

21/01/22

Exp: 18

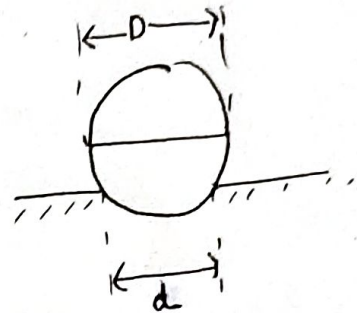
(Group 24)

AIM: To learn about hardness testing machines and perform Vicker's Hardness Test.

Definitions :- (Q4)

i) Bainell Hardness (HB) :-

$$HB = \frac{2F}{\pi D [D - \sqrt{D^2 - d^2}]}$$



→ A hard spherical indenter (usually carbide ball) is forced into metal surface which is to be tested.

Advantages

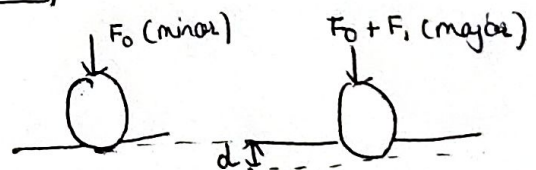
- Can be used over non-homogeneous material also.
- Large range of forces can be applied (1-3000 Kgf)

Disadvantages

- Not well suited for softer materials
- slower process compared to other testing methods.

Conversion to Vicker ⇒ $HB = 0.95HV$

ii) Rockwell Hardness (HRC) :-



$HRC = A - \frac{d}{B}$, where A & B are scaling constants.

→ It is determined by application of minor load followed by a major one and increment of depth (d) is noted.

Advantages

- Quick, reliable and commonly used
- Minor load nullifies surface roughness effects.

Disadvantages

- Sensitive to error in depth measurements
- Surface must be free of all contaminations.

• Conversion to Vickers: $HRC = \frac{100 HV - 14500}{HV + 23}$

iii) Knoop Hardness (HK):

→ It is a microhardness test, which uses a pyramidal point indenter and used for brittle material.

⇒ $HK = \frac{P}{C_p L^2}$ where L is length of indentation along axis
 $C_p \approx 0.07$ (correction factor)
 P is load applied.

Advantages

- Can be used for brittle / thin materials
- Very precise results.

Disadvantages

- Slow preparation & indentation process.
- Microscopic measurement of indentation is difficult.

• Conversion to Vicker's: $HV \approx \frac{3033 HK}{\left(\frac{62.5}{1088 - HK} \right) + 0.077} + \frac{|HK - 355|}{355}$

Que 5 Given:- $P = 10 \text{ kgf}$
 $d_1 = 210 \mu\text{m}$
 $d_2 = 227.5 \mu\text{m}$

Thus, $d_{avg} = \frac{d_1 + d_2}{2} = \frac{210 + 227.5}{2} = 218.75 \mu\text{m}$
 $= 0.21875 \text{ mm}$

⇒ $HV = \frac{2P \sin\left(\frac{136^\circ}{2}\right)}{d_{avg}^2} = \frac{2 \times 10 \times \sin 68^\circ}{(0.21875)^2} (\text{kgf/mm}^2)$
 $= 387.45 \text{ kgf/mm}^2$
Ans.

Question 1:-

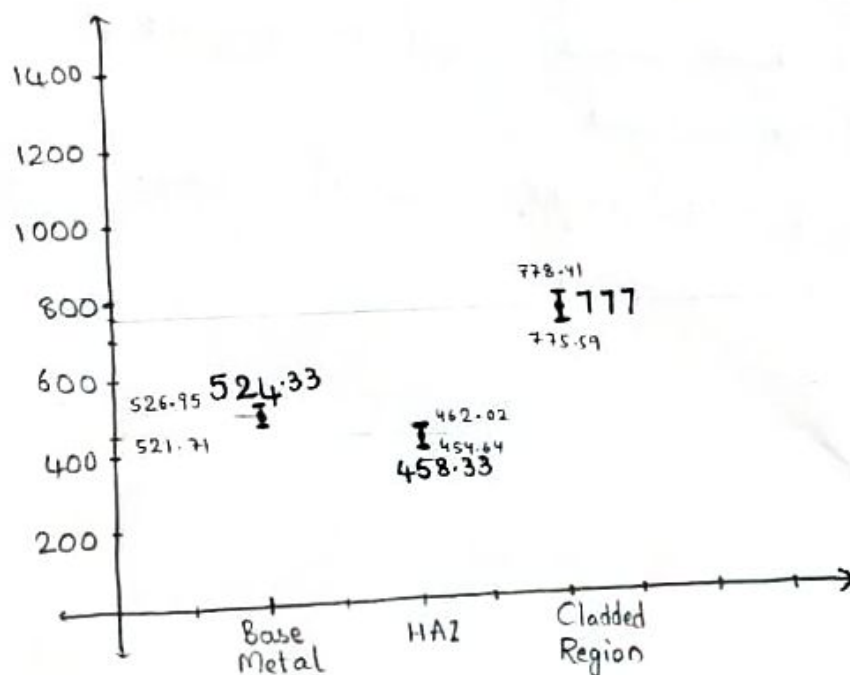
Present the results about the hardness of base metal, HAZ zone & the cladded region. Find the mean and standard deviation.

Results:-

Phases ↓	R ₁	R ₂	R ₃	Mean HV	Std. dev
Base Metal	522	523	528	524.33	2.62
HAZ	454	458	463	458.33	3.69
Cladded Region	778	775	778	777	1.41

Question 2:-

Plot the diagram of mean Vicker's hardness (HV) vs Region with error bars.



Question 3:-

Write conclusions and sources of error.

Conclusions:-

Vicker's Hardness test is a non-destructive test. Higher the hardness of the material, the more it is difficult to make an indentation or scratch. The hardness at Ni-Cr cladding is highest and at heat affected zone (HAZ) is least.

Sources of error:-

1. The sample surface is not perfectly horizontal
2. Human error while setting zero and handling camera.
3. There isn't enough space between indentations.
4. Vibrations and impulses while indentations.