

LAMPIRAN A
CONTOH PERHITUNGAN

Lampiran A. Contoh Perhitungan

1. Perhitungan Ukuran Butir *ImageJ*

a. *Quenching & Partitioning* 250°C selama 5 Menit (QP250-5)

$$\text{Ukuran Butir 1} = \frac{116}{47} = 2,46 \mu\text{m}$$

$$\text{Ukuran Butir 2} = \frac{116}{51} = 2,27 \mu\text{m}$$

$$\text{Ukuran Butir 1} = \frac{116}{50} = 2,32 \mu\text{m}$$

$$\text{Rata-rata ukuran butir} = \frac{2,46 + 2,27 + 2,32}{3} = 2,35 \mu\text{m}$$

2. Perhitungan nilai rata-rata uji kekerasan (RHN)

a. *As Received*

$$\text{As Received} = \frac{104+106+106,2+105,3+104,2}{5} = 105,28 \text{ RHN}$$

b. *Quenching & Partitioning* 250°C selama 5 Menit (QP250-5)

$$\text{QP250-5} = \frac{101,6+105,6+106+105,3+98,6}{5} = 103,44 \text{ RHN}$$

c. *Quenching & Partitioning* 250°C selama 10 Menit (QP250-10)

$$\text{QP250-10} = \frac{97,6+95,6+105,2+106,3+103,2}{5} = 101,58 \text{ RHN}$$

d. *Quenching & Partitioning* 250°C selama 15 Menit (QP250-15)

$$\text{QP250-15} = \frac{95,3+91,4+103,5+102,2+107,8}{5} = 100,04 \text{ RHN}$$

e. *Quenching & Partitioning* 325°C selama 5 Menit (QP325-5)

$$QP325-5 = \frac{100,3+100,7+103,6+101,9+102,4}{5} = 101,78 \text{ RHN}$$

f. *Quenching & Partitioning* 325°C selama 10 Menit (QP325-10)

$$QP325-10 = \frac{98,1+101+102+101,4+103}{5} = 101,1 \text{ RHN}$$

g. *Quenching & Partitioning* 325°C selama 15 Menit (QP325-15)

$$QP325-15 = \frac{103,4+104,4+97,5+97,4+93,3}{5} = 99,2 \text{ RHN}$$

h. *Quenching & Partitioning* 400°C selama 5 Menit (QP400-5)

$$QP400-5 = \frac{109,4+108,7+109,3+109,7+104,6}{5} = 108,34 \text{ RHN}$$

i. *Quenching & Partitioning* 400°C selama 10 Menit (QP400-10)

$$QP400-10 = \frac{106,7+107,9+107,8+106,5+106,7}{5} = 107,12 \text{ RHN}$$

j. *Quenching & Partitioning* 400°C selama 15 Menit (QP400-15)

$$QP400-15 = \frac{105,1+105,7+108,4+106,3+105,1}{5} = 106,12 \text{ RHN}$$

3. Perhitungan Harga Impak (J/mm^2)

$$\text{Luas Penampang} = 2,5 \text{ mm} \times 8 \text{ mm} = 20 \text{ mm}^2$$

$$\text{Harga Impak (HI)} = \frac{\text{Energi (J)}}{\text{Luas Penampang (mm}^2\text{)}}$$

a. *As Received*

$$NQP = \frac{4,36 \text{ J}}{20 \text{ mm}^2} = 0,218 \text{ J/mm}^2$$

b. *Quenching & Partitioning* 250°C selama 5 Menit (QP250-5)

$$QP250-5 = \frac{13,81 \text{ J}}{20 \text{ mm}^2} = 0,6905 \text{ J/mm}^2$$

c. *Quenching & Partitioning* 250°C selama 10 Menit (QP250-10)

$$QP250-10 = \frac{15,53 \text{ J}}{20 \text{ mm}^2} = 0,7765 \text{ J/mm}^2$$

d. *Quenching & Partitioning* 250°C selama 15 Menit (QP250-15)

$$QP250-15 = \frac{16,84 \text{ J}}{20 \text{ mm}^2} = 0,842 \text{ J/mm}^2$$

e. *Quenching & Partitioning* 325°C selama 5 Menit (QP325-5)

$$QP325-5 = \frac{16,40 \text{ J}}{20 \text{ mm}^2} = 0,82 \text{ J/mm}^2$$

f. *Quenching & Partitioning* 325°C selama 10 Menit (QP325-10)

$$QP325-10 = \frac{17,71 \text{ J}}{20 \text{ mm}^2} = 0,8855 \text{ J/mm}^2$$

g. *Quenching & Partitioning* 325°C selama 15 Menit (QP325-15)

$$QP325-15 = \frac{19,04 \text{ J}}{20 \text{ mm}^2} = 0,952 \text{ J/mm}^2$$

h. *Quenching & Partitioning* 400°C selama 5 Menit (QP400-5)

$$QP400-5 = \frac{15,53 \text{ J}}{20 \text{ mm}^2} = 0,7765 \text{ J/mm}^2$$

i. *Quenching & Partitioning* 400°C selama 10 Menit (QP400-10)

$$QP400-10 = \frac{16,84 \text{ J}}{20 \text{ mm}^2} = 0,842 \text{ J/mm}^2$$

j. *Quenching & Partitioning* 400°C selama 15 Menit (QP400-15)

$$\text{QP400-15} = \frac{18,15 \text{ J}}{20 \text{ mm}^2} = 0,9075 \text{ J/mm}^2$$

LAMPIRAN B
DATA PENELITIAN

Lampiran B. Data Penelitian

1. Data Karakteristik Material Baja AISI 4140

SeAH Besteel Corp.
1-6, SORYONG-DONG, KUNSAN,
CHEONGBUK, KOREA(573-711)

MILL CERTIFICATE

TEL : +82-(0)63-460-8572, 8318(QA)
+82-(0)63-460-8114(Repres.)
FAX : +82-(0)63-460-8423 Page(0/0)

Date : 2019-01-11
Cert. No. : 201901-039434
Customer :
Heat No. : 286991

Steel Grade : AISI 4140/SCM 440
Shape of Product : ROUND BAR
Delivery Condition : As Rolled

Size (mm) : 16 - 600
Length (mm) : 6,000
Weight (kg) :
Quantity(pcs) : 1

Inspection Items		Chemical Composition (wt. %)								
		C	SI	MN	P	S	CU	NI	CR	MO
Spec.	Min.	38	15	75	35	20		80	15	
	Max.	43	35	100				110	25	
	Result	41	25	67	16	20	25	103	15	

Inspection Items	Product Hardness (HB)		
	SURFACE	255-273 HB	50-52 HRC

Mechanical Properties AISI 4140/SCM 440

Mechanical Properties	Symbol	Steel
Yield strength (N/mm ²)		≥739
Tensile Strength (N/mm ²)		≥892
Extension ratio (%)		≥18.2
Area reduction (%)		≥63
Impact (V)		87 - 88

<<Remarks>>

B/DS : 4

End of report

We hereby certify that the material described herein has been made in accordance with the rules of the contract.	Certified by  Manager of Quality Assurance Dept
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Gambar B.1 Sertifikat Baja AISI 4140

2. Data Hasil Uji Impak Menggunakan Metode *Charpy*



TESTING REPORT

Customer : Dwi Rahayu Address : UNIVERSITAS SULTAN AGENG TIRTAYASA	Total of Page : 1 of 1 Date of Received : December 2, 2024 Date of Tested : December 2, 2024	
Object to be Tested : Sample Location of Performance : PT Detech Profesional Indonesia		
Client's Description of Sample Material Type/Grade : AISI 4140 Material Size : - Heat No. : - Testing Purpose : Material Testing	Sample Marking : -	

Environment Temp : 25 ± 2 °C Type of Test : Charpy Impact Test (Charpy V-Notch) Test Method : ASTM E23-23a		Reference Code : -
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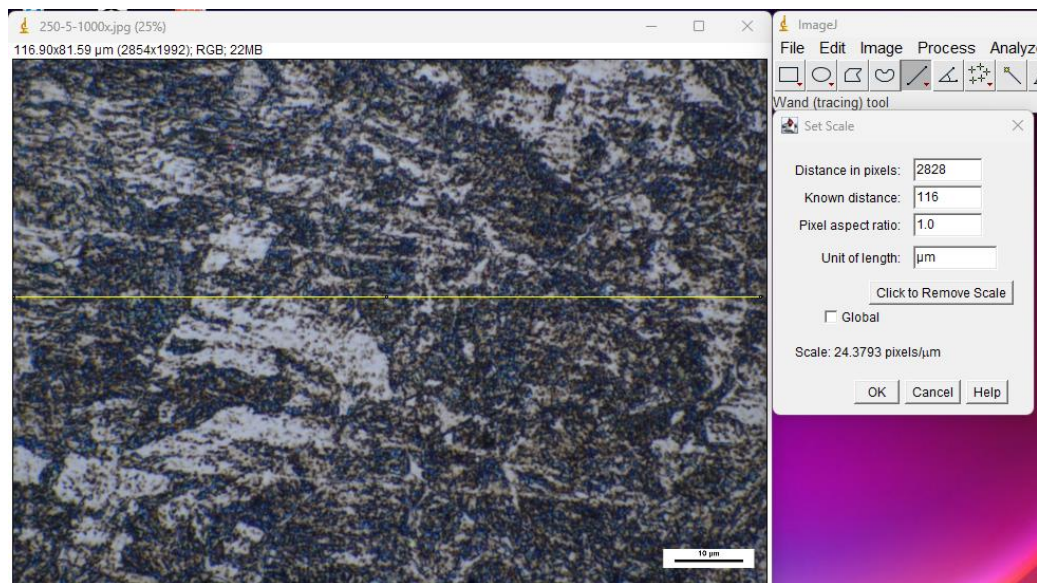
Specimen Size (mm)	Test Temp (°C)	Sample Orientation
2.5 x 10 x 55	25	-

No.	V-Notch Position	Impact Value Specimen (J)	Average (J)	Lateral Expansion (mm)	Remarks
1	Non HT	4.36	-	-	-
2	Partitioning 250°C, 5 menit	13.81	-	-	-
3	Partitioning 250°C, 10 menit	15.53	-	-	-
4	Partitioning 250°C, 15 menit	16.84	-	-	-
5	Partitioning 325°C, 5 menit	16.40	-	-	-
6	Partitioning 325°C, 10 menit	17.71	-	-	-
7	Partitioning 325°C, 15 menit	19.04	-	-	-
8	Partitioning 400°C, 5 menit	15.53	-	-	-
9	Partitioning 400°C, 10 menit	16.84	-	-	-
10	Partitioning 400°C, 15 menit	18.15	-	-	-

Testing Machine Used : Charpy Impact Tester, Model : HT-8041A, S/N : 7472 Remarks : -		
Test Conducted by : Muhammad Baihaqi, S.T Witnessed By : -		

Gambar B.2 Data Hasil Pengujian Impak

3. Menghitung Ukuran Butir dari *Software ImageJ*



Gambar B.3 Ukuran Butir *Software ImageJ*

4. Data Ukuran Butir Struktur Mikro Baja 4140

Tabel B.1 Data Ukuran Butir Struktur Mikro Baja 4140

Sampel	Ukuran Butir (μm)	Rata-rata Ukuran Butir (μm)
QP250-5	2,46	2,35
	2,27	
	2,32	
	2,32	
QP250-10	2,10	2,16
	2,07	
	1,43	
	1,57	
QP250-15	1,64	1,54
	2,85	
	2,23	
	2,85	
QP325-5	2,23	2,64
	2,85	

Tabel B.1 Tabel Lanjutan

Sampel	Ukuran Butir (μm)	Rata-rata Ukuran Butir (μm)
QP325-10	1,54	1,65
	1,77	
	1,66	
QP325-15	1,40	1,38
	1,35	
	1,41	
QP400-5	2,10	1,97
	1,93	
	1,90	
QP400-10	1,49	1,51
	1,57	
	1,47	
QP400-15	1,22	1,23
	1,20	
	1,28	

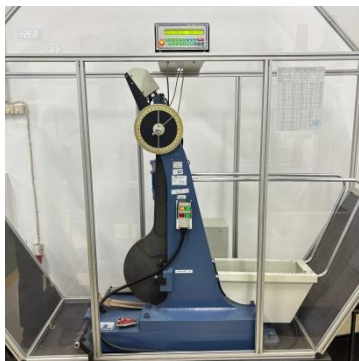
LAMPIRAN C
GAMBAR ALAT DAN BAHAN



Gambar C.1 Air



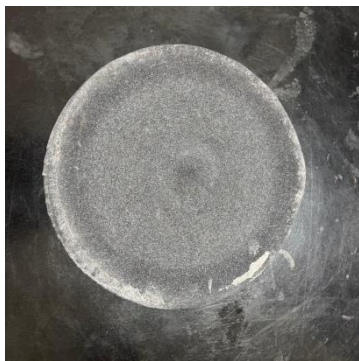
Gambar C.2 Alat Pelindung Diri



Gambar C.3 Alat Uji Impak



Gambar C.4 Alat Uji Kekerasan



Gambar C.5 Ampelas



Gambar C.6 Aquades



Gambar C.7 Baja AISI 4140



Gambar C.8 Ember



Gambar C.9 *Furnace*



Gambar C.10 *Nabertherm Furnace*



Gambar C.11 *Gelas Beker*



Gambar C.12 *Hair Dryer*



Gambar C.13 *Krusibel*



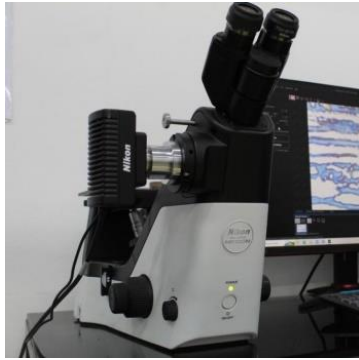
Gambar C.14 *Larutan Asam Nitrat (HNO₃)*



Gambar C.15 *Mesin Grinding dan Polishing*



Gambar C.16 *Metal Polish*



Gambar C.17 Mikroskop Optik



Gambar C.18 Oli



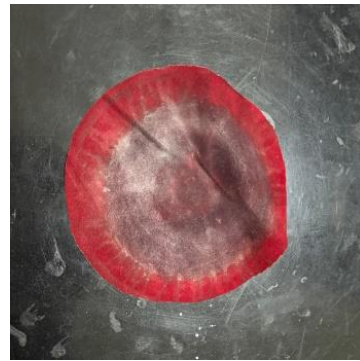
Gambar C.19 Oven



Gambar C.20 Tang Penjepit



Gambar C.21 Thermogun



Gambar C.22 WoolPolish



Gambar C.23 Resin



Gambar C.24 Katalis