PRACTICAL WORKBOOK
MY-101: INTRODUCTION TO METALLURGICAL ENGINEERING

Name: ______________________________
Roll No: ______________________________
Batch: ______________________________
Year: ______________________________
Department ______________________________

DEPARTMENT OF METALLURGICAL ENGINEERING
NED UNIVERSITY OF ENGINEERING AND TECHNOLOGY

PRACTICAL WORKBOOK

MY-101: INTRODUCTION TO METALLURGICAL ENGINEERING

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(Course Teacher)

This is to certify that this practical book contains eleven practical and _____ pages. All practical are prepared as per contents of course.

Approved By:

Chairman
MYD

DEPARTMENT OF METALLURGICAL ENGINEERING
NED UNIVERSITY OF ENGINEERING AND TECHNOLOGY,

CERTIFICATE

It is Certified that Mr. / Miss ____

Student of class ______________________________ Batch_________________

Bearing Roll No. _______________________________________ has completed

his/her course work in the subject of ____________________________________

as prescribed and approved by Board of Review of Materials and Metallurgical Engineering Department.

His/Her performance is reflected by index/contents of his/her practical workbook. This overall performance of the student is Excellent/Very Good/Good (satisfactory)/Not Satisfactory

____

Course Teacher

MY-101: INTRODUCTION TO METALLURGICAL ENGINEERING

List of Practical

EXPERIMENT No. 01

Object
Name of the equipments and their purposes in Metallurgical Engineering laboratory.

Theory
Metallurgy is a study of Material sciences that studies the physical and chemical behaviour of metallic elements, their inter-metallic compounds, and their compounds, which are called alloys. It is also the technology of metals: the way in which science is applied to their practical use. Metallurgy is commonly used in the craft of metalworking.

In simpler words the study of behavior of metals and their compounds is known as metallurgy.

Procedure
Name all the equipments present in the laboratory and write down purposes in the table given below:

Observation

EQUIPMENT	PURPOSE

Questions

1. Define metallurgy?

____

____

____

2. How many types of optical microscope are present in laboratory?

____

____

____

3. Responsibilities of a Metallurgical Engineer in the industry?

____

____

____

____

EXPERIMENT No. 02

Object
Identification of various engineering materials on the basis of density

Apparatus
Weight balance, Vernier Caliper, Assorted Specimen

Theory
The density of a material is defined as the mass per unit volume of the material
Density can be expressed as follows:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Its unit is grams per centimeters cube (g/cm^3). Metals, as a category, have higher density than plastic however, some metals are denser than others. Therefore, materials can be categorized on the basis of density.

Procedure
First we take the mass of specimen by using weight balance. Measure the dimension of the specimen by using vernier caliper. Using the dimension, determine the volume of the specimen by using the formulas

Volume (cylinder) = $\pi r^2 h$

Volume (rectangular) = Length * Width * Height

Volume (cone) = $1/3 \pi r^2$ * height

Volume (sphere) = $4/3 \pi r$

1. Compare the observed density of each specimen with standard density.

Table: 01 **DENSITY OF MATERIALS**

MATERIAL	DENSITY (gm/cm^3)
Aluminum	2.7
Copper	8.8
Steel	7.85
Polymers (Elastomers)	0.98
Ceramics (Concrete)	2.4
Composite Material (Wood)	0.46-0.50

Table:02 STANDARD DENSITY FOR VARIOUS ENGINEERING MATERIALS AT 20 ^{0}C

No.	Materials	(gm/cm^3)
01.	Aluminum Alloys	2.6 to 2.9
02	Copper alloys	7.5 to 9.o
03	Lead alloys	8.9 to 11.3
04	Magnesium alloys	1.9
05	Nickel alloys	7.8 to 9.2
06	Titanium alloys	4.3 to 5.1
07	Zinc alloys	5.2 to 7.2
08	Carbon & low alloy Steels	7.8
09	High alloy Steels	7.8 to 8.1
10	Engineering Ceramics	2.2 to 3.9
11	Glasses	2 to 3
12	Thermoplastics	0.9 to 1.6
13	Polymer Foams	0.04 to 0.7
14	Engineering Composites	1.4 to 2
15	Concrete	2.4 to 2.5
16	Wood	0.4 to 1.8
17	Polyester (Thermoset)	1.04 to 1.46

2. Now identify the materials on the basis of density

Materials may also be identified by appearance to some extent when in pure form

Table: 03 **COLOUR IDENTIFICATION**

MATERIALS	COLOUR
Aluminum	White
Copper	Reddish
Iron	Grey
Zinc	Bluish
Tin	Silvery

Calculation

Volume (specimen one) = ____________________________

= ____________________________

= ____________________________

Volume (specimen two) = ____________________________

= ____________________________

= ____________________________

Volume (specimen three) = ____________________________

= ____________________________

= ____________________________

Density of specimen one = ____________________________

= ____________________________

Density of specimen two = ____________________________

= ____________________________

Density of specimen three = ____________________________

= ____________________________

Observation

No.	Specimen	Mass	Volume	Density
1				
2				
3				

Result

Specimen one has identified as ___________

Specimen two has identified as ___________

Specimen three has identified as ___________

Questions

1. The density of a material is defined as the _______________of the material.

2. The theoretical density of a metal can also be calculated using the properties of the___________________

3. The unit of density in S.I system ______________, C.G.S system ___________, F.P.S system _______________.

4. The density of Aluminum is______________

5. The density of Copper is_________________

6. The density of Stainless Steel is___________

EXPERIMENT No. 03

Object
Identification of iron ores on the basis of colour.

Apparatus
Iron ores

Theory

IRON

Iron is a metallic element with atomic number 26 and atomic weight 56. it is symbol is Fe which comes from a Latin word “ferrum”. When its is pure it has a dark slivery grey colour. It is a very reactive element and oxidizes (rusts) very easily.

Iron constitutes about 4.6% of earths crust and hence it is one of the most widely distributed an abundant element in the nature.

The naturally occurring materials containing iron are known as minerals of iron. The minerals deposits from which iron is extracted are known as iron ores.

CLASSIFICATION OF IRON ORES

The ores of iron are classed according to the iron mineral which is predominant. They are in the order of theoretical percentage of iron present in the mineral.

MAGNETITES (Black Ores) Fe_3O_4

These iron ores contain 40% to 70% of iron. They are very hard and strongly magnetic. Magnetites also occur in a mixture with silica (35-37 iron and upto 60%silica) and are then known as “ferruginous quartzites”. Ferruginous quartzites call for special methods of dressing perpartion prior to smelting. The colour of magnetite is dark gray to black and a specifc gravity 5.16 to 5.18. the magnetic property is important for it primary exploration by magnetic method and makes possible the megnetic separation of magnetite from gangue materials to produce a high quality concentrate. Magnetite occurs in igneous, metamorphic and sedimentary rocks.

HEMATITES (Red Ores) Fe_2O_3

These iron ores contain 45% to 65% of iron. Hematite are easily reduceable to metallic form and iron from. It can be produced at a lower cost. It usually contains little phosphorous and sulphur. Usually, hydrated hematites contains 25% to 50% of iron. The colour of hematite ore are from steel gray to dull or bright red. The specific gravity is 5.26. it’s common varieties are termed crystalline; specular, martite, earthy, maghemite, and compact.

LIMONITES (Brown Ores) $Fe_2O_3.H_2O$

These iron ores contain57.14% of iron with a 25.3% of water combination. Limonite’s are porous minerals. Limonites is the name commonly given to hydrous iron oxides that is a mixture of the cyoethite Hfe O_2 (Hydrous iron oxide) or lepidocrocite FeOCOH. It has a specific gravity in the range of 3.6 – 4.0, is commonly yellow or brown to nearly black in colour and is compact in early occurrence. It is a secondary mineral, formed commonly by weathering and occurs in association with other iron oxides and in sedimentary rocks

SIDERITE (White Ores) $FeCO_3$

It has a chemical compound of $FeCO_3$ (Iron Carbonate). The ore contains 48.20% of iron, 37.99% of CO_2, and 13.81% oxygen. The specific gravity is 3.83 and it's colour varies from white to greenish gray and brown. It's commonly contained variable amount of Ca, Mg, Cr, Mn. Sidrite varries from dense, fine grained and compact to crystalline. That ore are sometimes termed as spatrie iron ore or black band ore.

LIMENITE ($FeTiO_3$)

It has a chemical compound of $FeTiO_3$ (iron titanium oxide) contains to 36.82% iron, 31.7% titanium and 31.63% oxygen. This is commonly considered as iron titanate. It is often associated in small amount with magnetite

Procedure

Identify the name and the properties of the sample of given iron ore by looking at its colour and physical properties.

Colour

____

Physical Properties

____

____

____

____

Conclusion: ________________________________

____

____

Questions:

1. Define iron?

 ____

 ____

 ____

 ____

2. Complete the table below with the name, colour and chemical composition of all the iron ores.

Name of Iron Ore	**Colour**	**Chemical composition (%)**

3. What is the percentage of iron metal in earth's crust (a) 4.6% (b) 3.55% (c) 40% (d) None of above.

EXPERIMENT No.04

Object

Introduction to raw materials for pig iron production

Apparatus

Iron ore, coke, flux (lime stone), and ferroalloys

Theory

These are the raw materials used for the production of pig iron. **Coke (fuel),** a solid carbonaceous residue derived from destructive distillation of coal.

Iron ores are rocks and minerals from which metallic iron can be economically extracted. The ores are usually rich in iron oxides and vary in colour from dark grey, bright yellow, deep purple, to rusty red. The iron itself is usually found in the form of magnetite (Fe_3O_4), hematite (Fe_2O_3), goethite, limonite or siderite. Hematite is also known as "natural ore"(Fig.1). The name refers to the early years of mining, when certain hematite ores contained 66% iron and could be fed directly into iron making blast furnaces. Iron ore is the raw material used to make pig iron, which is one of the main raw materials to make steel. 98% of the mined iron ore is used to make steel.

A related use of the term **flux** is to designate the material added to the contents of a smelting furnace or a cupola for the purpose of purging the metal of impurities, and of rendering the slag more liquid. The flux most commonly used in iron and steel furnaces is limestone, which is charged in the proper proportions with the iron and fuel. The slag is a liquid mixture of ash, flux, and other impurities

Whereas Ferroalloy refers to various alloys of iron with a high proportion of one or more other element, manganese or silicon for example. It is used in the production of steels and alloys as a raw material

(Fig.1) IRON ORE

Procedure

Explain yourself about this practical.

Questions

1. Flux is used for ____

2. Coke serves main three purposes

(a) ____________________________(b) _____________________________________

(c)______________________________

3. Define pig iron

____

____

4. What is difference between iron and pig iron

____

____

____

____

5. Pig iron production is ________________________process?

6. Steel is an alloy of (a) iron and carbon (b) iron and silicon (c) iron and manganese (d) all of above

7. Which furnace is used for production of pig iron (a) Cupola Furnace (b) Reverbatory Furnace (c) Blast Furnace (d) Electric Arc Furnace

8. Slag is by-product of (a) Cupola Furnace (b) Induction Furnace (c) Blast Furnace (d) all of above

9. Slag is used for?

____

____

10. Pig iron is used for?

____

____

EXPERIMENT No.05

Object

Introduction to raw materials for steel production

Apparatus

Steel Scrap, coke breeze (powder form) and/or Carbon powder (98% pure), flux (lime, dolomite, CaF_2 (fluorspar)), and ferroalloys

Theory

These are the raw materials used for the production of steels. **Coke (fuel),** a solid carbonaceous residue derived from destructive distillation of coal.

Scrap is a term used to describe recyclable materials left over from every manner of product consumption (such as parts of vehicles, building supplies, and surplus materials). Often confused with waste, scrap in fact has monetary value and is one of the United States' largest exports. Whereas ferroalloys are the raw materials (impure/raw alloys of Fe, Cr, Mn, C) containing iron (Fe) and other elements like Mn, Cr, C, etc

A related use of the term **flux** is to designate the material added to the contents of a smelting furnace or a cupola for the purpose of purging the metal of impurities, and of rendering the slag more liquid. The flux most commonly used in iron and steel furnaces is limestone, which is charged in the proper proportions with the iron and fuel. The slag is a liquid mixture of ash, flux, and other impurities.

Whereas **Ferroalloy** refers to various alloys of iron with a high proportion of one or more other element, manganese or silicon for example. It is used in the production of steels and alloys as a raw material.

Procedure

Explain yourself about this practical.

Questions

1. Flux is used for ____

2. Oxygen serves different purposes in case of steel production?
   (a)______________________________(b)______________________________
   (c)______________________________

3. Define steels?
   ____
   ____

4. What is difference between iron and pig iron, and steel
   ____
   ____
   ____

5. Steel production is ____process?

6. Steel is an alloy of (a) iron and carbon (b) iron and silicon (c) iron and manganese (d) all of above

7. Which furnace is used for production of steel (a) Cupola Furnace (b) Electric Arc Furnace (c) Blast Furnace (d) None of above.

8. Slag is composed of _________________________eg. (a) _______________ (b) __________________ (c) ________________ (d) ____________________

9. Slag is used for?
   ____
   ____

10. De-oxidation is important in steel making why?
   ____
   ____
   ____
   ____

EXPERIMENT No. 06

Object
To carry out mounting of given specimen using Mounting Press Machine.

Apparatus
Mounting press specimen, bakelite, funnel, measuring spoon, and mould release wax.

Theory
The mounting press machine is an Automatic Mounting Press shown in Fig. 1. The primary purpose of mounting is for convenience is handling specimens of difficult shapes or sizes during the subsequent steps of preparation and examination. A secondary purpose is to protect and preserve extreme edges of surfaces defects during preparation. Thickness of the mount should be sufficient to enable the operator to hold the mount firmly during grinding and polishing thereby to prevent a rocking motion and to maintain a flat surface. Circular mounts are commonly 1 to 2 in. in diameter and are the most easily handled. Different types of mounting methods are available e.g. clamp mounting, compression mounting, cold mounting etc. we use compression mounting method in experiment using automatic hydraulic mounting press.

Compression mounting, the most common mounting method involves molding around the specimen by heat pressure. Molding materials used are bakelite, aniline formaldehyde compound resins, and acrylic, Lucite resins etc. bakelite and aniline formaldehyde compound resins are thermosetting, and acrylic and Lucite resins are thermoplastic. For making transparent mold we may use Lucite. Both thermosetting and thermoplastic materials require head and pressure during the molding cycle, but after curing, mounts made of thermosetting materials may be ejected from the mold at maximum temperature. Thermoplastic materials remain molten at the molding temperature and must cold under pressure before ejection. Mounting presses quipped with molding tools and a heater is necessary compression mounting. The cylinder is nearly filled with molding material in powder form, and the plunger is inserted into open end of the cylinder. A cylinder heater is placed around the mold assembly, which has been exerted and maintained on the plunger to compress the molding material until it and the mold assembly has been heated to the proper temperature, the finished mount may be ejected from the mould by forcing the plunger entirely through the mould cylinder.

(Fig.1) MOUNTING PRESS MACHINE

Procedure

1. The inner ram pressure I supplied by hydraulic pressure. To activate the ram, the “Ram Up” and “Ram Down” buttons on the control panel are used.
2. Raise the ram until the top below the edge of mold assembly.
3. Apply mold release inside the mold chamber. When using either spray of liquid silicone mold release.
4. Raise the ram from flush with the top of the assembly.
5. Place the specimen onto the lower ram and lower is using the ram down button until fully down.
6. Apply enough mounting material to cover the mount, as well extra material on top, so the top ram does not make contact with the part.
7. If using the duple Xing spacer to produce two mounts in one cycle, place the spacer on top of the mounting material covering the first sample.
8. Swing the top ram/die over the mold chamber. The ram is spring loaded for ease of removal when unloading the chamber. Push down on the bayonet handles and turns it clock wise to lock the lid until stops hard against the bayonet.
9. Press the button “RUN” to the menu screen, select the menu and press “Run” again to begin the cycle.

10. This cycle will automatically raise the ram into the top and begin heating the mold.
11. Do not touch the molds while it I heating or cooling, as it may cause a painful burn.
12. During the cycle, an illuminated LED on the display panel will indicate operation of a cycle (Cycle On), and whichever cycle is operating: Pre-Heat, Heat or Cool.
13. When the cycle is complete, an alarm will sound as a series beeps. The mold will lower automatically enough to loosen and rotate bayonet open. Loosen the bayonet by turning the top handle, counterclockwise, until it is unlocked. It might be necessary to lower the ram a little more to loosen the bayonet, which can be done by pressing the "Ram Down" button.
14. List the top ram up and swing it away around to the rear where it may rest on the heat sink until it is ready to be used again. The sample may be removed at this time.

Result

Small specimen is successfully mounted in thermosetting plastic and bakelite.

Questions

1. The purpose of mounting is to _______________________________________.
2. Different types of mounting methods are ______________________________.
3. Mounting press used in the experiment is ______________________________.
4. Mounting material used in the experiment is ____________________________.
5. The mounting temperature for thermo setting plastic is ___________________.
6. For making transparent mount we use _______________ as mounting material.
7. Diameter of the mount made in the experiment is _______________________.
8. Mounting force is used in the experiment is _____________________________.

EXPERIMENT No. 07

Object

To study the working of Brinell hardness tester

Apparatus

Brinell hardness tester

Theory

The figure 1. Below shows the description of brinell hardness tester

The principle of hardness tester:
Hardness is the resistance to penetration, scratching. In the Brinell hardness method, the indenter size and the load to be applied are determined from the scales provided for the type of material to be tested.

The hardness is calculated by the following formula.

$$BHN = \frac{P}{\pi D/2 \left(D - \sqrt{D^2 - d^2}\right)}$$

Where,

P= Major Load
D= Diameter of the ball
d= Indentation diameter

An indenter (An hard metal ball with diameter D) is forced into the surface of a test piece and the diameter of the indentation d left in the surface after removal of the force F is measured.

The brinell hardness is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation. The indentation is assumed to be spherical with a radius corresponding to half of the diameter of the ball.

The brinell number which normally raises from HB50 to HB750 for metals, will increase as the sample gets harder.

(Fig. 1) BRINELL HARDNESS TESTER

Tester Parts

1. LCD	2. Keyboard
3. Protective Nose	4. Indenter (Inside protective nose)
5. Anvil	6. Screw Pindle
7. Emergency stop	8. Printer
9. RS232	10. Cable interface
11. Main switch	12. Fuse holder

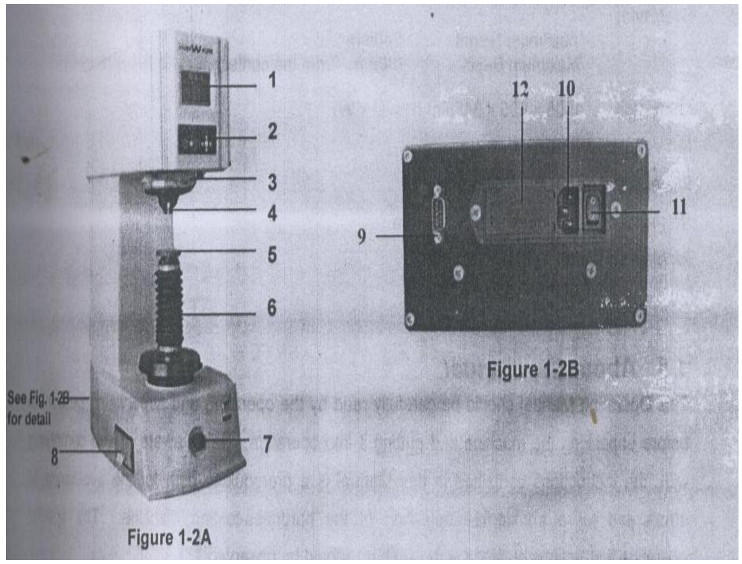

Figure 1-2A
Figure 1-2B

Procedure

Explain yourself about this practical.

____

____

____

____

____

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____

____

____

____

____

Question

1. Unit for measuring Brinell's hardness is
   a. HRB
   b. Hardness number
   c. Grams /mm
   d. None of the above

2. Diamond indenter is used in
   a. Brinell is Hardness test
   b. Rockwell Hardness test
   c. Both of the above

3. A Brinell's Hardness test was done on the following materials and results tabulated As follows

   a. Materials A, HB=200
   b. Materials B, HB=100
   c. Materials C, HB=50

   Which materials is the hardest?
   Answer ____________

4. A ball of 5mm diameter is used as indenter in a brinell's Test on 3 different materials all subjected to the same load. The size of the indentation diameter was found to be

   a. MATERIAL A, d= 1.5mm
   b. MATERIAL B, d=1.3mm
   c. MATERIAL C, d=1.1mm

Which material is the hardest?

Answer ______

EXPERIMENT No. 08

Object

To Study the working of Rockwell hardness tester

Apparatus

Rockwell hardness tester

Theory

The Rockwell Hardness tester shown in fig.1 is uses a machine to apply a specific load and then measure the depth of the resulting impression. The indenter may either be a steel ball of some specified diameter or a spherical diamond-tipped cone of 120° angle and 0.2 mm tip radius, called a brale. A minor load of 10 kg is first applied, which causes a small initial penetration to seat the indenter and remove the effects of any surface irregularities. Then, the dial is set to zero and the major load is applied. Upon removal of the major load, the depth reading is taken while the minor load is still on. The hardness number may then be read directly from the scale. The indenter and the test load used determine the hardness scale that is used (A, B, C, etc).

For soft materials such as copper alloys, soft steel, and aluminum alloys a 1/16" diameter steel ball is used with a 100-kilogram load and the hardness is read on the "B" scale. In testing harder materials, hard cast iron and many steel alloys, a 120 degrees diamond cone is used with up to a 150 kilogram load and the hardness is read on the "C" scale. There are several Rockwell scales other than the "B" & "C" scales, (which are called the common scales). A properly reported Rockwell value will have the hardness number followed by "HR" (Hardness Rockwell) and the scale letter. For example, 50 HRB indicates that the material has a hardness reading of 50 on the B scale.

The Basic Principle of Rockwell Hardness Tester

All the beginning of the test, place the indenter of tester on the specimen surface, applies a preliminary load and establishes a reference point that a displacement transducer measures. Because the indenter penetrates into the specimen surface by means of preliminary load, surface roughness or irregularities do not affect the test. Next, the tester applies the main load. The larger force penetrates deeper into the specimen. Then, the tester removes the main load, meanwhile, still applying the preliminary load. At this point, the tester measures the depth of the indent relative to the established reference point.

(2) Rockwell hardness test formulas

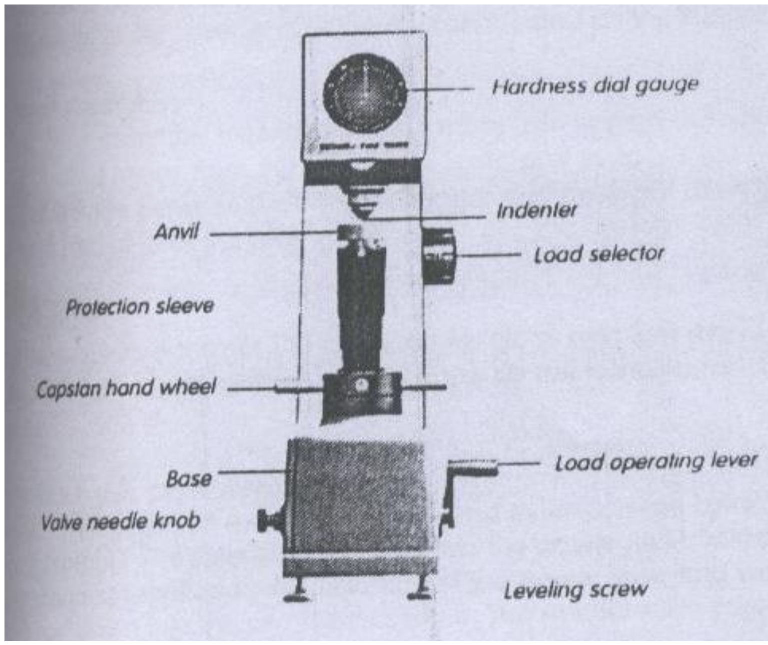
$$HRC.A = 100 - \frac{n1 - n0}{0.002}$$

$$HRB = 130 - \frac{n1 - n0}{0.002}$$

In which:
n0 = indenter depth from preliminary load
n1 = indenter depth from applies total test load F, then removes main load F1, but remains preliminary test load F0.

(Fig.1) ROCKWELL HARDNESS TESTER

Tester Parts



Procedure

Explain yourself about this practical.

EXPERIMENT No. 09

Object

To study the working of Micro Vicker Hardness Tester

Apparatus

Micro Vickers Hardness Tester

Theory

The digital Vickers micro-hardness tester is shown is fig.1 is especially designed to test the structure of tiny or minute metal parts, this plates, metals foil, high quality cord, thin hardening layers and electroplated layers. In addition, it can also find wide applications in testing non-metallic materials such as glass, jewelry, ceramics etc, which can hardly be measured with Rockwell or other hardness testers using relatively large test load. In particulars, it could manage to measure the internal hardness of induction hardening material or carburized material by following the metal structure.

The test is performed in two steps. First, the diamond indenter is driven into the surface of the tester material by applying a known load force. Second, the user measures the diagonals(s) length of the resulting indentation and input the measured length of diagonals(s) to the integrated calculator, by which hardness value could be acquired either in Vickers scale (HV).

Principle of Operation

The tester will exert test forces on a specimen by using weights and a lever mechanism (force amplification).

After selecting a test force, the user should press <START>. The motor drives the lever to release the weights corresponding to the selected force, then the released weights press indenter down to make an indentation on the specimen in a specified period which is preset in the software system by the user.

After the indenter has left the specimen to travel back to the starting position, the user turns the turret to 40* objective to measure to diagonals(s). The measuring microscope has adjustable filer lines. The user can adjust the lines to just touch the tips of the indentation. Now the user can press the “Reading Enter Key” to input the measured result into the integrated calculator.

The calculator then computer and displays the Vickers hardness value by using formulas presented in this chapter.

Principle of Test Method

The top of the Vickers indenter is in shape of pyramid with a face angle of 136. The depth of indentation it makes is about 1/7 of its diagonal length.

The Vickers indenter can penetrate into the specimen about twice as deep as that by knoop indenter. Therefore, the Vickers tester is less sensitive to specimen surface as the knoop tester. Because, the indentation is finish, Vickers test can be used on materials that cannot be tester by knoop indenter. However, because of the deeper indentation, the Vickers test is not suitable for testing very thin metal foils and thin (coating) layers. In these cases knoop test could perform better. Under condition of equal loads, the Vickers indenter (because of its shorter length) is more sensitive to errors in measuring the indent.

Vickers test is generally divided into two types:

Micro = 10 to 2000 gf
Macro = above 2000

The Vickers hardness value could be calculated from the following formula:

$$HV = 0.102\ \frac{F}{S} = 0.120\ \frac{2FSin\ \frac{(\theta)}{2}}{D^2} = 0.1891\ \frac{F}{D^2}$$

Where:

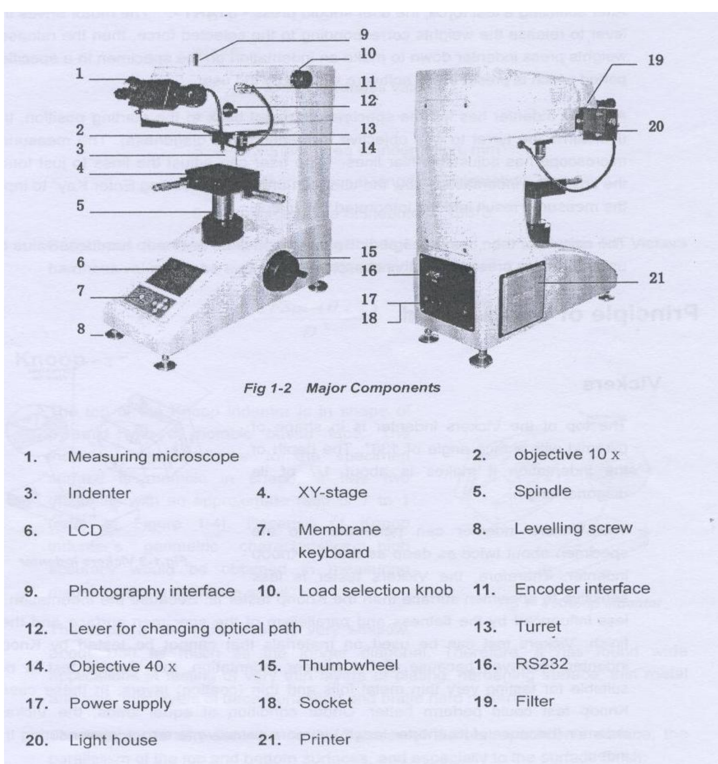
HV- Vickers Hardness value
F- Test Force, N
S- Surface area of indentation, mm^2
D- Mean diagonal length of indentation, mm
θ- Face angle of indenter = 136°0

Sometimes the load unit **kgf is** used**.** If **kgf** is used, the equation for Vickers hardness value can be expressed as following:

$$HV = \frac{F}{S} = 0.120\ \frac{2FSin\ \frac{(\theta)}{2}}{D^2} = 1.854\ \frac{F}{D^2}$$

(Fig.1) MICRO VICKER HARDNESS TESTER

Tester Parts



Procedure

Explain yourself about this practical.

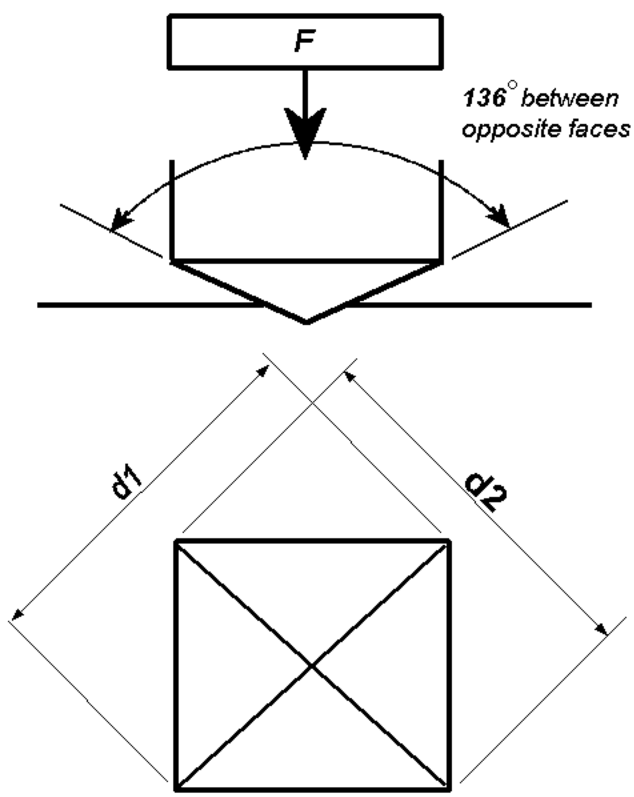
EXPERIMENT NO. 10

Object
To study the working of Vickers hardness tester

Apparatus
Vickers hardness tester

Theory

The Vickers hardness tester as shown in fig.1. The method consists of indenting the test material with a diamond indenter, in the form of a right pyramid with a square base and an angle of 136 degrees between opposite faces subjected to a load of 1 to 100 kgf. The full load is normally applied for 10 to 15 seconds. The two diagonals of the indentation left in the surface of the material after removal of the load are measured using a microscope and their average calculated. The area of the sloping surface of the indentation is calculated. The Vickers hardness is the quotient obtained by dividing the kgf load by the square mm area of Indentation



Where,

F= Load in kgf
d = Arithmetic mean of the two diagonals, *d1* and *d2* in mm

HV = Vickers hardness

$$HV = \frac{2F\sin\frac{136^o}{2}}{d^2} \qquad HV = 1.854\frac{F}{d^2} \text{ approximately}$$

When the mean diagonal of the indentation has been determined the Vickers hardness may be calculated from the formula, but is more convenient to use conversion tables. The Vickers hardness should be reported like 800 HV/10, which means a Vickers hardness of 800, was obtained using a 10 kgf force. Several different loading settings give practically identical hardness numbers on uniform material, which is much better than the arbitrary changing of scale with the other hardness testing methods. The advantages of the Vickers hardness test are that extremely accurate readings can be taken, and just one type of indenter is used for all types of metals and surface treatments. Although thoroughly adaptable and very precise for testing the softest and hardest of materials, under varying loads, the Vickers machine is a floor standing unit that is more expensive than the Brinell or Rockwell machines.

VICKERS HARDNESS TEST (Fig.1)

Tester Parts

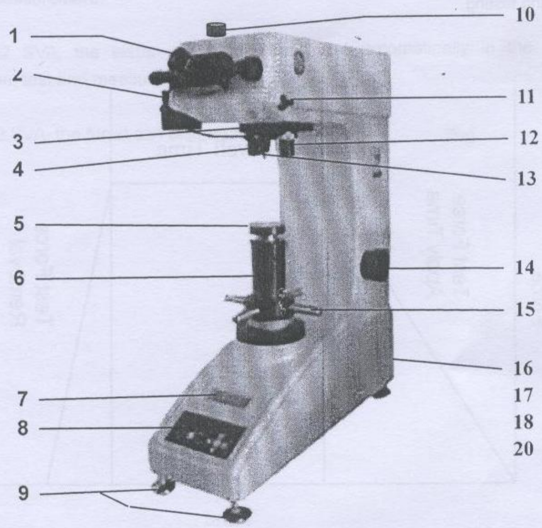
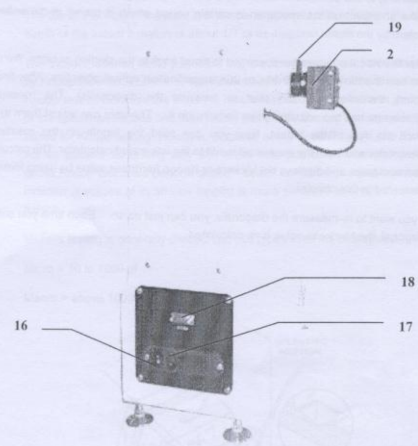


Figure 1-2-A Major Components

Fighure 1-2-B: See next page

1.	Measuring microscope			2.	Light source
3.	Turret	4.	Objective 10×	5.	Anvil
6.	Spindle	7.	LCD	8.	Membrane keyboard
9.	Levelling screw	10.	Photography tube		
11.	Lever for optical path changeover			12.	Objective 20×
13.	Indenter	14.	Load selection knob	15.	Thumbwheel
16.	Power switch (back side)	17.	Power connector (back side)	18.	RS232 tube (back side)
19.	Filter (next page)				



Procedure

Explain yourself about this practical.

EXPERIMENT No. 11

Object

To study the operation of Metallurgical Microscope

Apparatus

Metallurgical Microscope

Theory

Metallurgical microscopes as shown in fig.1 are used for identification and analysis of the structures of different metals and alloys. They are important instruments for the research of metallurgy. They can be used for quality research of foundry, smelt and heat treatment, for testing of raw and processed materials or for analysis of heat treatment materials. They are ideal instrument for scientific research, teaching, factories and so on.

Principle of Metallurgical Microscope

In Metallurgical Microscope, a horizontal beam of light from some light source is reflected, by means of a plane-glass reflector, downward through the microscope objective onto the surface of the specimen. Some of this incident light reflected from the specimen surface will be magnified in passing through the lower lens system, the objective, and will continue upward through the plane glass reflector and be magnified again by the upper lens system, the eyepiece. The initial magnifying power of the objective and the eyepiece is usually engraved on the lens mount. When a particular combination of objective and eyepiece is used at the proper tube length, the total magnification is equal to the product of the magnifications of the objective and the eyepiece.

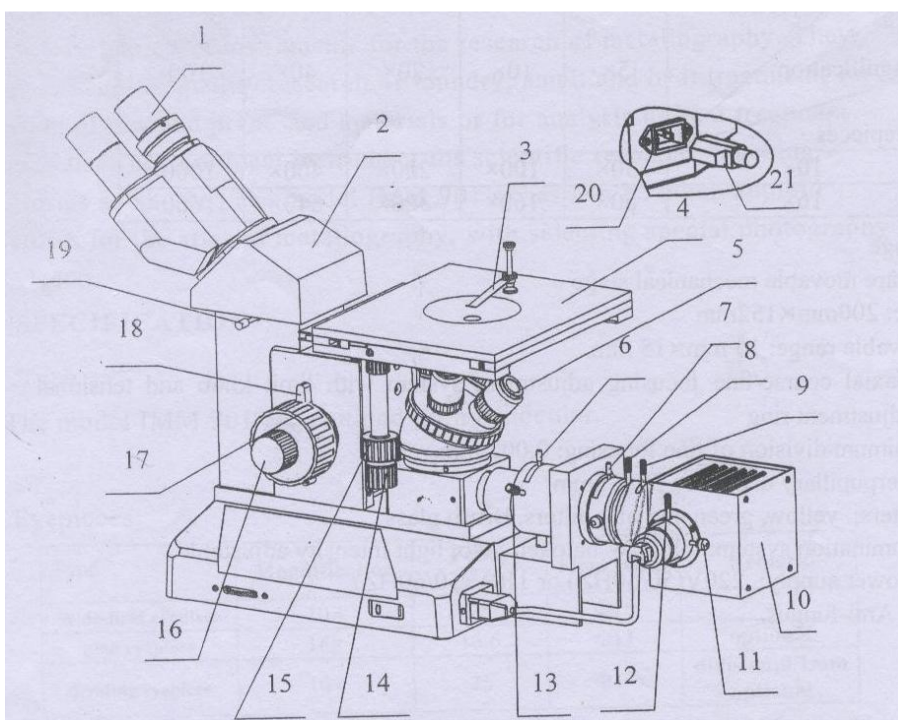
The maximum magnification obtained with the optical microscope is about 2OOOx

Principle Limitation

The principal limitation is the wavelength of visible light, which limits the resolution of fine detail in the metallographic specimen. The magnification may be extended somewhat by the use of shorter-wavelength radiation, such as ultraviolet radiation, but the sample preparation technique is more involved.

(Fig.1) METALLURGICAL MICROSCOPE

Microscope Parts



1. Eye Piece	10. Lamp Box
2. Binoculars	11. Lamp Holder Lock Screw
3. Stretchy Clip	12. Lamp Adjustment Pole
4. Mechanical	13. Field Diaphragm Adjustment Screw
5. Objective	14. Cross Movement Knob
6. Field Diaphragm	15. Lengthways Movement Knobs
Stage Adjustment Pole	16. Fine Focusing Knob
7. Aperture Diaphragm Adjustment Pole	17. Coarse Focusing Knob
8. Filter	18. Limit Knob
9. Condenser Adjustment Pole	19. Tube Holding Screw
20. Electrical Outlet	21. Power Supply

Question

1. In Metallurgical Microscope a horizontal beam of ________________________ Passes through a plane glass reflector.

2. The total magnification is equal to the product of the magnification of the objective and the ________________.

3. The maximum magnification obtained with the Metallurgical Microscope is about ___________________.

4. A Metallurgical Microscope helps determine ____________and ____________.

5. In Metallurgical Microscope illumination beam is _________________.