricks. At the top the cupola shaft is lined with grey iron blocks that prevent it from damage with the charge materials.

Two main processes take part in the cupola shaft: burning of the fuel and melting of the cast iron. For better burning of the fuel and intensification of the melting process several rows of tuyres are set. Air to the tuyres comes from wind box. Cupola is operated by varying the air blast and the percentage of the coke in the charge. Products of burning go outside through the cupola stack. The stack is crowned with a spark arrester that catches burning hot dust and sparks.

The hearth and some part of the cupola shaft are charged with a layer of the burning hot coke. This layer of the coke is called the coke bed. Iron charge is charged on it by small portions. The iron charge consists of cast iron, scrap, scrap steel and the coke. The coke is called the fuel charge. Lime that is used as flux is charged after each fuel charge of the coke. When the metal melts it flows out of the cupola through the tap hole and intermixes in the forehearth. Metal in the forehearth has the uniform temperature and chemical composition.

If the cupola is tapped continuously as most medium-size and large cupolas are the cast iron and slag flow continuously through the same tap hole and are separated in a small basin in a spout, the slag floating and being discarded.

For intermittent tapping there are both a cast iron tap hole at the front of the cupola and a slag tap hole at the rear some 12 to 24 in. higher. The cast iron tap hole is closed with a fireclay plug so that cast iron and slag are accumulated in the hearth. As the level rises the molten slag floating on the cast iron reaches the slag hole and flows out. When the cast iron level is near or at the slag hole the cast iron tap hole is opened by removing the fireclay plug and most of the cast iron is drained out at a rate much higher that the melting rate.

The cast iron tap hole is then reclosed and the cycle is repeated. The cupola walls may overheat, crack or even burn during operation. So it is better to have them water-cooled. Modern cupolas have two types of water-cooling: water wall or water flood. It greatly effects the cupola sevice life and productivity.

4.2. List of special terms

1. cast iron – чугун
2. per hour – в час
3. conventional – обычный
4. shaft – шахта
5. stack – труба
6. spark arrester – искрогаситель
7. tuyre – фурма
8. hearth – горн, топка (рабочее пространство печи)
9. forehearth – копильник
10. sand bottom plate – плита пода
11. props – опоры, стойки

12. mixture of raw materials – шихта
13. charge material – шихта
14. charge – шихта
15. to charge – загружать
16. charging door – загрузочное окно
17. to line with – облицовка
18. fireclay bricks – огнеупорный кирпич
19. damage – повреждение
20. fuel – топливо
21. melting – плавка
22. molten metal – расплавленный металл
23. to set – устанавливать
24. set – комплект
25. wind box – воздушная коробка
26. air blast – воздушный поток
27. dust – пыль
28. sparks – искры
29. coke bed – холостая колоша
30. fuel charge – топливная колоша
31. lime – известь
32. scrap – металлический лом
33. fuel charge of coke – топливная колоша из кокса
34. tap hole – чугунная летка
35. to tap – пробивать летку
36. continuously – непрерывно
37. spout – сливной желоб
38. to float – всплывать, плавать
39. to discard – удалять
40. intermittently – с перерывом
41. tapping – выпуск металла из печи
42. at the rear – с обратной стороны
43. plug – пробка
44. to drain out – отводить, выпускать
45. rate – скорость

Step 5

The chart contains some terms from the text.

Study the other forms of the same words. Complete the chart with the missing forms of Participle I and Participle II.

Nouns	**Adjectives**	**Verbs**	**Participle I**	**Participle II**
variability variation	variable various	to vary	Varying	varied
charge	-	to charge	charging	charged
melt	molten	to melt		
operator operation	operational	to operate		
blast	-	to blast		

Nouns	Adjectives	Verbs	Participle I	Participle II
product production productivity	productive	to produce		
crown	-	to crown		
fuel	fuel	to fuel		
slag slagging	slaggy	to slag		
tap		to tap		
flow		to flow		

Step 6

Put these words in the correct places.

damage/stack / layers / wind box / coke / shaft / fireclay plug/

1. The charging door for charging the cupola is in the upper part of the .... .
2. The cupola shaft is lined inside with two ..... of fireclay bricks.
3. Iron blocks prevent the top of the cupola shaft from ..... .
4. Air to the tuyres comes from a ..... .
5. The ..... is crowned with a spark arrester.
6. ..... is called the fuel charge.
7. The cast iron tap hole is closed with a .....

Step 7

Brainstorm

Brainstorming is an activity when you give different answers, suggest different ideas the more, the better but do not criticize the answers given by other students.

1. How did people melt metal in old times ?
2. What is lime used for ?
3. How is the cupola fired ?
4. Is it possible to throw fume directly into the air ?

Step 8

You can find some terms and their explanation. Match the terms with the explanation.

1. charge, 2. melt, 3. raw, 4. shaft, 5. mind box, 6. plug, 7. product.

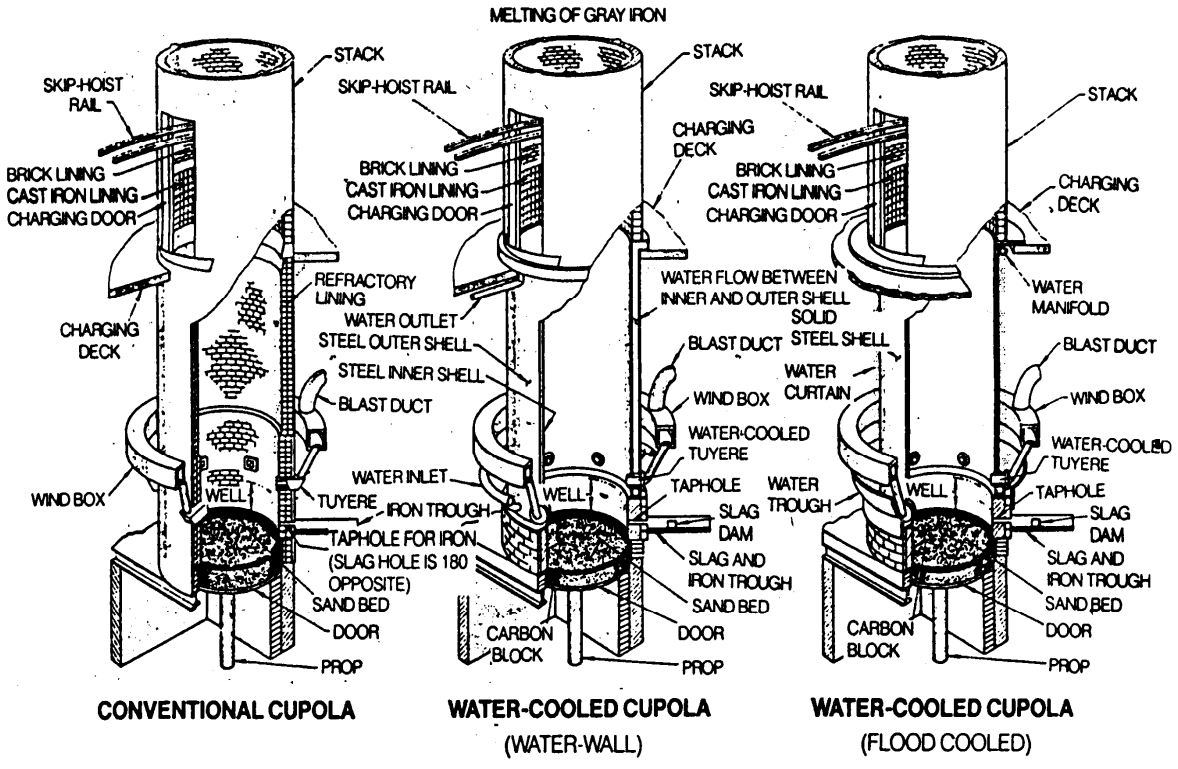
a. A material such as wood, coal, gas or oil burnt to produce heat.
b. In a natural condition; not subjected to manufacturing or refining.
c. To change or be changed from a solid to a liquid state by the application of heat.
d. An object used to stop hole.
e. A result obtained by manufacturing.
f. The main part of the cupola.
g. An apparatus from which air to the tuyres comes.

Step 9

Case study:

Look at the pictures of cupolas! Find the difference between them.

Use the words given below.

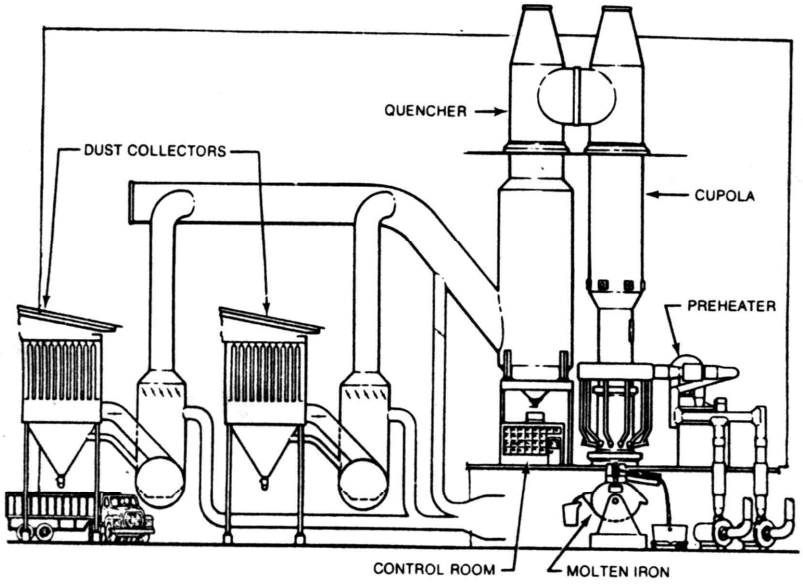


MAIN PARTS OF THE CUPOLA

Cupola – вагранка
Spark arrester – искрогаситель
Stack – дымовая труба
Charging door – загрузочное окно
Shell – кожух
Iron charge, metal charge – металлическая колоша
Lining – футеровка
Charge – колоша
Coke charge – коксовая колоша
Coke bed – холостая колоша
Cupola shaft – шахта
Tuyere – фурма
Slag hole – шлаковое отверстие
Iron trough – желоб для чугуна
Blast duct – труба для подвода воздуха
Cast iron lining – футеровка из чугуна
Charging deck – загрузочная площадка
Carbon blok – перекрытие из углерода
Water-cooled tuyere – водоохлаждаемая фурма
Steel inner shell – стальной внутренний кожух
Fireclay plug – пробка из огнеупорной глины (шамотная)
Accumulate – накапливать
Slag dam – перегородка из шлака
At the rear – с обратной стороны
Wind box – воздушная коробка
Sand botton – под, лещаль
Forehearth – копильник
Spout – желоб
Door – дверца
Tap hole – летка
Blast – дутье
Mixture of raw materials – шихта
Charge calculator – шихтовка
Scrap – лом
Coke – кокс
Flux – флюс
Prop – стойка, подпорка
Tap hole for cast iron – летка, выпускное отверстие
Tuyere – фурма
Refractory lining – огнеупорная футеровка
Brick lining – футеровка из кирпича
Skip-hoist-rail – трос скипового подъемника
Well – металлоприемник
Water outlet – выпускное отверстие для воды
Water manifold – коллектор для воды
Tapping – выпуск металла из печи
Drain out – отводить, выпускать

Step 10

Study the drawing. What are the main parts of the new cupola iron-melting system?



The new cupola iron-melting system at the Michigan Casting Center is one of the largest in the country. It includes cupola and preheaters, right, and air pollution equipment including a quencher. Supplemental equipment includes a 100-ton channel holding furnace to receive molten metal. Capacity is as much as 75 to 85 tons per hour

1. Preheater - установка для подогрева
2. Quencher - гаситель
3. Dust collector - пылесборник
4. Air pollution control equipment - оборудование по очистке воздуха от загрязнений
5. Supplemental equipment - дополнительное оборудование
6. Channel holding furnace - канальный миксер

Step 11

11.1. Read the text and answer the questions: 1. What is the capacity of a new coke-burning cupola? 2. With what material is the cupola charged? 3. What is "dry slagging technique"? 4. What does the parallel arrangement of the cupola to electric arc melting ensure? 5. How much is the environmental control investment of the company?

GIANT CUPOLA OPERATING AT MICHIGAN CASTING CENTER

A new coke-burning cupola went into operation at Ford Motor Co' s Michigan Casting Center. The new cupola has a basic capacity of 20 tons per hour and a maximum capacity of 85 tons per hour. The cupola uses two 1200- deg. externally fired preheating units, supplied with blast air blowers driven by 800 hp motors.

The emission control system consist of a giant "quencher" as tall as the cupola, two exhaust fans and two dust collectors each containing 12 sections and 1.400 filter bags. In addition to the cupola the installation includes a 100-ton capacity channel holding furnace.

The cupola is charged with blends of coal of different grades, foundry coke, iron scrap and steel that can be recycled.

The new system uses a "dry slagging" technique. It doesn't need water to cool the slag skimmed off before the molten iron is poured, avoiding potential water pollution. The slag is recycled. It is pulverized and used for cinder blocks and road surfaces. The parallel arragement of the cupola to electric arc melters ensures continuous production even when electric supply is limited. The cupola is installed at a foundry parallel to six operating electric arc melting furnaces.

Fifteen percent less coal is needed to produce the coke to melt a ton of iron in the new cupola than it is required to generate the electricity to melt a ton of iron in the arc furnace.

The company spent $ 4.8 million on air pollution control equipment for the new cupola raising the Casting Center's total environmental control investment to almost $ 29 million.

11.2. List of special terms:

basic capacity – базовая мощность

blower – вентилятор, воздуходувка

to drive (drove, driven) – приводить в движение

hp=horse power – лошадиная сила

emission – выброс

exhaust fans – выхлопные вентиляторы (лопасти)

dust collector – пылесборники

channel holding furnace – канальные печи для выдержки металла

blend – смесь

grade – сорт

scrap – металлический лом

to recycle – подвергаться повторной обработке

to skim off – удалять

to pour – лить, заливать

to avoid – избегать

cinder blocks – шлаковые блоки

arrangement – размещение

to ensure - обеспечивать

arc furnace = electric arc melting furnace – электродуговая плавильная печь

to raise – увеличивать

Step 12

You are a production manager of a plant.

Discuss with the sales manager the advantages of a new cupola installed at the Michigan Casting Centre.

Step 13

The company wants to install a new cupola, write 5 – 6 requirements that should be considered to make the final decision.

Step 14

In groups of 3 students compare your requirements.

Draw out the joint decision. Write a draft.

Step 15

You are a chief of a foundry workshop.

Write a short report to the chief engineer of the plant about the cupola operation during a typical working day at your workshop.

Step 16

16.1. Let's talk shop. Dramatize the dialogue between two engineers:

A. - As, you know, coke is used in foundry practice as a melting fuel and as a source of carbon as well.

B. - Yes, that's right. Thus it greatly results the quality of the iron to be produced. What are the main requirement, for the foundry coke, to your mind?

A. - First of all, it should avoid degradation and segregation during handling. It is to be hard and fissure free hardness is important to support the weight of the charge above it and not to splinter into smaller pieces.

B. - Right, right I fully agree with you. Especially when it is subjected to a sudden impact.

A. - Yes, that's it. One should also know the nature of the coke. It is such that each piece has not the same size and shape. The main rule is the less handling the better.

B. - Yes, and it is very important to observe special tips during handling the coke.

16.2. Word-list

a source of carbon – источник углерода; degradation – ухудшение (качества); segregation – превращаться в пыль; handling – перевозка (транспортировка); fissure – трещина, излом; to splinter – раскалываться; to subject to a sudden impac – неожиданно подвергаться удару; tips – советы.

Step 17

17.1. TIPS FOR HANDLING FOUNDRY COKE

Read the text and translate it in written form.

Here are some tips on proper coke handling.

1. When transporting the coke by conveyors keep the drop hight as low as possible to prevent segregation.

2. A feed hopper should be installed at the end of the conveyor-belt because the larger pieces are thrown farther than the smaller ones when leaving the conveyor. Large and hard pieces of coke are used for coke bed.

3. Pile coke in several smaller heaps rather than one large one due to the tendency of larger pieces of coke to roll to the bottom of the heap.

4. Never run over coke with a truck to prevent degradation of coke into coke fines.

5. Mind the less handling the less segregation there will be by size.

6. Coke should not be contaminated from dirt when it is stored. Cover it with a layer of granular slag. Use paved storage area.

7. Prevent the coke from exposure to moisture when it is stored. Excessive surface moisture of the coke will result in bad quality and even explosion.

8. Accurate weighing of coke, limestone and metallics will result in producing iron with good chemical analysis and uniform nature.

9. Do not use coke from the previous day's heat for bed preparation. Select new coke that is free of fines.

10. Thus, coke that is used in foundry practice requires proper care and storage on the part of the cupola operator.

17.2. Word-list

drop hight – высота конвейера; a feed hopper – подающий бункер;
to pile – собирать в кучу; heaps – груды, кучи; to run over – переезжать;
truck – грузовик; coke fines – мелкий уголь, частицы;
paved – асфальтированный; exposure – воздействие;
moisture – влага; proper care – хорошее обращение.

Step 18

Draw in your copybook the scheme of a foundry section . In small groups compare it with the scheme of other students and discuss advantages and disadvantages. Make the alterations in your scheme.

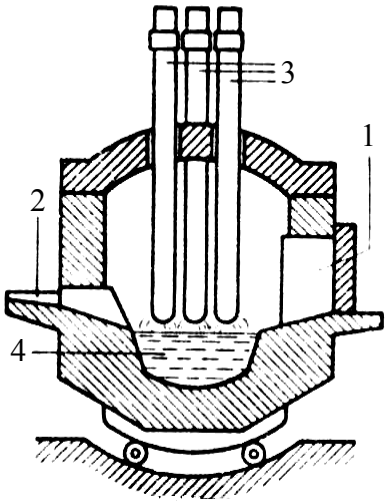
Unit II

FURNACE MELTING

Step 1

Look at the drawing of the electric arc furnace, study the names of the parts and match with the parts in the drawing.

Electric arc furnace



1. Charging door – загрузочное окно
2. Spout – желоб
3. Graphite electrode – Графитовый электрод
4. Molten metal – расплав

Step 2

Put the questions about construction of the electric arc furnace and ask your partner.

1. In what part of the electric arc furnace is the charging door?
2. What for is the spout used?
3.
4.

Step 3

Describe the construction of the electric arc furnace in the drawing.

Step 4

4.1. Read the text and find out:

1. What alloys are manufactured in electric arc furnaces? 2. What are the basic parts of electric furnaces? 3.What is used as charge material for one slag and two slag processes? 4. What is the purpose of refining?

ELECTRIC ARC FURNACE MELTING

Electric arc furnaces are used in manufacturing high-alloy steels, including stainless steels, cast iron, modified cast iron and cast iron of high strength.

The walls and the bottom of the basic electric arc furnace are covered outside with a steel shell. Inside they are lined with basic refractory such as magnesite bricks for basic melting or silica bricks for acid melting.

The roof of the furnace has holes for graphite electrodes that can be transferred vertically by special mechanism with the speed of 0.8-1mpm. The current to the electrodes is sent through the electrode holders. Clearance between the electrodes and refractory lining in the roof is closed with the rings that are cooled with water. Two processes can take part in the electric arc furnace one slag and two slag.

For one slag process the mixture of raw materials is charged through the charging door that is in the sidewall of the furnace.

About 40 % of the charge is usually made up of scrap and returns. First the small pieces of scrap are added to form a compact mass in the furnace thus aiding electrical conductivity. The heavy and lumpy portion of the charge is placed over the smaller pieces followed by the lightest portion.

During melting small quantities of lime are added to form a protective slag over the molten metal. Iron ore is added to the bath just as melting is complete.

The slag is highly oxidizing and in the right condition to take up phosphorus from the metal.

In a two slag process shortly after all of the steel has melted the first littered slag is taken off and a new slag composed of lime, fluorspar and sometimes a little sand, is added.

As soon as the second slag is melted the current is reduced and at intervals pulverized coke, carbon or ferrosilicon or a combination of these is spread over the surface of the bath. This period of furnace operation is known as the refining period. The refining slag has approximately the following composition: 45 to 55 % CaO, 15 to 20 % SiO_2, 0.50 to 1.5 % FeO, 5 to 15 % CaF.

After the proper bath temperature is obtained ferromanganese and ferrosilicon are added into the ladle for modification. Aluminum generally is added in the ladle as a final deoxidizer.

4.2. List of special terms.

cast iron of high strength – высокопрочный чугун

bottom – под

basic – обычный

to line with – футеровать

basic melting – обычная плавка

acid melting – кислая плавка

silica bricks – кирпичи на основе кремнезема

roof – свод (печи)

electrode holders – электродержатели

clearance – зазор

scrap – литейный скрап

returns – возвраты собственного производства

is highly oxidizing – насыщен большим количеством окислов

to take up – поглощать

litter – мусор

fluorspar – плавиковый шпат

to spread over – равномерно рассыпать

refining period – восстановительный период

ferrosilicon – ферросилиций

bath temperature – температура заливки

deoxidizer – раскислитель

Step 5

The chart contains some words from the text. Complete the chart with the missing forms.

Nouns	Adjectives	Verbs	Participle I	ParticipleII
lining		to line		
refrectory	refractory			
	cool	to cool		
scrap				
conductivity				
		to add		
	protective			
			oxidizing	
			refining	

Step 6

Put these words in the correct places.

Refractory / lime / refining / steel shell / roof / carbon / clearance.

1. The walls and the bottom of the basic electric arc furnace are covered outside with a ... .

2. Inside they are lined with basic ... .

3. The ... of the furnace has holes for graphite electrodes.

4. ... between the electrodes and refractory lining in the roof is closed with the rings.

5. ... is added to form a protective slag.

6. During ... oxides in iron are reduced.

7. Pig iron reduces the ... content in the bath.

Step 7

You can find some terms and their explanation. Match the terms and the explanation.

1. electric arc furnace 2. current 3. clearance 4. refractory
5. lining 6. refining 7. seag

a. A flow of electric charge

b. an apparatus in which heat is generated by electric arc

c. material left over or discarded as refuse

d. to free from coarse characteristics

e. material to withstand heat without breaking

f. A covering or a coating

g. some distance

Step 8

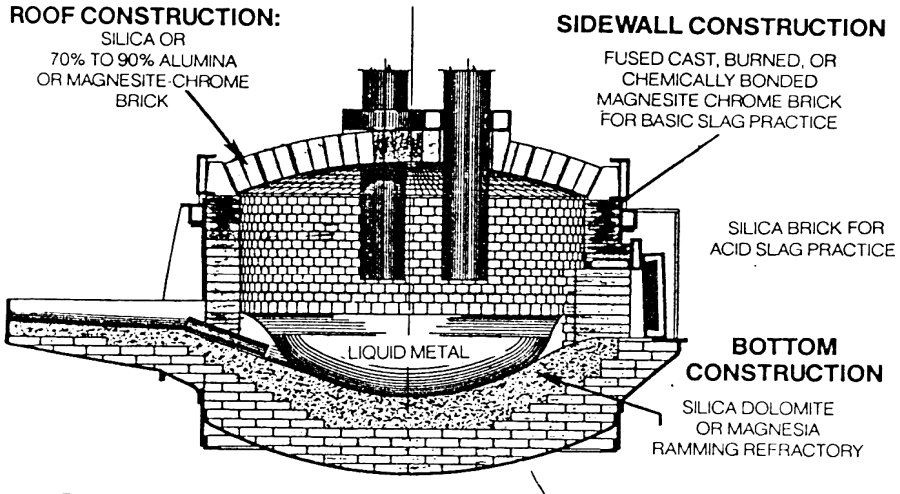
Brainstorming.

1. What principle of operation is used in this type of the furnace?
2. What chemical reactions take place during the process of melting?
3. What is to your oppinion the effect of aluminium added in the ladle?

Step 9

Case study.

Look at the picture of electric arc furnace. Study the construction and compare it with the furnace in task 1. Discuss the process that can take place there. Use the words given below.



Electric arc furnaces are used predominantly for steel melting, but also for iron melting and holding. Courtesy Refractories Institute.

Word-list

silica – силикатный, кварцевый; alumina – глинозем, окись алюминия; magnesite-chrome brick – хромо-магнизиальный кирпич; fused – спеченый; cast – литой; burned – обожженный; chemically bonded – химически связанный; basic slag practice – переплавка металла под обычным шлаком; silica brick for acid slag practice – силикатный кирпич для переплавки металла под кислым шлаком; ramming refractory – набивка из огнеупора.

Step 10

Brainstorm:

What materials are used for refractories?

What are the main qualities for refractories?

Step 11

Study the glossary of frequently used refractory terms. Cover the left column and from description in the right column, name refractories and then cover the right column and describe each refractory.

Alumina	An oxide of aluminum
Bauxite	A rock consisting of hydrous aluminum oxide with various impurities. It is the principle ore of aluminum and raw material for mullite and high alumina refractories
Ceramic	A broad term for products such as pottery and bricks made from heat-resistant, nonmetallic, inorganic materials (clay, bauxite, alumina, silica, magnesia, silicon carbide and the like)
Dead-burned	A material heated to a temperature at which gases and other volatile substances in it are driven off, producing a stable, granula product
Dolomite	A mineral consisting of calcium magnesium carbonate
Monolitic	Made of a single piece or as a continuous structure without separate sections
Refractoriness	The ability to retain physical shape and chemical identity in the presence of high temperatures
Spalling	Cracking or flaking of particles from a surface particularly when subjected to rapid temperature change

Word-list

glossary – глоссарий; oxide – окись, окисел; rock – горная порода, камень; hydrous – водный; impurity – примесь, включение; mullite – мулит; ore of aluminum – руда алюминия; pottery – керамика; clay – глина; dead-burned – обожженный до спекания; volatile – быстро испаряющийся; carbonate – соль угольной кислоты; spalling – растрескивание, отслаивание; cracking – растрескивание; flaking – отслаивание.

Step 12

12.1. Read the text and make up a chart of different types of refractories and the types and parts of the furnaces they are used for and compare it in groups of three students.

REFRACTORIES

All high-temperature units require a protective lining. A fundamental characteristic of refractories used as protective lining in foundry processes is that they can withstand higher than a dull red heat (1,100F) and up to 3.200 F.

Depending on the application refractories must resist chemical attack and withstand sudden changes in temperature, great pressure, abrasive forces, etc.

Most refractories are based on heterogeneous multicomponent materials with variable chemical and physical characteristics. There are more than 4.000 brands of refractory products. They can consist of natural or manmade or combination of other compounds and minerals such as alumina-silicate clays, bauxite, chromite, dolomite, magnesite, silicon carbide, zirconia and many others.

The primary types of refractories are: fireclay , semi-silica and high alumina. The primary types of non refractories are silicon carbide, extra high alumina, mullite, zircon and their fibers.

Different types of furnaces use different refractories or combination of them. Radiant tube furnaces for example are lined with a phosphate bonded high alumina plastic ramming mix. Maintenance coating is applied too. Bonnets carrying the heating elements are lined with materials having superior dielectric and insulating properties. Well cover and charging door are fiberlined. In lift-coil-induction furnaces bases are lined with extra-high alumina containing stainless steel fibers added to extend life. In tilt furnaces walls are lined with high alumina plastic refractory allowing rapid meltdown. Crucibles used with the furnaces are made of silicon carbide.

12.2. Word-list

a dull red heat – тусклый красный накал; heterogeneous – неоднородный; brand - марка; radiant tube furnaces – трубчатая печь с излучателем;
lift-coil-induction furnace - индукционная печь с приподнятой катушкой;
tilt furnace - качающаяся печь; crucible - тигель; alumina - корунд;
life - срок службы; bonnets - колпак крышки; fibers - волокна, волоски, прожилки; maitenance coating - защитный слой;
phospate bonded high alumina plastic ramming mix - высокоглиноземная пластичная масса на фосфатном связующем.

Step 13

The company decides what refractory is the best for a new electric arc furnace. Write down your preposals

Step 14

In a group of three students compare your requirements.

Step 15

You are a production engineer. Write a short report to a chief engineer of the plant what charge you use during 5 days of electric furnace operation.

Step 16

You are a chief engineer of the plant, ask a manufacturing engineer to give you a report about electric arc furnace operation during a typical working day. Invite them to the meeting and listen to their reports. Give new instructions.

Step 17

Let's talk shop. Dramatize the dialogue between engineers.

A. - Hi , glad to meet you. I'm ... . I work for a Thomson manufacturing foundry department.

B. - I'm ... . I work for this company too in marketing dpt. I've heard you are having some difficulties now.

A. - Hot at all. The problem is that we are under reconstruction and the output is less than usual.

B. - Oh, I see. Recently some foundries have installed new equipment because of significant changes in foundry processes and development of alternate methods.

A. - We are reconstructing but not that radically, we are repairing electric arc furnace ... . (continue the dialogue)

Step 18

Read the text and translate it in written form. Give the title to the text.

Selecting a metal or a metal alloy for making castings depends on many factors. Final cost of a casting always is in the centre of negotiations between a customer and a producer.

Foundry alloys and metals can be classified as ferrous (iron-base) or nonferrous. Ferrous category is divided into cast steel and cast iron.

Steel is basically an alloy of iron and carbon. There are three basic types of steel: 1. Carbon steel; 2. Low alloy steel; 3. High alloy steel.

Cast irons are classified into six groups: 1. White iron; 2. Malleable iron (ferritic, pearlitic and martensitic); 3. Gray cast iron, plain; 4. Ductile cast iron; 5. Compacted graphite (CG); 6. Alloy cast iron.

Nonferrous metals and alloys can be classified as: 1. Aluminum - base; 2. Copper-base (brasses and bronzes); 3. Lead-base; 4. Magnesium-base. 5. Nickel-base; 6. Tin-base; 7. Zinc-base; 8. Titanium-base.

Another way of grouping nonferrous alloys is to divide them into heavy metals: 1. Copper; 2. Zinc-base; 3. Lead; 4. Nickel and light metals. 1.Aluminum; 2. Magnesium-base; 3. Titanium.

Ferrous metallurgy

Iron and steel are the most common of the commercial metals. Iron melts at 2.777 F and boils at 4.442 F Small additions of carbon reduce the melting point. Manipulation between iron, carbon and alloying elements at the atom-to-atom level transforms the crystal lattice from one form to another and changes the properties of the ferrous alloys. The metallurgy of iron and steel studies how these transformations take place. A metal undergoes "phase transformation" when it changes from one crystal lattice to another. For iron-carbon alloy system an important phase transformation takes place between 1.300 and 1.600 F. The exact temperature is determined by the amount of carbon and other alloying elements in the metal. Iron transforms from a face-centered cubic (FCC) structure - called the gammor phase, or austenite-.at high temperature to a body-centered cubic (BCC) structure - alpha phase, or ferrite- at a lower temperature. In pure iron that transformation is longer as the metal cools below the critical temperature because the body- centered lattice is less compact than the face-centered lattice.

Cast Steel Properties

The most common types of steel used in castings are carbon steels. Carbon is the principal alloying element. Carbon steels are classified by the carbon content in three basic groups: 1. Low carbon steel - -C≤ . 20 %; 2. Medium carbon steel - C = .20 - 50 %; 3. High carbon steel - C ≥ .50 %. Other alloying elements are present in small quantities.

By definition low alloy steels contain alloying elements in addition to carbon, up to a total alloy content of 8 %.

Cast steel is classified as a low alloy type: 1. Manganese - 1.00 %; 2. Silicon -.80 %; 3. Nickel - .50 %; 4. Copper - .50 %; 5. Chromium - .25 %; 6. Molybdenum - .10 %; 7. Vanadium - .05 %; 8. Tungsten - .05 %.

For deoxidation of carbon and low alloy steels - that is for control of their oxygen content - aluminum, silicon and manganese are used. Of these elements, aluminum is added most frequently because of its effectiveness and low cost. There are many types of cast low alloy steels that meet the specific requirements (such as structural strength and resistance, wear, heat, corrosion).

High alloy steels contain alloys that total more than 8 %. Technically tool steels and stainless steels are high alloy steels. Tool steels usually are heat treated to develop their best properties. They are classified according to their composition and hardenability and mechanical properties into 6 major groups: 1. Cold work; 2. Hot work; 3. High speed; 4. Shock resisting; 5. Water hardening; 6. Special purpose.

Stainless steels are grouped into three classes: 1. Martensitic; 2. Ferritic; 3. Austenitic.

They are more resistant to corrosion than plain carbon and lower alloy steel, and they contain either chromium or chromium and nickel. Cast stainless steel grades are designated as heat- resistant or corrosion-resistant.

Stainless steel castings should be specified by ACI designations, which are established by the alloy casting Institute (ACI). The C series designates corrosion - resistant steels. The H series designates heat – resistant steels, that are suitable for service temperatures in the 1.200 - 2.200 range. C- series castings used for valves, pumps, fitting. H-series are used for furnace parts, turbine components and other high-temperature applications.

Unit III

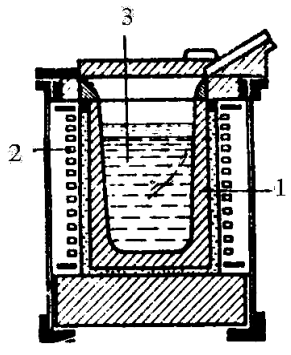
CRUCIBLES
INDUCTION FURNACES
REVERBERATORY

Step 1

In the drawings you can see the crucibles. Before reading the text answer the questions:

1. What types of crucibles are there in the drawings ?
2. What are their parts and functions ?

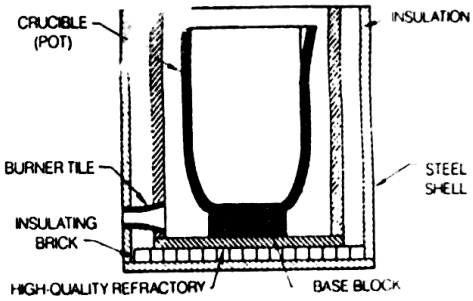
Индукционная печь
Induction furnace



1. Тигель

   Crucible
2. Индуктор

   Induction coil
3. Заливка, разливка



Liftout crucible (pot) is used widely, especially in nonferrous melting.

Crucible Furnaces

Crucible or pot furnaces are the most typical of indirect fuel-fired furnaces. The main features of the crucibles are: 1. in a crucible furnace there is a wall of silicon carbide that protects the combustion gases from the material of the charge; 2. crucible furnaces are used for melting or holding or both.

The simplest form of crucible is used for quick melting. The pot is stationary and the molten metal is ladled from it. Lift-out crucibles are used for slow melting and holding metal hot. In a lift - out crucible the pot is removed from a steel shell by means of tongs and metal is ladled out of pouring spout.

Word-list

crucible, pot – тигель; a wall – перегородка; to hold – выдерживать; indirect fuel-fired furnaces – печи косвенного нагрева; tongs – щипцы.

Step 2

Use the above information for asking questions about the crucibles in the drawings.

1. Is this crucible used for melting or holding?
2. Is the pot in this crucible stationary?
3.
4.
5.

Step 3

3.1. Read the text and answer the questions:

1. What principle is the work of induction furnace based on 2. What are the main types of low-frequency induction furnaces? 3. In what way does the melting and stirring action take place in the core type induction furnaces? What is the induction furnace charged with?

INDUCTION FURNACES

The work of induction furnaces is based on the principle when electromagnetic alternating field induces Foucault currents in the metal and electric energy in it is transformed into heat the quantity of which depends on the electrical resistance of the charge. The less the size of the pieces in the charge the more should be the current frequency feeding the inductor of the furnace to speed the melting of the charge. Most electric furnace melting is done in low-frequency induction furnace of the channel (core) and coreless types.

The powerful electromagnetic field formed in the channels of the core type induction furnace causes the molten metal to flow from the sides to the center of each channel from which it is forced in opposite directions out of the ends of the channels. This flowing action stirs and mixes the molten metal so that mechanical stirring is rarely needed; it also helps to maintain uniform temperature of the molten metal.

A coreless induction furnace is a refractory crucible surrounded by a copper coil connected to an ac power supply. The current passing through the coil induces a secondary current in the metallic charge within the crucible. The electrical resistance of the metallic bath generates the heat energy necessary to heat the bath to its desired temperature. Of the energy delivered more than 75% is used for increasing the melting temperature while most of the remaining heat is carried away by the water cooling system.

Coreless furnaces have the same melting and stirring action as channel or core furnaces and there is little loss of metal by oxidation.

Electromagnetic forces in a coreless furnace produce intense stirring that lifts the center of the surface of the molten metal to a higher level than the level at the crucible wall. Non-metallics gather as a ring around the furnace walls. The circulation washes fresh charge quickly into the molten bath resulting in high recovery of metal.

The initial charge should consist of large shapes to at list 15 % of furnace capacity. After meltdown of the large shapes the furnace can be charged with fines and turnings.

In practice several furnaces are generally used as one unit. Each furnace is tapped up to 30 % of its capacity in rotation and then they are immediately recharged.

3.2. List of special terms

1. alternating – переменный
2. to induce – индуцирует
3. Foucault currents – токи Фуке
4. the current frequency – частота тока
5. electrical resistance – электросопротивление
6. to feed – подавать
7. to speed – ускорить
8. channel type furnaces – канальные печи
9. to cause – вызывать
10. the flow – поток
11. to force out – вытеснять
12. to stir – перемешивать
13. to remain – оставаться
14. rarely – редко
15. to maintain – поддерживать
16. to surround – окружать
17. a copper coil – медная катушка, индуктор
18. a power supply – подача энергии
19. a secondary current – вторичный ток
20. to generate – вырабатывать
21. desired – необходимый
22. to deliver – подавать
23. loss – потеря
24. the same – тот же самый
25. oxidation – окисление
26. to lift – поднимать
27. plane – плоскость
28. recovery – восстановление
29. turnings – повторно используемый

Step 4

The chart contains some words from the text. Find the other forms of the same words. Complete the chart with the missing forms.

Nouns	Adjectives	Verbs	Participle I	Participle II
	alternating	to alter		
heat		to heat		
frequency				
	powerful			
		to connect		
resistance		to resist		
circulation				
rotation				

Step 5

Leave the correct word.

1. The work of induction furnaces is (bathed / balanced / based) on the principle when electric energy is transformed into heat.

2. The quantity of heat depends on electrical (resistance/repair/resonance) of the charge.

3. The less size of the charge pieces the more should be the (currency / current / curtain) frequency.

4. The powerful electromagnetic field is present in the channels of the core type induction (furniture / function / furnace).

5. A coreless induction furnace is a (reference / refractory/ reflection) crucible.

6. The current passing through the coil (indicates / initiate / induces) a secondary current.

7. The initial charge should consists of large (shapes / shakes / shelve).

Step 6

Read the explanation of some terms from the text. Find them in the text and read the sentences with them.

1. A tubular passage.
2. A degree of hotness or coldness.
3. Reddish brown metal.
4. A vessel made of a refractory substance used for melting materials at high temperatures.
5. The combination of a substance with oxygen.
6. Movement of electrons in a conductor.
7. Foucault currents induced in the metal.

Step 7

Brainstorm

1. What for is water forced through a copper coil?
2. What is forced in the direction from the bottom to the top and why?
3. What is the law according to which the metal rises from the bottom along the central axis and goes down along the walls of the furnace?

Step 8

8.1. Read the text. Imagine that you are a production manager of a plant.

Discuss with the chief executive officer what furnace should be installed in a new foundry department: induction or reverberatory?

REVERBERATORY FURNACES

Reverberatory or "air" furnaces are used to melt large amounts of metal or to remelt scrap for production of malleable iron castings. They may hold up to 80 metric tones of molten metal.

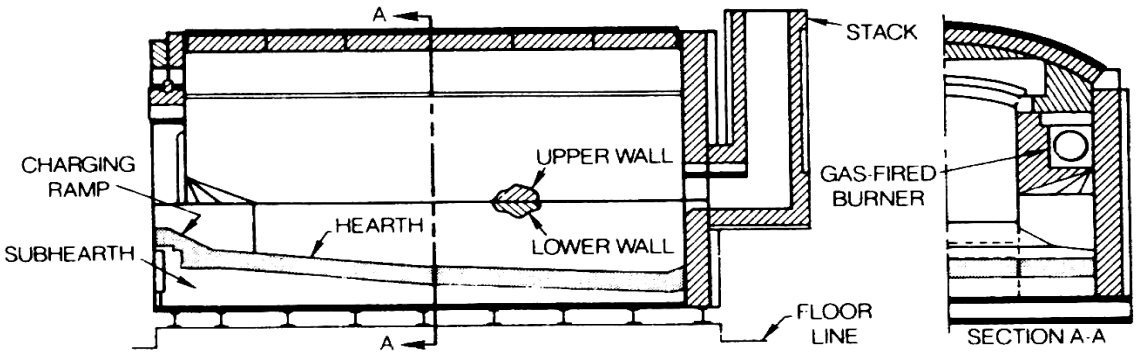
The larger furnaces are disproportionately wider and larger than smaller furnaces because bath may have maximum depth of about 750 mm regardless of the size of the furnace.

Roof height above the molten metal depends on the height of the charging door and depends on the kind of the charge used. Roof height also depends on the heat-release factor relating the furnace volume to the heat input. In general furnace builders prefer not to exceed 1.12 kj/cu meter of space above the bath of the molten metal.

Most reverberatory furnaces utilize a nozzle-mix burner that throw a long flame making use of "double-pass firing". This begins with luminous or semiluminous flame relatively high in the combustion chamber that radiates heat to the refractory walls and roof. As the walls and roof became incandescent they radiate the heat to the bath. On the return paht to the flue, which is in the same wall as burners, convective heat is transferred from the gases. This provides a double transfer of heat, radiation on the outgoing path and convection on the return path.

The exhaust port of a reverberatory furnace should have a cross-sectional pressure in the furnace during melting. Reverberatory of (air) furnaces are predominatly fired with powdered coal, rarely with gas or oil. Ordinarily only one heat per day is melted.

In an indirect fuel-fired furnace a barrier of some sort prevents contact of the hot combustion gases with the metal to be melted. Thus there can be no pick up of the products of combustion by the metal charge such as in direct fuel-fired furnace.



Large reverberatory furnace is charged through a ramp.

8.2. List of special terms

1. reverberatory furnace – отражательная печь
2. malleable – ковкий
3. amount – количество
4. scrap – скрап
5. to melt – плавить
6. to remelt – переплавить
7. molten – расплавленный жидкий
8. regardless – независимо
9. roof – свод
10. heat-release factor – тепловой коэффициент
11. heat input – подвод тепла
12. volume – объем
13. to prefer – предпочитать
14. to exceed – превышать
15. space – пространство
16. to utilize – использовать
17. a nozzle-mix burner – горелки с насадкой смешанного типа
18. to throw – отбрасывать
19. flame – пламя
20. double-pass firing – двухэтапное разжигание
21. luminous – светящийся
22. semiluminous – слабосветящийся
23. combustion chamber – камера сгорания
24. to radiate – излучать
25. incandescent – доводить до свечения, накаливать
26. flue – газовый канал
27. convective heat – конвекционное тепло
28. outgoing path – жолоб выхода металла
29. exhaust port – выпускной клапан
30. ramp - уклон

Step 9

You are a chief engineer of a plant. You have decided to install a reverberatory furnace.

Explain to the manager:

1. What maximum depth may have a reverberatory furnace and why? 2. What is the roof hight? 3. What "double pass firing" is? 4. Double transfer of heat? 5. Difference from the direct fuel-fired furnace.

Step 10

Draw out a project for a small foundry. Decide whether induction or reverberatory furnaces should be installed.

Step 11

Let's talk shop. Dramatize the dialogue between a seller and a customer.

A. - What can I do for you?

B. - Be so kind as to tell me what filters can be ordered with you?

A. - Just a moment. Here's our new catalogue. You can look it through and place your order with us.

B. - Oh, I see. What would you recommend?

A. - It depends. I can recommend honeycomb filters with straight pores and constant cross section. They are the simplest. By the way the pore size can be different.

B. - If I am not mistaken the pore size is the number of cells per square inch. Is that so ?

A. - You are right. But different filters have different pore geometry.

B. - Yes, I see. Is pore geometry of foam filters more complex ?

A. - Much more. Foam filters have rounded cells that are interconnected by several "windows".

B. - And what about funnel shaped filters.

A. - Funnel shaped filters have narrow slots in the funnel body

B. - I see. Do different types of filters influence the filling rates.

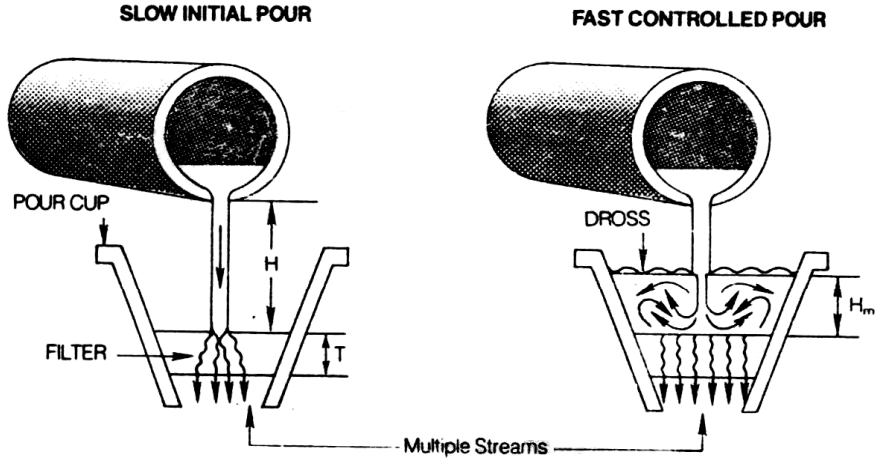
A. - Let me explain that to you. Filters with larger pore size are used for iron and steel castings and filters with smaller pores can be used for alloys of very high super heat and also in investment casting in which the filter is preheated with the mold.

B. - We are interested in filters because they minimize nonmetallic inclusions: deoxidation products, slag, refractories that originate during melting.

A. - Oh, yes. Filtration is a very efficient method, especially if filtration is coupled with the right placement of filters in the gating system. We produce filters for industrial use for many years. When you decide what filters you need we'll be glad to help you.

Step 12

You are a production engineer. Make the list of requirements to the filters after studying these drawings



Investment casters *frequently place a filter in the pouring cup. T = filter thickness; H = distance between crucible lip and filter; H_m = metal head above filter.*

Step 13

13.1. Read the text and translate it in written form.

HOW TO DESIGN A METAL FLOW SYSTEM.

1. Make a list of the basic metal flow system elements:

Number of molding lines; number of ladles required to pour each mold; weight of metal required for one pour; time required to complete one pour; frequency of pours both maximum and normal; starting pouring temperature.

2. Information from the preceding factors will determine:

Size and number of pouring ladles required; size and number of distribution ladles required, and nature of the distribution system (truck, monorail, etc); volume, rate and discrete increments of metal flow required.

3. From that data make a projection of:

What tap and melt temperatures are required to allow for loss in metal handling; whether direct melt or duplexing system is indicated, size, number and type of furnaces needed.

4. Now the point has been reached to test the plan. Imagine operations minute-by-minute for a typical hour, a typical day, a typical Monday, a troublesome Friday, a week, and a month. Make such changes to make the plan practical. Be sure to include necessary safety factors. It is possible to estimate:

Conversion cost (to convert cold charge materials to 1 ton of molten metal in the ladle); capital expenditure required; installation cost.

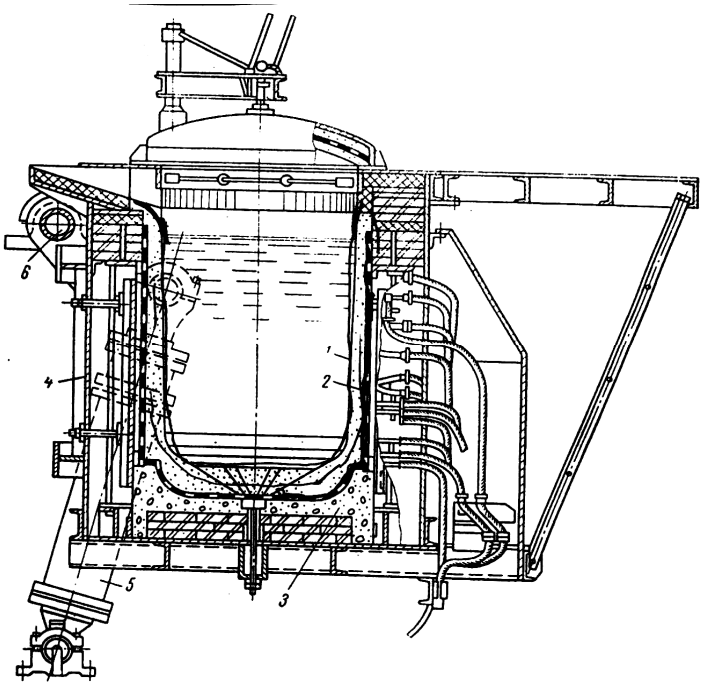
If the cost appears to be excessive make system design changes. Follow through step by step until cost limits and system functions are satisfied.

13.2. Word-list

1. mold – форма
2. typical hour – час работы в обычном режиме
3. molding lines – формовочные линии
4. to be sure – не забудьте
5. frequency – частота
6. to include – включить
7. volume – уровень
8. capital expenditure required - необходимые капитальные расходы
9. rate – скорость
10. to require – требовать
11. to be excessive – быть избыточным

Step 14

Look at the drawing of a crucible. Discuss the construction of this model in groups of three students.

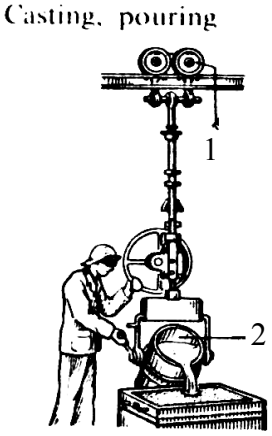


Unit IV

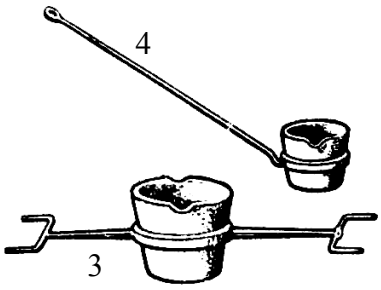
LADLES

Step 1

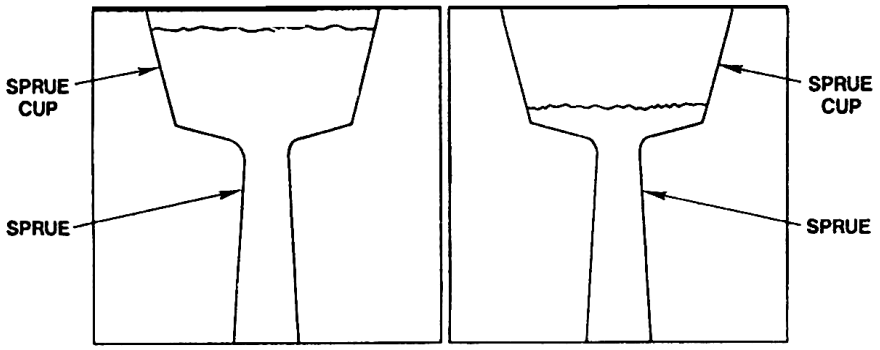
Look at the drawings of the different kinds of ladles used for manual and automatic pouring, study the terms and match them with the drawings.



1. Разливочная тележка
   Ladle handler
2. Монорельсовый ковш
   Monorail ladle
3. Заливочный ковш,
   разливочный ковш
   Ladle
4. Ручной ковш
   Hand ladle



Automatic Pouring System



Automatic pouring systems reduce costs by minimizing metal poured per mold. After fill, metal should just cover the sprue post, right, instead of nearly filling the sprue cup, as is common in manual pouring.

sprue – литниковая система

sprue cup – литниковая чаша

sprue post – стояк (литниковой системы)

Step 2

Put the questions about construction of the ladles and about pouring operation and ask your partner.

1. What types of ladles do you know ?
2. Does pouring operation influence the quality of metal ?
3.
4.
5.

Step 3

Describe the construction of the ladles in the drawing.

Step 4

4.1. Read the text and find out:

1. What is the role of pouring in the foundry process? 2. What requirements should a pourer meet? 3. On what problems should the pourer concentrate most? 4. What are other terms for a pouring cup?

SOME FACTS ABOUT POURING

Mastering proper pouring technique always has been a matter of great pride among pourers. The pouring department is no place for workers who are careless, clumsy or poorly trained. Pouring the mold is the culmination of a long series of steps that lead to producing a final metal casting.

Pouring dynamics is the matter of great concern for production engineers. First things they should concentrate on are fill rate and turbulence.

The correct fill rate should be properly regulated for filling the cup and holding it full until mold filling is complete. In automatic pouring properly poured mold becomes its own bottom pour system.

To minimize turbulence a pour stream should be smooth and even without splashing and separated metal streams. Proper control of the molten metal stream is important throughout the pour.

The pouring cup that is often called sprue cup or pouring basin plays an important role. To avoid a vortex the proportional depth of metal in the pouring cup should equal the diameter of the down sprue, particularly during the initial stage of mold pouring when flow rates are the highest.

Accurate premeasuring can ensure that the quantity of metal poured in the mold will fill it to a level at which the top of the sprue post is just covered. Most today's computerized automatic pouring system can achieve it.

4.2. List of special terms

1. to master – овладевать
2. proper – правильный
3. to pour – заливать
4. pour, pouring – заливка
5. pouring cup = pouring basin – литниковая чаша
6. pourers – литейщики
7. pouring department – литейный участок
8. a matter of great pride – повод для гордости
9. a matter of great concern – дело большой важности

10. careless – небрежный, невнимательный
11. clumsy – неуклюжий, неповоротливый
12. fill rate – скорость наполнения
13. poorly trainer – плохо обученный
14. throughout – в течение (всего времени)
15. to hold it full – (здесь) оставаться наполненной
16. bottom pour system – система донной разливки
17. turbulence – турбулентность
18. a pour stream – поток разливаемого металла
19. smooth – плавный
20. even – ровный, равномерный
21. splashing – плескание, разбрызгивание
22. to avoid – избегать
23. vortex – завихрение
24. particularly – особенно, в особенности
25. flow – поток, течение
26. to ensure – обеспечить
27. to achieve – достигать

4.3. Look at the drawing of an automatic pouring system and say why the quantity of the metal poured in the mold is important.

Step 5

The chart contains some words from the text. Complete the chart with the missing forms.

Nouns	**Adjectives**	**Verbs**	**Participle I**	**Participle II**
master				
pour				
pourer				
		to train		
turbulence				
system				
splash		to splash		
vortex				
		to achieve		
	initial			
		to regulate		

Step 6

Put the words in the correct places.

sprue cup / fill rate and turbulance / dynamics / bottom pour system / premeasuring / series / pour stream.

1. Pouring is the culmination of a long ..... of steps.
2. Pouring ..... is the matter of great concern.
3. ..... and ..... are the first things to concentrate on.
4. In automatic pouring properly poured mold becomes its own .... .
5. To minimize turbulence .... should be smooth and even.
6. The pouring cup is often called ..... .
7. Accurate ..... can ensure filling the sprue cup to a level at which the top of the sprue post is just covered.

Step 7

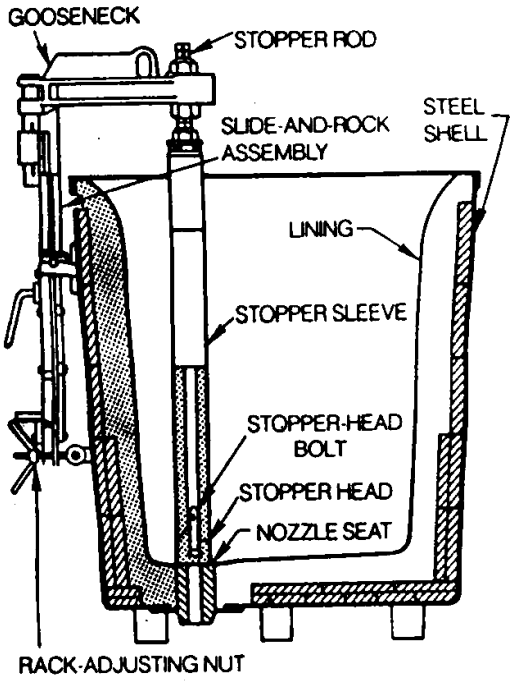
Case study.

Three types of ladles are used for pouring steel castings with capacities between 50 kg to 36 tons although ladles with greater capacity are also used.

Here you'll find the description of a bottom-pour ladle, a teapot ladle and a lip pour ladle. Read the description and make notes about the advantages and disadvantages of each. Discuss them in small groups.

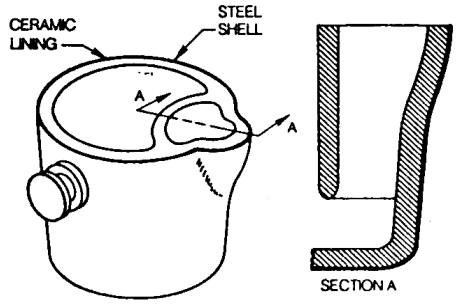
7.1. Ladles

The bottom-pour ladle has an opening in the bottom that is fitted with a refractory nozzle. A stopper rod inside the ladle pulls the stopper head up from its seat in the nozzle and the molten steel flows from the ladle. When the stopper head is returned to the seated position the flow is cut off.



Bottom-pour ladles are used commonly to pour large steel and iron castings.

The teapot ladle has a ceramic wall or baffle that separates the bowl of the ladle from the spout. The baffle extends almost 4/5 (four fifth) of the distance to the bottom of the ladle. As the ladle is tipped hot metal flows from the bottom of the ladle up the spout and over the lip. Since the metal is taken from near the bottom of the ladle it is free of slag and pieces of eroded refractory although it may pick up foreign materials in the spout section or at the lip.



Typical teapot-type ladle is used to pour medium or smaller steel castings.

Lip pour ladles are similar in their external form to the teapot type but they have no baffle to hold back the slag. That is why this type of ladles is not very often used in the steel foundry except as a transfer ladle.

7.2. Word-list

1. (Foundry) ladle – (литейный) ковш
2. Bottom pour ladle – разливочный ковш с донным стаканом
3. The teapot ladle – чайниковый литейный ковш
4. Lip – край, выступ
5. Lip pour ladle – разливочный ковш со сливным носком
6. Refractory – огнеупор, огнеупорный материал
7. Opening – отверстие
8. To fit with – снабжать

9. Seat – место (установка)
10. Refractory – огнеупорный, огнестойкий, тугоплавкий
11. Nozzle – насадка
12. Stopper rod – стопорный стержень
13. To pull up – выталкивать
14. Stopper head – пробка разливного ковша
15. Stopper – стопор, запирающее устройство
16. Seated position – посадка
17. Baffle – (отражательная) перегородка
18. Spout – носик, горлышко (у сосуда)
19. Tip – наклон
20. To tip – наклонять, опрокидывать
21. To erode – постепенно разрушать
22. To pick up – подбирать, захватывать
23. Foreign materials – инородный материал, посторонний материал
24. To extend – перекрывать
25. Similar to – похожий
26. To hold back – задерживать
27. Transfer ladle – ковш для транспортировки металла
28. Gooseneck – насадка с двойным коленом
29. Rack-adjusted nut – гайка, регулируемая рейкой

Step 8

Demand in producing clean non-ferrous metals with fewer inclusions and ferrous metals with lower sulphur and oxigen content led to the development of processes that are carried out in the ladle. This family of procedures is called "ladle metallurgy".

What conclusions can you draw out from the following information ?

For proper use of ladle metallurgy in practice it is important to know the chemistry of the initial elements and to control the chemical composition throughout the process. Knowledge and examination of the thermodynamics of chemical reactions during the process can help to control the final chemistry of melt in the ladle.

Major purpose of ladle metallurgy for non-ferrous metals is to obtain homogeneous temperature and composition of the molten metal to help float out unwanted inclusions and to promote refining reactions. This can be achieved by stirring metal in the bath.

For ferrous metals deoxidation is a key element in any ladle metallurgical process and it is carried out with great care. The main element in deoxidation is aluminium. The oxigen content is also very important especially at the end of the process before tapping.

Microinclusions primarily sulphides can be decreased in the result of desulphurization process. The main element that modifies suphide morphology is calcium, It should be added to the melt and the process should be carried out with great care.

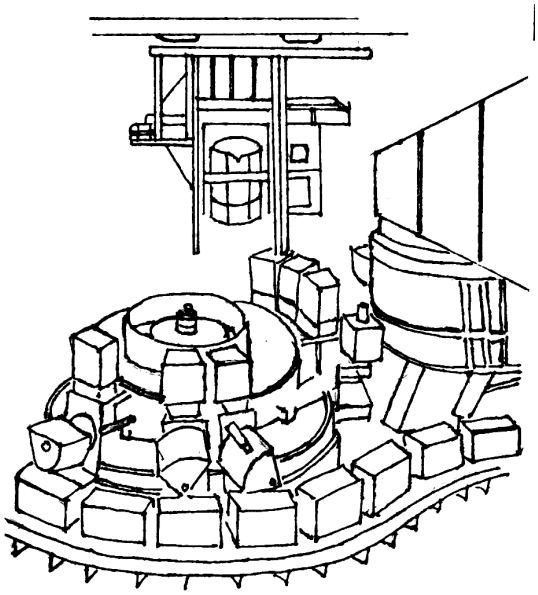
As refractory materials used for ladle lining greatly affect the metallurgical process, generally fireclay is not used in ladle metallurgy as the basic top slag dissolves fireclay quickly. In Europe, dolomite is commonly used and in the U.S. they use 70 % AI_2O_2 , chrome-magnesite and MgO refractories.

Step 9

After reading the text in small groups act out the meeting of engineers and lead the discussion about development, patenting and licensing a new automatic rotary pouring system.

"ROTO-POUR" SYSTEM

An automatic rotary pouring system for pouring malleable iron has been developed and installed at the Central Foundry Division of General Motors Corp. General Motors has patented this system and licensed Roberts Corp. to manufacture and sell it. Roberts has named this system "Roto-Pour".



Drawing shows main features of CFD's rotary pouring system. Metal is brought from melters in a cab-operated transfer ladle, top rear, on an overhead monorail and is poured into a resistance rod-type holding furnace, right. As the circular track turns, empty ladle carriages pass under a pour box on the furnace, center, and are filled. Full ladle carriages continue to rotate, and molds are poured as the carriages pass by the continuously moving mold line.

The pouring ladle is a quarter-round section with the pouring spout about 8 in, in the front corner. The spout position is centered on the ladle shaft. When the shaft rotates clockwise the ladle is elevated and pours iron out the spout. After about 120^{o} (degrees) of rotation the ladle is returned to the level position. Sometimes with the help of pneumatic logic elements.

Empty ladle carriages travel to the ladle filling station beneath the pour box on the holding furnace. When a signal is received that a ladle carriage is in the fill position the pour box stopper rod raises and the ladle carriage is filled.

Full ladle carriages continue to rotate and pour molds as the carriages pass the continuously moving mold line. The process of mold filling is the following.

As the ladle carriage enters the pouring area, it slows down and is positioned by contacting the carriage ahead of it. That contact causes a pneumatically operated locating arm to extend from the lower part of the ladle carriage and engage the mold car, so that the ladle pouring spout is lined up with the pouring basin.

When the ladle carriage is aligned with the mold car, iron pouring starts. During pouring the ladle is rotated through 120 deg. of arc.

When pouring has been completed the ladle returns to level position and locating arm is retracted when the next ladle carriage is aligned with its respective mold car. The carriage with the emply ladle then proceeds to the ladle-filling station to receive a new charge.

The pouring operation is very accurate and the furnace-to-pour-time is about 6 seconds so the iron holds its heat. Pouring rate is constant, there is no splash, no false starts or stops and no overpowers.

Word-list

1. malleable – ковкий
2. to license – выдавать лицензию
3. licence – лицензия
4. pour box – заливочная камера
5. clockwise – по часовой стрелке
6. to elevate – поднимать
7. holding furnace – печь для выдержки
8. ladle carriages – ковшовая тележка
9. locating arm – установочный рычаг
10. to engage – (тех.) зацеплять

Step 10

Brainstorm.

1. What parts does the stopper rod of the bottom pour ladle consist of?
2. What for is the bottom pouring used?
3. What for is a teapot-type ladle used for?
4. Where else do you think roto-pour system can be used?

Step 11

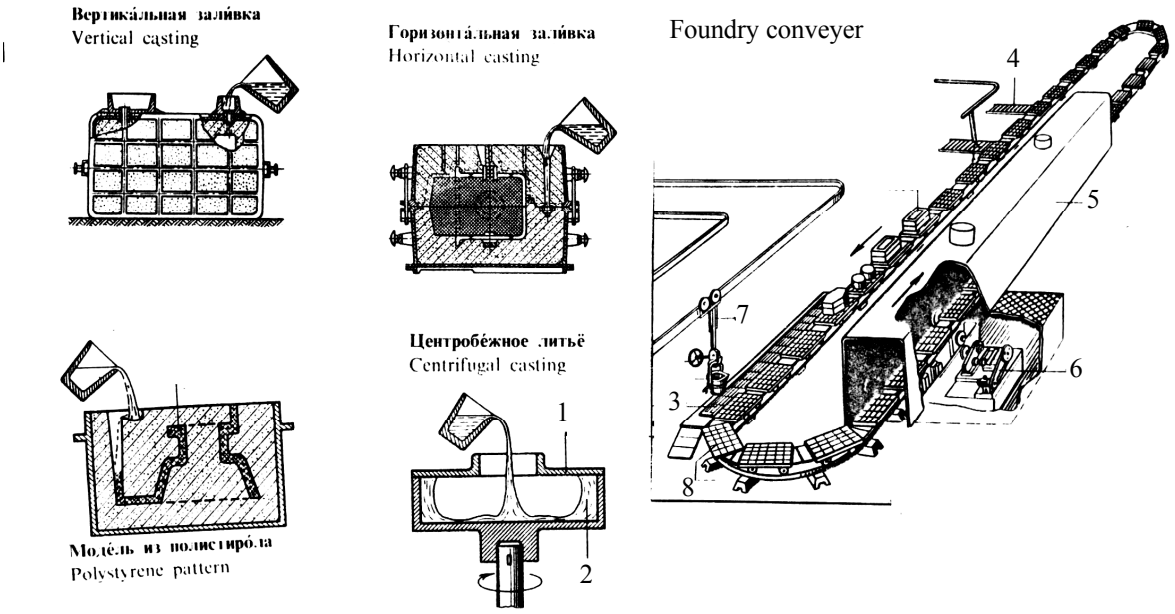
You can find here some useful terms and their explanations. Match the terms with the explanations.

1. fill rate 2. refractory 3. ladle metallurgy 4. turbulence 5. pouring cup.

a. treatment of metal in the ladle; *b*. important factor for pouring metal of the proper quality; *c*. vortexing mode of the metal flow; *d*. inner ladle lining; *e*. a device for holding and regulating of pouring metal fill rate.

Step 12

Look at the drawings. Choose some to make up the dialogue between two engineers.



1. Центробежная изложница - Rotating mold
2. Расплав - Molten metal
3. Заливочная движущаяся платформа - Moving platform for pouring
4. Сборочный рольганг - Assembly roller conveyer
5. Охладительная ветвь конвейера - Cooling zone of the conveyer
6. Приводная станция - Power-drive station
7. Монорельсовый ковш - Monorail ladle
8. Тележечный конвейер - Truck conveyer

Step13

You are a production manager. You are to decide what type of ladles should be used in your bay. Write you proposals.

Step 14

In a group of three students compare your proposals.

Step 15

You are a research engineer. You are writing instructions for production engineers. What is a matter of great concern during pouring operation?

Step16

Translate the text in a written form.

FILTRATION OF MOLTEN METAL

All foundry processes are designed to minimize formation of nonmetallic inclusions such as deoxidation products, slag, refractories, etc, that originated in melting, refining or pouring. Filtration is a new method to prevent nonmetallic inclusions to enter the mold cavity with the molten metal. Filters that are produced for industrial use are known as:

1. honeycomb filters that have straight pores with a constant cross section; 2. foam filters that have interconnected pores with numerous changes in direction and cross section; 3. funnel shaped filters with narrow slots in the funnel body.

Honeycomb and foam filters are produced with pores of different sizes. For honoycomb filters, pore size is expressed in the number of cells per square inch. Pore sizes of extroded filters range from 64 to 121 pores per square inch.

For foams, pore size is expressed in the number of pores intersected by a straight line, that is pores per inch (ppi).For foam filters the most common pore sizes are 10, 20 and 30 ppi. The pore geometry of foam filters is much more complex.The larger pore sizes are used for iron and steel castings to permit satisfactory rates of mold filling. Smaller pores can be used when alloys are pored with very high super heat and also in investment casting in which the filter is preheated with the mold.

Efficient filtration coupled with strategic placement of filters in the gating system will help to receive inclusion free castings, a small gating system and improved casting yield.

Word-list

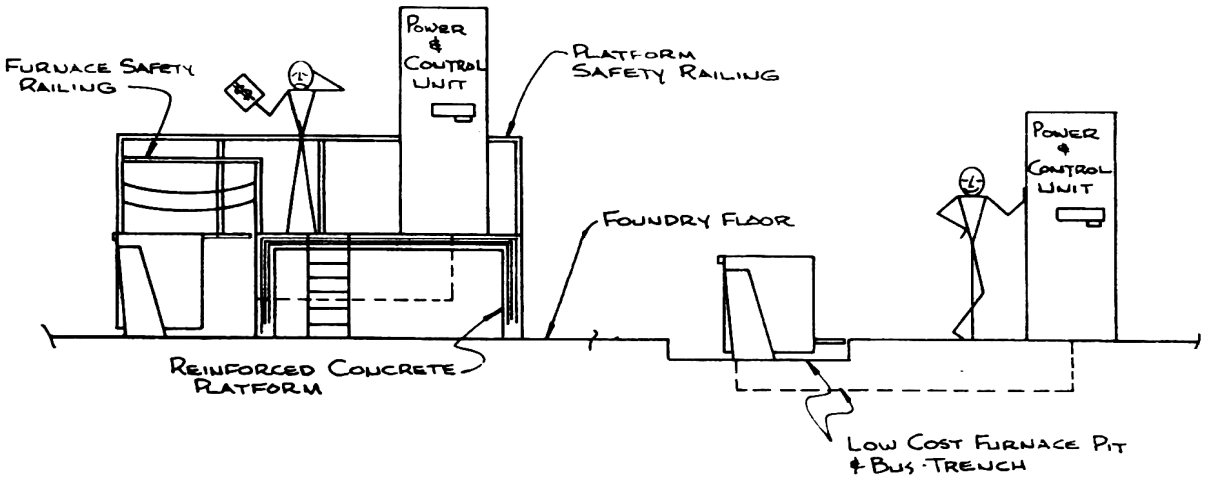
honeycomb filters – сотовые фильтры; foam filters – пенистые фильтры; investment casting – точное литье по выплавляемым моделям; gating system – литниковые системы; funnel shaped filters – фильтры с раструбом.

Unit V

FOUNDRY LAY OUT AND LABOUR PROTECTION

Step 1

Look at the drawings of the different placement of the furnace platform. In one approach (right) the furnace is installed at floor level and has a very low step-up platform. In the other approach (left) the furnace needs a relatively large and expensive deck with railings and chains around the perimeter of the furnace area. Study both approaches, and compare them in small groups.



Step 2

Put the questions about two different approaches of furnace platform placement.

1. Is placement of the furnace platform important?
2. Is furnace with a high platform convenient for work?
3.
4.
5.

Step 3

Describe the construction of a) low platform; b) high platform.

Step 4

4.1. Read the text and find out:

1. Why proper placement of the furnace is important? 2. What is the basic advantage of a low platform placement? 3. What are two approaches to coil protection? 4. What are additional advantages for desk-height-mounted furnaces?

ADVANTAGES OF DESK-HEIGHT FURNACES

Backaches, problems with OSHA and installation expenses can be reduced by proper placement of a small to medium capacity electric furnace.

Placement of the furnace platform may seem relatively unimportant at first. Fig 1 compares two typical approaches to furnace platform placement.

In one approach, induction melting equipment is installed at floor level or on a very low, step-up platform. Also eliminated are the railings and chains around the perimeter of the furnace area. In the other, the furnace is installed with a high platform, flush mounted at the top of the furnace.

The floor mounted furnace have the entire coil beneath the ground and the furnaces installed on a raised deck and a flush-mounted platform sometimes have an outer protective shell for the coil. Now, most furnace manufacturers protect furnace coil with either transit boxes or steel shells.

A furnace with protected coil can be mounted in a low-cost furnace pit. There is no need for a relatively large and expensive deck, or protective railings and chains around the perimeter of the furnace area.

There are additional advantages for desk-height mounted furnaces. The operator of the flush-mounted furnace is exposed to the full force of the radiant heat when he stands near the furnace. The operator of the desk-height furnace works in a greater comfort.

In the case of furnace splatter, the operator of the desk-height furnace is better protected. He can take cover below the top of the furnace at the first sign of a splash. The desk height of the furnace reduces the possibility of the operator stumbling toward the furnace with the supporting structure on which to catch himself. The physical exertion required to slag a desk-height furnace is less because the furnace frame can be used as a lever to easy slag removal. Once slag is removed from the metal bath of the desk-height furnace, it can be easily placed in a barrel or other receptacle. Charging a flush-mounted furnace with a rake or push tool appears to be a single approach. This can be very hard and inefficient work because material tends to fall through the opening between the platform and the desk. Operators who charge flush-mounted furnace with tote buckets for that they spend extra efforts for bending over to pour material into the furnace with a minimum of splash. Use of the desk-height furnaces permits use of labor-saving devices. It is easier to use a hoist-mounted trough or rakes material from a charge chart mounted at desk height.

4.2. List of special terms

1. Backaches – боли в спине
2. proper placement – правильная установка
3. step-up platform – помост с приступом
4. installation expenses – затраты на установку
5. to reduce – уменьшать
6. small capacity – небольшая мощность

7. medium capacity – средняя мощность
8. typical approaches – обычный подход
9. to eliminate – устранять
10. railings – перила, поручни, ограда
11. entire coil – вся катушка
12. raised desk– приподнятая платформа
13. beneath the ground – под землей
14. flush mounted – установленный вровень
15. furnace pit – углубление для печи
16. relatively – относительно
17. to be exposed to – подвергаться
18. splash – выплеск
19. stumble – споткнуться
20. to catch himself – ухватиться
21. physical exertion – физическое усилие
22. furnace frame – каркас печи
23. lever – рычаг
24. barrel – бочка
25. receptacle – емкость
26. rake – скребок, кочерга
27. push tool – толкатель
28. to appear – оказаться
29. tote buckets – (ам) ведра для переноски
30. hoist-mounted trough – лоток на подъемнике

Step 5

The chart contains some words from the text. Complete the chart with the missing forms.

Nouns	**Adjectives**	**Verbs**	**Participle I**	**Participle II**
installation				
placement				
approach				
level				
		to mount		
	protective			
operator				
operation				
splatter				
		to stumble		
exertion				

Step 6

Choose the right word.

1. Proper platform placement (removes) reduces (remains) backaches.
2. Placement of the furnace platform may (shake / seek / seem) unimportant at first.
3. The railings and chains around the platform are (elected / eliminated / elongated).
4. Most furnace manufactures (promote/ protect / propose) furnace coil with either transit boxes or steel shells.
5. There is no need for a relatively large and expensive (desk / deck / dice).
6. The furnace frame can be used as a (level / lever / label).
7. Slag can be easily placed in a (barrier / barrel / battle).

Step 7

Case study.

Two production engineers are discussing in what way to install the furnace to provide better working conditions for a worker. Read the descriptions under the drawings and make notes about the advantages and disadvantages of both approaches.

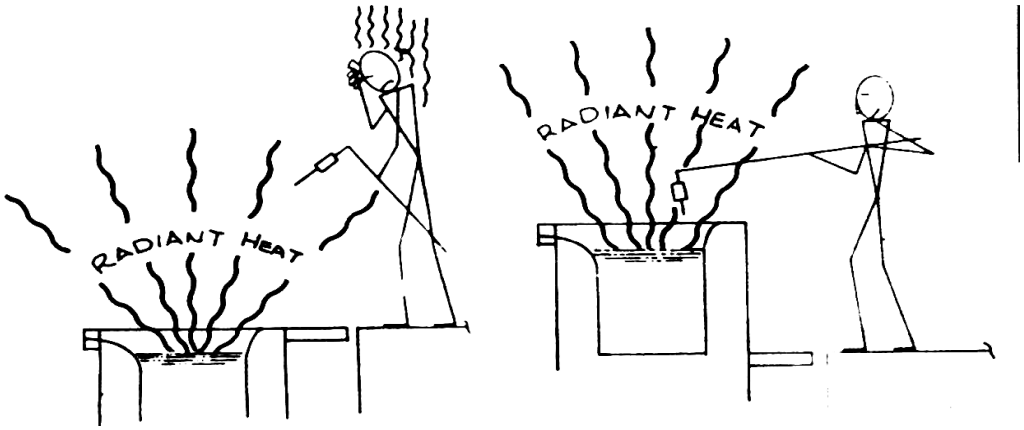


Fig. 1. The operator of the flush-mounted furnace (left) is exposed to the full force of the radiant heat when he stands near the furnace. The operator of the desk-height furnace can assemble charge material, control and take analyses in greater comfort.

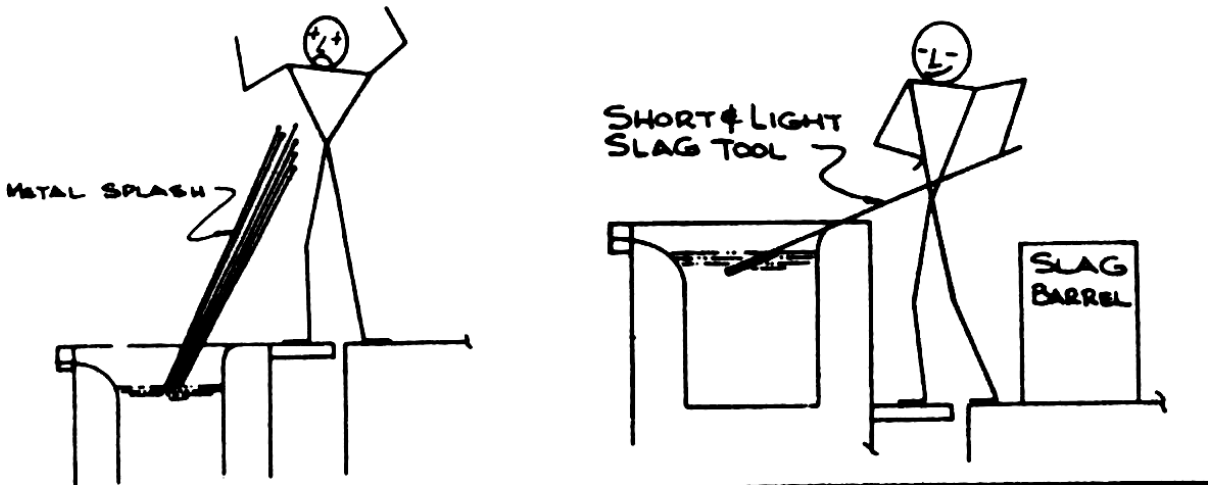


Fig. 2. In the case of furnace splatter, the operator of the desk-height furnace is better protected. He can take cover below the top of the furnace at the first sign of a splash. The desk height of the furnace at the right also reduced the possibility of the operator stumbling toward the furnace with no supporting structure on which to catch himself.

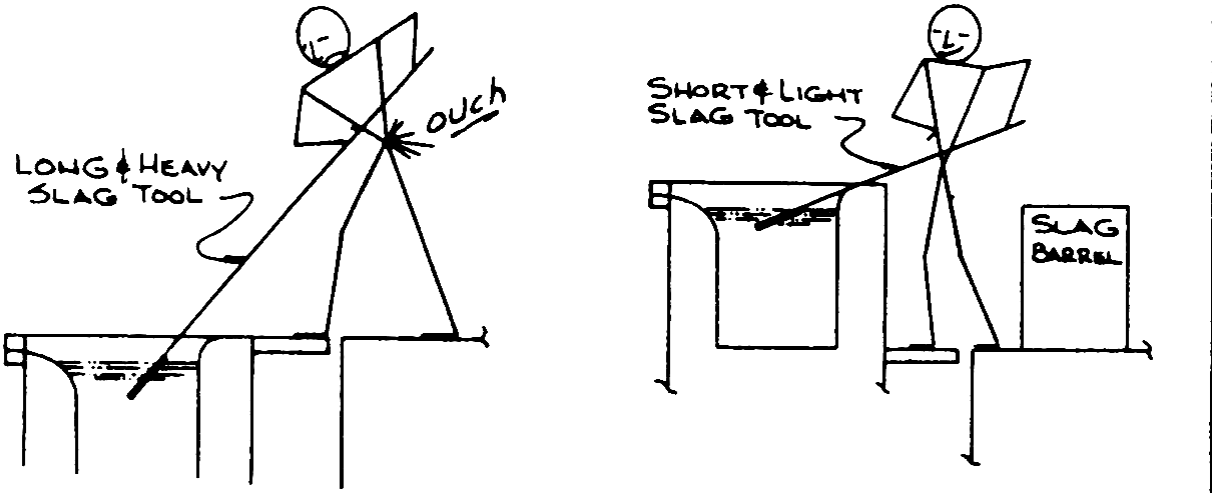


Fig.3. The physical exertion required to slag a desk-height furnace is less because the furnace frame can be used as lever for easy slag removal. Once slag is removed from the metal bath of the desk-height furnace, it can be easily placed in a barrel or other receptacle.

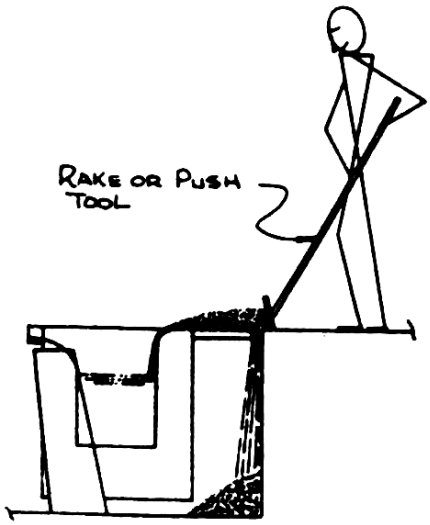
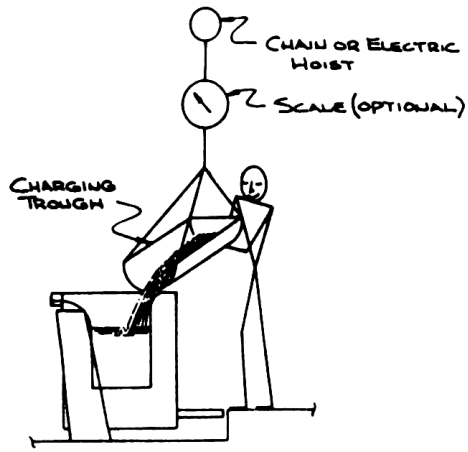


Fig. 4. Charging a flush-mounted furnace with a rake or push tool appears to be a simple approach. This can be very hard work and inefficient because material tends to fall through the opening between the platform and desk. Operators who charge flush-mounted furnaces with tote buckets must expend the extra effort of bending over to pour material into the furnace with a minimum of splash.



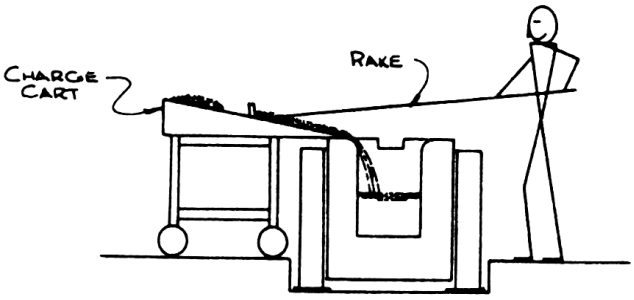


Fig. 5. Use of the desk-height furnace permits use of labor-saving devices as shown. Whether he uses a hoist-mounted trough or rakes material from a charge cart, the operator will find it easier to charge the furnace if it is mounted at desk height.

Step 8

8.1. The Georgia Iron Works (GIW) was founded in 1891. Since then several foundries have been brought on line. A new foundry opened in Warrenton has doubled the production. Read the text and find out what helped GIW to open a new foundry in the hard times that led to closing of many foundries.

NEW FOUNDARY in WARRENTON

A major producer of iron and steel castings Georgia Iron Works opens a new foundry in Warrenton. Ironically but the hard times that led to closing of many foundries made it possible to construct Warrenton plant. Much equipment was bought from foundries that phased out some operations or closed down that led to considerable savings. The GIW engineers did most of design and construction work to use maximum efficiency of the production layout. As a result of good planning in the design stage the Warrenton plant is very flexible. The melting department is in the center of the plant so that other departments can be expanded if needed.

Melting at Warrenton is performed in three 10ft electric arc furnaces; each rated at 12.5 tons with a 6.500-kw transformer. There are two parallel 50-ton craneways each with a 60-ft span. Total nine 30-ton cranes are in operation; two in the charging and cleaning bay, three in the molding and pouring bay and four in the machine shop. The Warrenton foundry uses 100 % chemically bonded no-bake sand for molds and cores . Sand is combined with furan, alkyd, phenolic urethane or chemical binder systems. Three 200-ton capacity sand silo feed a 1.500 ppm (pound per minute) sand blender and a 1.000 ppm core sand mixer. The system was developed by GIW foundry engineers. The three-cell furnace dust collector processes 150.000 cu ft of fume and dust-laden air per minute and provides an unusually clean atmosphere. During production each melt is analyzed with an optical emission spectrometer and test samples are taken. All data are recorded. The liquid metal is tapped into a preheated pouring ladle in which it is treated by a special process developed at GIW and then poured into the prepared molds that are coated with zircon mold wash for the superior casting finishes. After pouring and cooling the molds are shaken out.

A sound cooling system cools the sand to 95 F. The sand transportation system then returns it to the silos. The system recycles up to 85-90 % of the sand. Most of the alloys require complex multi-step treatment.

Heat treating, stress relieving and air-quenching are done in two 60.000 lb gas-fired hydraulic tip-up furnaces that are the largest of their type.

The machine shop has unique combination of advanced tooling for super hard white irons. Most of the machine tools are CNC machine tools for precision operation. Machining equipment includes CNC horizontal mill and drill center, a CNC vertical turning center, and a vertical boring mill. Many turning of the tool holding and feed control systems were designed by GIW engineers for company needs.

Completed orders, mostly large size pump shell castings are shipped via rail or G1 W's truck fleet. Warrenton is located 125 km from two big sea ports and is well positioned for export shipments.

GIW hopes to expand markets both domestically and abroad with their new patented alloys, superior product design and low cost production. Despite the stormy weather to which the foundry industry was subjected G1 W engineers wait for tremendous growth but they also realize that nothing is guaranteed.

Building a new foundry during a recession was a risky proposition. Only time could tell whether or not expanding was a good idea.

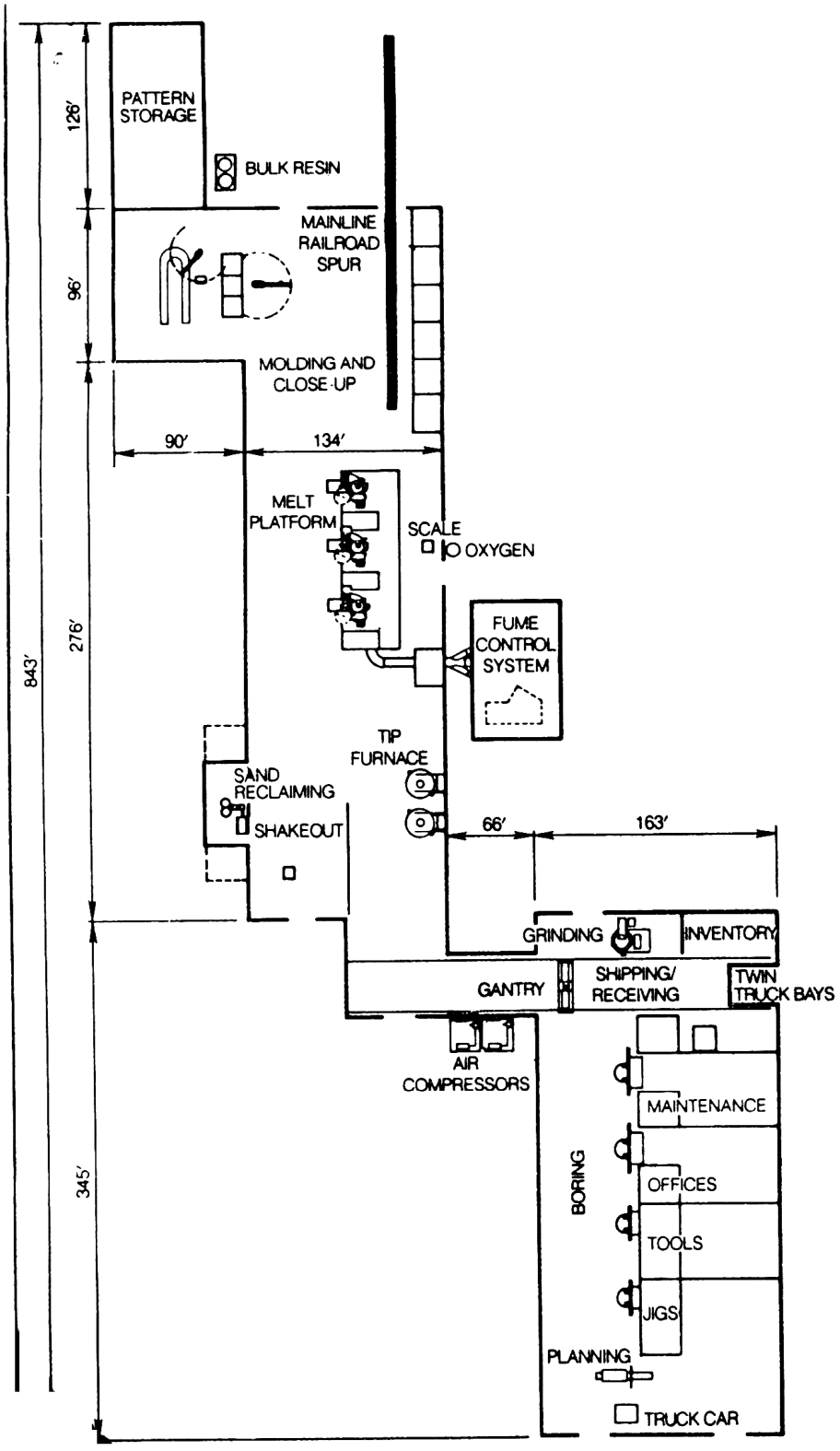
8.2. List of special terms.

1. to phase out – снимать с производства
2. considerable – значительный
3. savings – экономия
4. production layout – промышленная планировка
5. to rate – измерять
6. craneway – мостовой кран

7. cell – секция, камера
8. fume – дым
9. charging bay – загрузочная площадка
10. cleaning bay – площадка очистки
11. molding bay – площадка формовки
12. pouring bay – разливочный пролет цеха
13. chemically bonded no-bake sand – химически связанный необожженный песок
14. furan=furfuran – фуран
15. alkyd – алкид
16. sand silo – песчаный бункер
17. dust collector – пылеуловитель
18. dust-laden air – воздух, насыщенный пылью
19. test samples – контрольные образцы
20. to record – записывать
21. date-(pl) datum (sin) – данные
22. stress relieving – снимать напряжение
23. air-quenching – воздушная закалка
24. tip-up furnace – вертикальная печь
25. advanced tooling – современные инструменты
26. precision operation – сверхточные операции
27. turning center – токарный центр
28. boring mill – расточной станок
29. large size pump shells casting – отливка для корпуса насоса большого размера
30. to ship – перевозить, отправлять
31. truck fleet – парк грузовиков
32. domestically – на внутреннем рынке
33. despite – не смотря на
34. recession – спад

Step 9

Analyse the flow design of a new iron and steel foundry and machine shop. Redesign it in a group of 3 – 4 students.



Step 10

10.1. Read the text, find out and make notes what is important for design engineers and foundrymen in casting design.

MAKING COST-EFFECTIVE CASTING DESIGN

In looking at the same design, engineers and foundrymen may see differently important things. Design engineers focus their attention on loads, mechanical and physical properties, automated secondary operations and cosmetics. Foundry metallurgists see heavy hot metal flowing, heat transfer and solidification patterns, great variability of shapes, shrinkage. For cost-effective casting design it is important to tie design engineering together with manufacturing engineering.

First, it is important to understand physical properties of the metals. They are fluidity, solidification, shrinkage, slag, dross formation and temperature.

The fluidity of molten metal indicates how easily it flows through narrow channels to form thin sections and how readily it conforms to fine surface details like small lettering and trademarks. Fluidity does not necessarily increase with temperature. It can be significantly differed between alloys. Some aluminum alloys, for example, have excellent fluidity at 1.200 F whereas molten steel has very poor fluidity at 3.000 F.

There are three stages of shrinkage: liquid shrinkage, liquid-to-solid shrinkage and solid shrinkage. The first stage does not affect the casting design while the second is very important. In some alloys if the liquid-to-solid shrinkage is disregarded by the casting designer, voids can be produced in the casting. Solid shrink known also as the patternmaker's shrink becomes an important factor in secondary operations.

Slag usually is associated with high-melting-point metals and is composed of liquid non-metallic compounds such as fluxed refractories and products of alloying and oxidation.

Dross is produced by lower melting point metal, generally non-ferrous. It is composed of non-metallic compounds produced by molten metal reaching with air. Slag and dross can produce non-metallic inclusions in castings.

Temperature is a very important factor. The material of the mold must withstand the pouring temperature of the liquid metal.

Second, physical properties of the molten metal affect casting methods, casting sections and junction design, internal integrity and net shape and cosmetics.

Third, in making cost-effective casting design it is important to avoid traditional concepts of conflicting methods, typical dos and don'ts and software that cannot draw typical casting designs.

Word-list

solidification pattern – модель затвердевания; shrinkage – усадка; fluidity – жидкотекучесть; to conform to – соответствовать; small lettering – надписи мелкими буквами; trademarks – торговый знак; to disregard – не принимать во внимание; voids – пустоты; Secondary operations – вспомогательные операции; whereas – при этом

Step 11

Brainstorm

1. Why temperature is a very important factor in foundry?
2. What physical properties of the metal do you know?
3. What is the main focus of attention for foundry metallurgists?

Step 12

You can find here some useful terms and their explanations. Match the terms with the explanations.

1. fluidity 2. shrinkage 3. slag 4. dross 5. solidification 6.molten metal.

a. non-metallic compounds produced by molten metal reaching with air;

b. metal hardening;

c. metal in a fluid state;

d. an important factor that should be regarded to avoid voids;

e. non-metallic compounds such as fluxed refractories and products of alloying and oxidation;

f. ability to flow through narrow channels to form thin sections and readiness to conform to fine surface details like small lettering and trademarks.

Step 13

The company decides about proper placement of the furnace platform. Draw out your own project.

Step 14

In groups of three students compare your projects.

Step 15

Write a report about your idea of opening a new foundry in hard times. What work can be done by the engineers of the company?

Step 16

Read the text and make the instruction for workers that they should sign before they start working in the foundry.

PROTECTING THE FOUNDRY WORKER

No industry has so many potential hazards as foundry with its molten metal, heat, dust, fumes, noise and vibration.

The Occupational Safety and Health Act (OSHA) mandates that employer should use all possible engineering and administrative know-how to guarantee safety at the workplace.

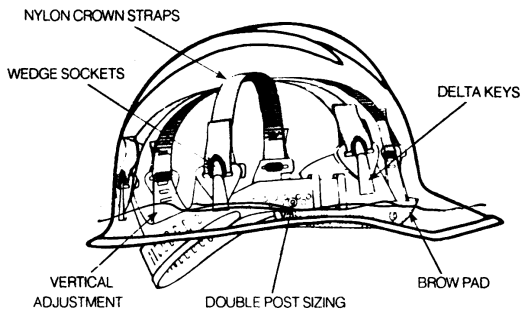
Besides the foundry must provide the workers with protective personal gear; hard hats and caps, eye and hearing protection, respirators, protective clothing, and hand and foot protection. Protective gear must have trademarks to identify the manufactures.

HEAD PROTECTION

Two kinds of safety helmets are used for head protection. Types 1 are hats with continuous brims that shield the front, sides and back of the head. Types 2 are brimless caps but they have a peak extending from the crown over the face.

Both Type 1 and Type 2 are made of lightweight materials such as plastic, glass or vulcanized fiber and protect against impact.

All safety helmets have a suspension system consisting of headband and hemispherical crown straps to absorb a blow. That suspension system must have a clearance of 1.25 in between the top of the head and hard shell to provide a shock absorbing space and distribute the forces of any blow. Besides all safety helmets have slots for attaching face- shields and earmuffs.



Head band and crown straps, as drawing shows, provide protective suspension system for hard cap. This design features a six-point suspension with both sizing and verical adjustments.

Eye and face protection

Eyes are protected by spectacles and goggles with clear hardened glass or hard plastic against flying objects, glare, sparks, metal splash and intensive heat. They must fit snugly and comfortably, easily cleaned and disinfected.

Face is protected by shields curved to surround the face. They can be clear or tinted green to protect from glare.

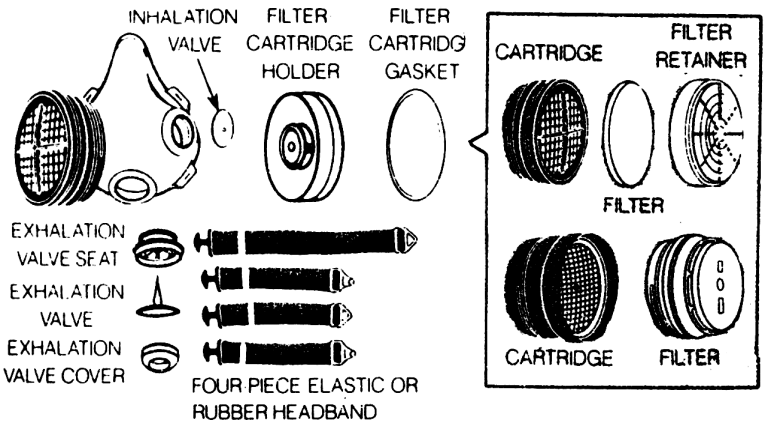
Hearing protection

When a worker is exposed to 8-hour time weighted average (TWA) noise level of 85 dB or about the employer must provide hearing protectors such as ear plugs and ear muffs.

Ear plugs can attenuate much of industrial noise, particularly high frequency noise when they are fitted properly in the outer part at the ear canal. They are made of rubber, silicon rubber, plastic or soft synthetic material and may be of different designs and sizes. Disposable plugs are made of waxed cotton, spun, acoustical mineral fibers or synthetics.

In the extreme situations ear plugs can be worn with acoustical ear muffs. Ear muffs consist of ear caps that are made from plastic and fitted with ear cushions. The ear caps are attached to a headband that is worn over the head, under the chin or behind the head. Ear muffs attenuate unwanted noise but magnifies the human voice. They have discriminating microphone that can be turned on or off.

Respirators



Respiratory hazards result either from oxygen deficiency or air contamination by dust, fumes, gases or vapours. If the air contains less than 19.5 % oxygen it is recommended to use atmosphere-supplying respirators, on which an air compressor supplies air. Air-purifying respirators use felt filters or filters with fine glass or other fibres and have a pore structure, fine enough to stop passage of particles but first it is too important to determine the air contaminants and their concentration that can be gaseous as particulate immediately dangerous for life and health.

Protective Clothing

A foundry contains many locations where temperature caused by radiant heat are high enough to create heat stress.

Protective clothing for work in these locations can be made of asbestos, aluminum-faced fabric, fire-resistant fabric, fire-resistant plastic-coated fabric, and leather.

For extreme radiant heat special water cooled clothing with plastic tubes for circulating water to transfer heat from the body or vortex tube jackets and helmets with compressed air and a value to regulate temperature are available.

Hand Protection

Gloves and mittens for metal pourers are available in aluminized fabric and asbestos suitable for direct heat or may be fabric lined for extra insulation. The ymay be made of leather protecting against moderate heat as well as sparks, molten metal splash, or terry cloth with additional insulating lining and multilayered fabric.

Foot protection

In addition to protective clothing foot protection is used.

Leather safety toe shoes incorporate a steel safety toe to protect the worker's foot from falling, rolling or moving objects. Foundry toe shoes class 75 can withstand at impact of 75ft-lb and compression of 2.500 lb.

Various sole materials, including leather, synthetics and rubber, protect against slipping, oil penetration and other hazards.

Word-list

1. hazard – опасность
2. fume – дым
3. occupational – профессиональный
4. to mandate – постановить
5. gear – одежда, экипировка
6. to identify – устанавливать

7. helmet – каска
8. brims – край, поля
9. head band – ремешок
10. shield – щиток
11. crown – верх
12. brimless – без полей
13. band – ремень, ремешок
14. straps – ремень, ремешок
15. sustention – подвесной
16. clearance – промежуток
17. shell – корпус
18. to absorb – поглощать
19. curve – закругление
20. plug – пробка
21. muff – муфта
22. attenuate – ослабевать
23. to fit – соответствовать, совпадать
24. disposable – могущий быть использованным
25. discriminating – умеющий различать

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