

Lampiran 1. Foto Mikro Hasil *Pack Carburizing*

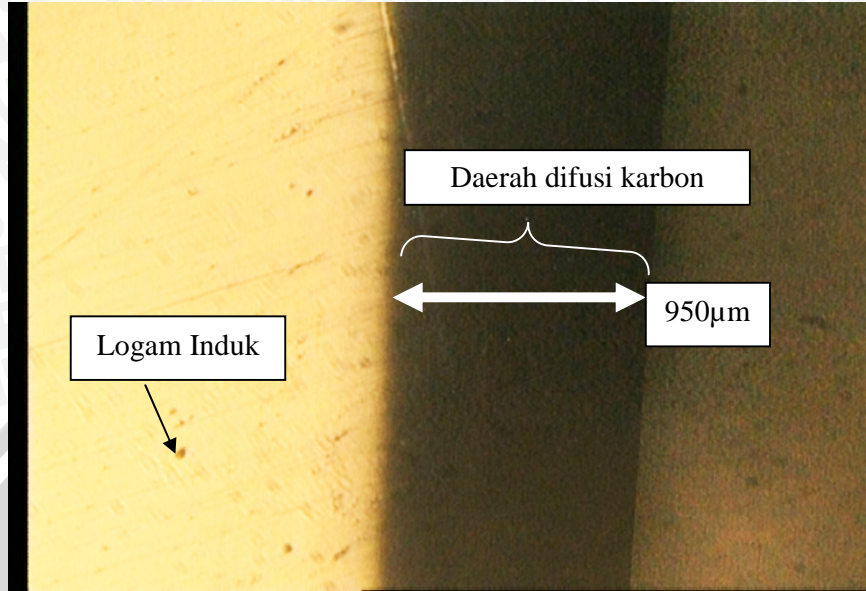


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 560-500µm *quenching* air (Perbesaran 450X)

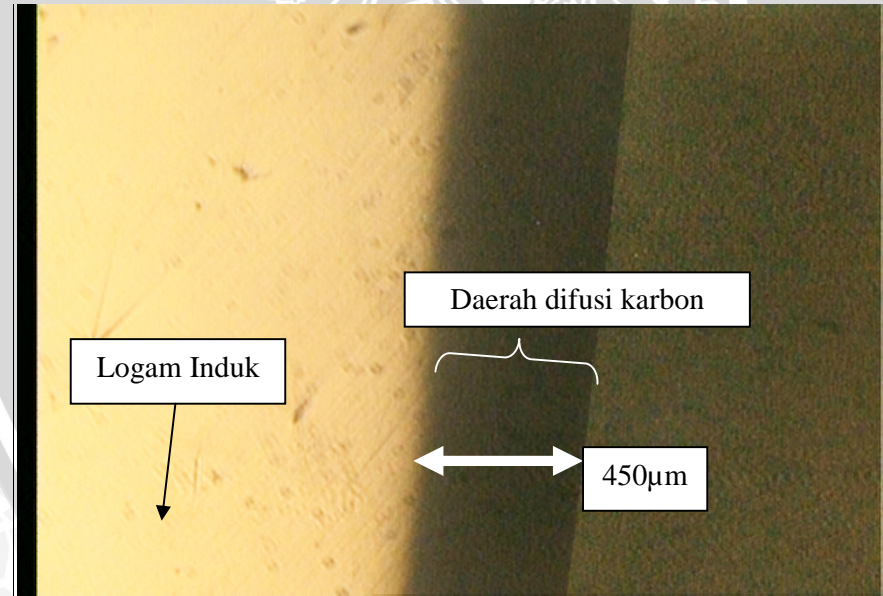


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 560-500µm *quenching* oli SAE 20(Perbesaran 450X)

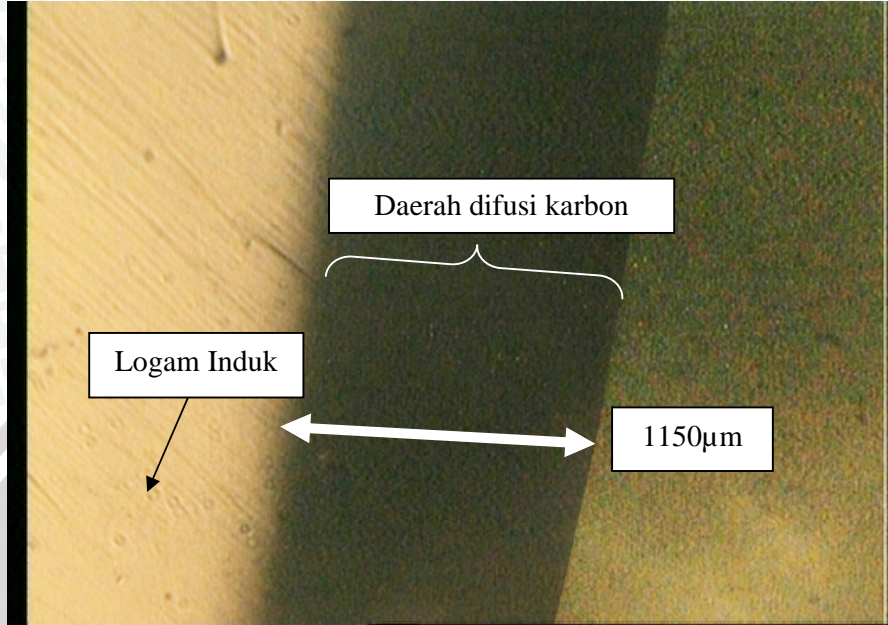


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 280-250µm *quenching* air (Perbesaran 450X)

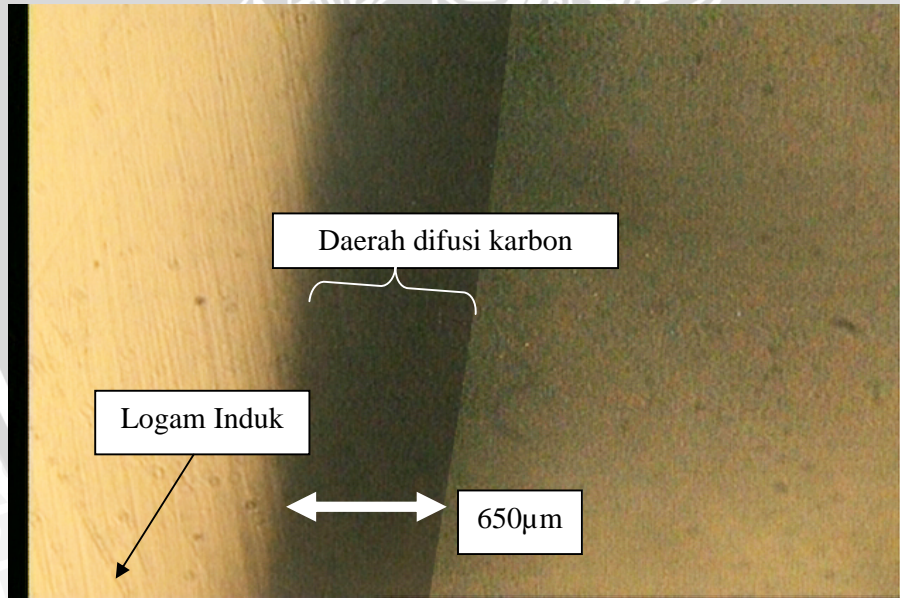


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 280-250µm *quenching* oli SAE 20 (Perbesaran 450X)

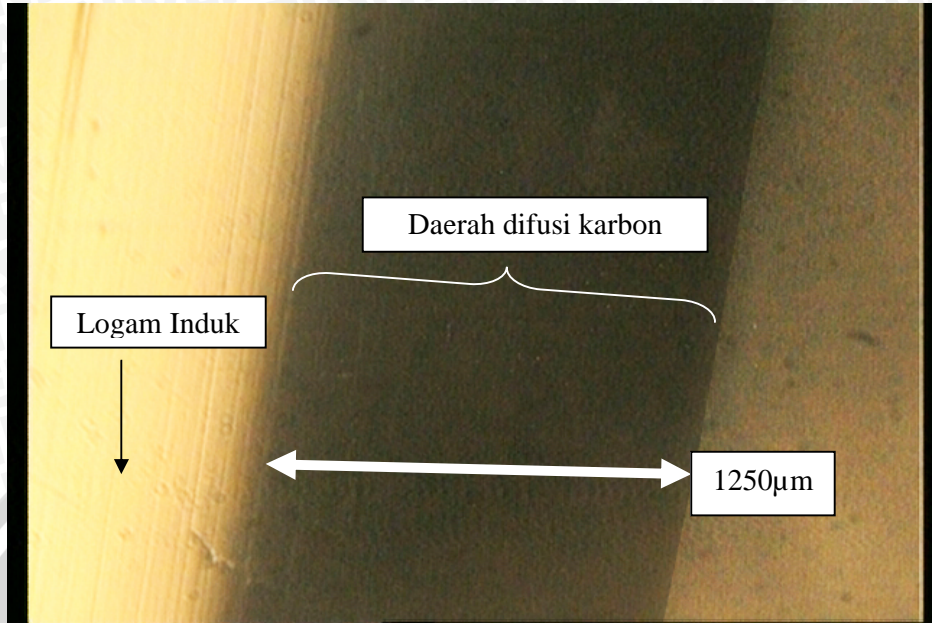


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 125-100µm *quenching* air (Perbesaran 450X)

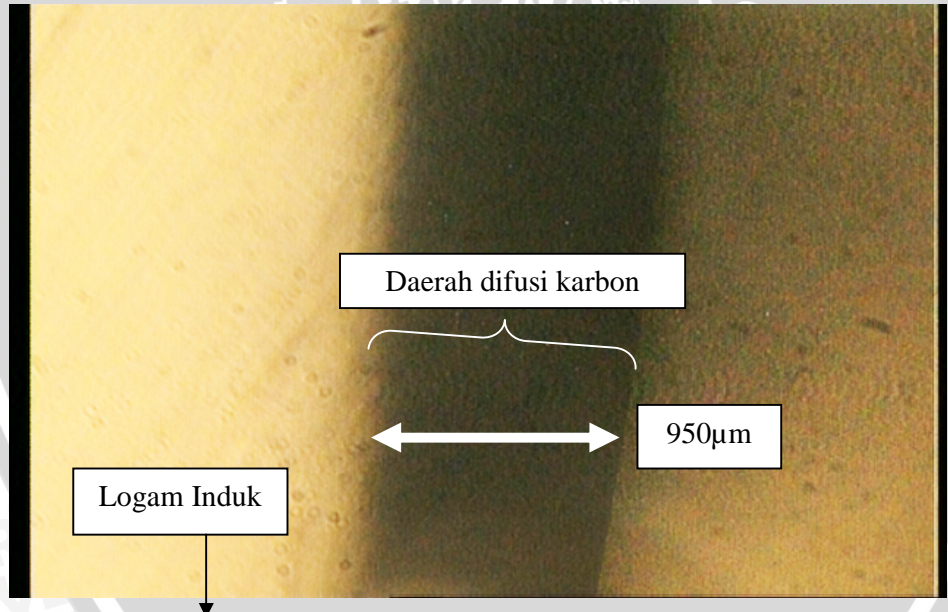


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 125-100µm *quenching* oli SAE 20 (Perbesaran 450X)

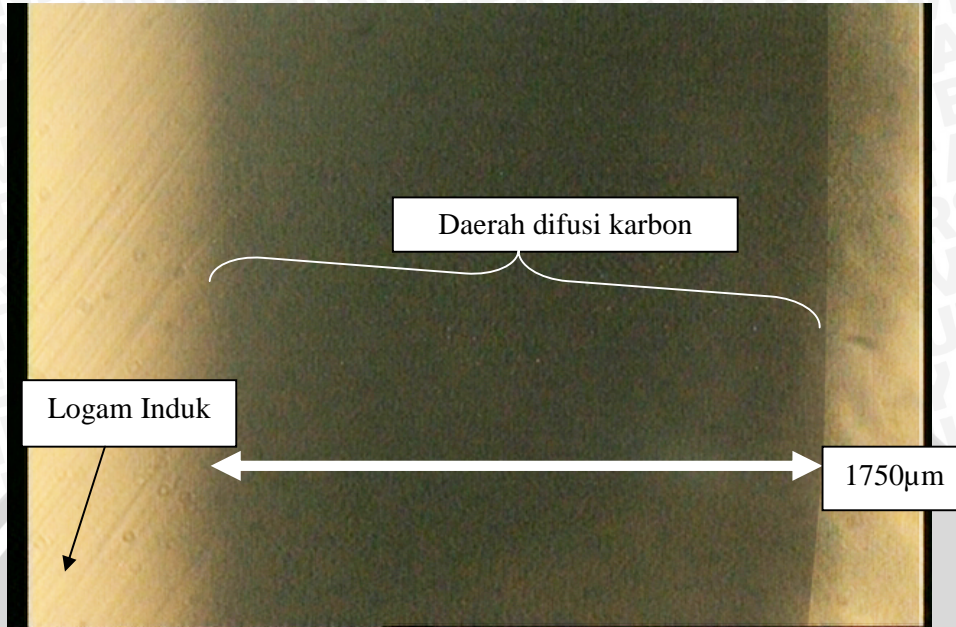


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 90-60µm *quenching* air (Perbesaran 450X)

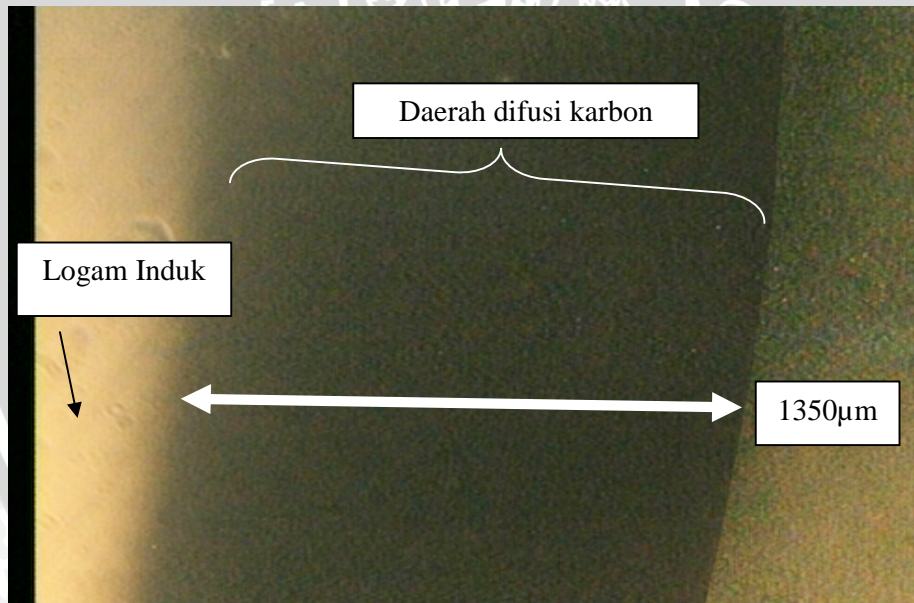


Foto mikro hasil *pack carburizing* dengan ukuran *carburizer* menggunakan *mesh* 90-60µm *quenching* oli SAE 20 (Perbesaran 450X)

Lampiran 2. Data Hasil Uji Komposisi Kimia Karbon Raw Material

| Element | Value |
|---------|--------|
| Int | .18540 |
| C | 0.166 |
| Si | 0.298 |
| Mn | 0.486 |
| P | 0.018 |
| S | 0.007 |
| Cu | 0.271 |
| Ni | 1.481 |
| Cr | 1.514 |
| Mo | 0.019 |
| V | 0.002 |

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 560-500 μ m quenching air

| Element | Value |
|---------|--------|
| Int | .18800 |
| C | 0.885 |
| Si | 0.272 |
| Mn | 0.424 |
| P | 0.017 |
| S | 0.009 |
| Cu | 0.268 |
| Ni | 1.454 |
| Cr | 1.304 |
| Mo | 0.020 |
| V | 0.002 |

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 560-500 μ m quenching oli SAE 20

| Element | Value |
|---------|--------|
| Int | .18540 |
| C | 0.692 |
| Si | 0.298 |
| Mn | 0.480 |
| P | 0.021 |
| S | 0.008 |
| Cu | 0.272 |
| Ni | 1.481 |
| Cr | 1.500 |
| Mo | 0.021 |
| V | 0.002 |

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 280-250 μ m quenching air

```
CONT READY Date 06-21-10 Time 11

Int      .18740
C        0.996
Si       0.267
Mn1     0.491
P        0.020
S        0.009
Cu       0.274
Ni1     1.459
Cr1     1.508
Mo1     0.021
V        0.002

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 20 TAN:6
AG-No.: [L-ALLOY ] ST-No.: [ ] [C SP. H
1:Menu 2:Job 3:Mode0
1:Start 7:Reset 8:-HV
```

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 280-250 μ m quenching oli SAE 20

```
CONT READY Date 06-21-10 Time 11

Int      .18350
C        0.937
Si       0.271
Mn1     0.493
P        0.020
S        0.008
Cu       0.274
Ni1     1.571
Cr1     1.509
Mo1     0.026
V        0.002

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 19 TAN:6
AG-No.: [L-ALLOY ] ST-No.: [ ] [C SP. B
1:Menu 2:Job 3:Mode0
1:Start 7:Reset 8:-HV
```

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 125-100 μ m quenching air

```
CONT READY Date 06-21-10 Time 10

Int      .18560
C        1.069
Si       0.268
Mn1     0.483
P        0.028
S        0.010
Cu       0.278
Ni1     1.528
Cr1     1.507
Mo1     0.023
V        0.002

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 14 TAN:4
AG-No.: [L-ALLOY ] ST-No.: [ ] [C SP. D
1:Menu 2:Job 3:Mode0
1:Start 7:Reset 8:-HV
```

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 125-100 μ m quenching oli SAE 20

```
CONT                                READY Date 06-21-10 Time 10

      N= 1
Int      .18160
C         1.034
Si        0.274
Mn1       0.494
P         0.020
S         0.009
Cu        0.279
Ni1       1.362
Cr1       1.518
Mo1       0.025
V         0.003

      karate indonesia

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 13 TAN:6
AB-No.: [L-ALLOY ] ST-No.: [ ] [ ] SP: C
1:Menu 2:Job 3:Mode0
1:Start                                7:Reset 8:-HV
```

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 90-60 μ m quenching air

```
CONT                                READY Date 06-21-10 Time 10

      N= 1
Int      .18490
C         1.131
Si        0.263
Mn1       0.483
P         0.019
S         0.009
Cu        0.271
Ni1       1.494
Cr1       1.502
Mo1       0.020
V         0.002

      karate indonesia

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 7 TAN:5
AB-No.: [L-ALLOY ] ST-No.: [ ] [ ] SP NO.5
1:Menu 2:Job 3:Mode0
1:Start                                7:Reset 8:-HV
```

Hasil pack carburizing dengan ukuran carburizer menggunakan mesh 90-60 μ m quenching oli SAE 20

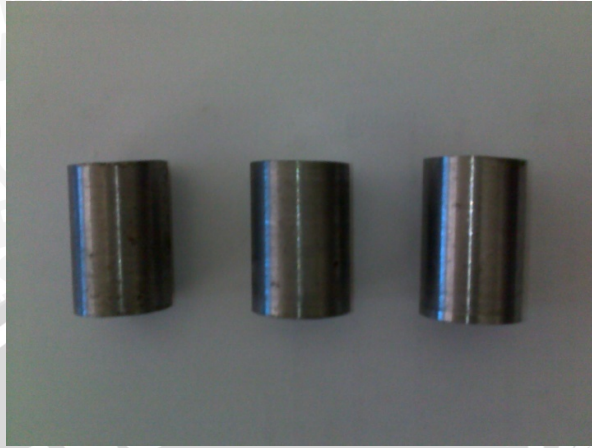
```
CONT                                READY Date 06-21-10 Time 11

      N= 1
Int      .18480
C         1.103
Si        0.270
Mn1       0.484
P         0.029
S         0.009
Cu        0.274
Ni1       1.497
Cr1       1.518
Mo1       0.022
V         0.002

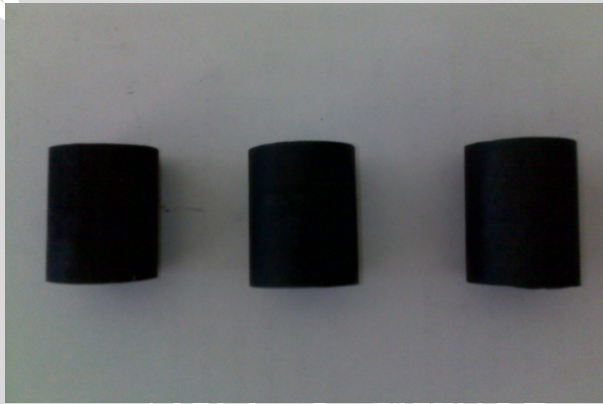
      karate indonesia

Display:1 Print:M2 Trans.-C:M Trans.-P:M File:M      N: 2 AN: 18 TAN:6
AB-No.: [L-ALLOY ] ST-No.: [ ] [ ] SP: F
1:Menu 2:Job 3:Mode0
1:Start                                7:Reset 8:-HV
```

Lampiran 3. Contoh Foto Spesimen



Contoh spesimen *raw materials*



Contoh spesimen yang sudah mengalami proses *pack carburizing*

Lampiran 4. Data Hasil Pengujian kekerasan



INSTITUT TEKNOLOGI NASIONAL MALANG
 FAKULTAS TEKNOLOGI INDUSTRI JURUSAN TEKNIK MESIN
LABORATORIUM PENGUJIAN MATERIAL
 Jl. Raya Karanglo Km. 2 Telp. (0341) 417636 Ext. 511 Malang

Nama : Oktasto Fahlevi
 NIM / Jurusan : 0610823047 / Teknik Mesin
 Hari / Tanggal : 19 Juni 2010
 Micro Vickers Hardness Tester
 Code No. : 810 - 100E
 Serial No. : 555186
 Model : Mituloyo MVK - E3 Akashi Corporation Japan
 Timer : 10 detik
 Beban : 100 gf
 Identor : Diamond 136 °

Raw Material 1

| No | Spesimea | Jarak (μm) | | | | | | | | | |
|----|---------------|-------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Hardening air | 399 | 400 | 401 | 400 | 401 | 400 | 400 | 400 | 401 | 400 |
| 2 | Hardening oli | 323 | 323 | 323 | 321 | 322 | 323 | 324 | 323 | 323 | 323 |

Raw Material 2

| No | Spesimen | Jarak (μm) | | | | | | | | | |
|----|---------------|-------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Hardening air | 397 | 400 | 400 | 401 | 399 | 400 | 400 | 401 | 400 | 403 |
| 2 | Hardening oli | 324 | 321 | 323 | 324 | 323 | 323 | 323 | 323 | 322 | 321 |

Raw Material 3

| No | Spesimen | Jarak (μm) | | | | | | | | | |
|----|---------------|-------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Hardening air | 401 | 403 | 399 | 399 | 399 | 403 | 399 | 397 | 400 | 397 |
| 2 | Hardening oli | 323 | 324 | 322 | 323 | 323 | 323 | 322 | 323 | 323 | 321 |



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Spesimen 1

| No | Spesimen | Jarak (μ m) | | | | | | | | | |
|----|------------------|------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Mesh 560-500 air | 590 | 552 | 501 | 441 | 402 | 399 | 399 | 400 | 402 | 399 |
| 2 | Mesh 280-250 air | 605 | 580 | 527 | 503 | 470 | 411 | 401 | 400 | 398 | 401 |
| 3 | Mesh 125-100 air | 602 | 588 | 533 | 508 | 481 | 415 | 401 | 399 | 401 | 398 |
| 4 | Mesh 90-60 air | 628 | 610 | 548 | 510 | 500 | 472 | 439 | 411 | 399 | 399 |
| 5 | Mesh 560-500 oli | 437 | 408 | 324 | 321 | 323 | 323 | 321 | 323 | 323 | 321 |
| 6 | Mesh 280-250 oli | 474 | 442 | 410 | 324 | 323 | 323 | 324 | 323 | 323 | 323 |
| 7 | Mesh 125-100 oli | 505 | 452 | 421 | 386 | 326 | 323 | 323 | 323 | 323 | 323 |
| 8 | Mesh 90-60 oli | 547 | 521 | 487 | 440 | 411 | 389 | 325 | 323 | 323 | 321 |

Spesimen 2

| No | Spesimen | Jarak (μ m) | | | | | | | | | |
|----|------------------|------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Mesh 560-500 air | 598 | 551 | 499 | 442 | 401 | 398 | 400 | 400 | 401 | 400 |
| 2 | Mesh 280-250 air | 597 | 583 | 532 | 504 | 463 | 409 | 400 | 401 | 398 | 402 |
| 3 | Mesh 125-100 air | 610 | 587 | 531 | 504 | 479 | 414 | 399 | 398 | 400 | 402 |
| 4 | Mesh 90-60 air | 623 | 611 | 540 | 508 | 509 | 471 | 438 | 408 | 403 | 402 |
| 5 | Mesh 560-500 oli | 436 | 410 | 323 | 324 | 323 | 324 | 324 | 321 | 321 | 323 |
| 6 | Mesh 280-250 oli | 476 | 443 | 408 | 324 | 321 | 324 | 321 | 323 | 324 | 324 |
| 7 | Mesh 125-100 oli | 505 | 453 | 420 | 384 | 325 | 323 | 323 | 323 | 324 | 323 |
| 8 | Mesh 90-60 oli | 549 | 519 | 487 | 442 | 409 | 389 | 321 | 324 | 323 | 323 |



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Spesimen 3

| No | Spesimen | Jarak (μ m) | | | | | | | | | |
|----|------------------|------------------|-----|-----|-----|-----|------|------|------|------|------|
| | | 50 | 250 | 450 | 650 | 850 | 1050 | 1250 | 1450 | 1650 | 1850 |
| 1 | Mesh 560-500 air | 593 | 558 | 497 | 449 | 399 | 403 | 401 | 401 | 398 | 400 |
| 2 | Mesh 280-250 air | 607 | 583 | 531 | 502 | 468 | 411 | 399 | 398 | 401 | 398 |
| 3 | Mesh 125-100 air | 612 | 588 | 530 | 506 | 478 | 415 | 400 | 399 | 400 | 400 |
| 4 | Mesh 90-60 air | 624 | 608 | 548 | 504 | 502 | 478 | 439 | 410 | 402 | 403 |
| 5 | Mesh 560-500 oli | 437 | 406 | 323 | 322 | 323 | 322 | 323 | 323 | 324 | 324 |
| 6 | Mesh 280-250 oli | 474 | 443 | 409 | 321 | 324 | 321 | 323 | 321 | 323 | 321 |
| 7 | Mesh 125-100 oli | 504 | 453 | 420 | 387 | 326 | 324 | 324 | 321 | 321 | 322 |
| 8 | Mesh 90-60 oli | 549 | 519 | 488 | 440 | 411 | 388 | 323 | 323 | 324 | 322 |

Malang, 14 Juni 2010
Kepala Laboratorium

Ir. H. Basuki Widodo, MT
NIP. Y : 1018100037

Lampiran 5. Pergeseran Titik Eutectoid

Komposisi kimia baja AISI 3115

| No | Nama Unsur | Simbol | Prosentase Berat (%) |
|----|-------------------|--------|----------------------|
| 1 | <i>Iron</i> | Fe | 95,778 |
| 2 | <i>Carbon</i> | C | 0,166 |
| 3 | <i>Silicon</i> | Si | 0,258 |
| 4 | <i>Manganase</i> | Mn | 0,486 |
| 5 | <i>Phosphorus</i> | P | 0,018 |
| 6 | <i>Sulphur</i> | S | 0,007 |
| 7 | <i>Chromium</i> | Cr | 1,154 |
| 8 | <i>Nickel</i> | Ni | 1,481 |
| 9 | <i>Molybdenum</i> | Mo | 0,019 |
| 10 | <i>Copper</i> | Cu | 0,271 |
| 11 | <i>Vanadium</i> | V | 0,002 |

Pergeseran Titik Eutectoid pada baja AISI 3115

| No | Unsur Paduan | Komposisi (%) | Suhu Eutectoid (°C) | Komposisi Eutectoid(%) |
|----|--------------|---------------|---------------------|------------------------|
| 1 | Si | 0,258 | 725 | 0,7 |
| 2 | Mn | 0,486 | 710 | 0,72 |
| 3 | Cr | 1,154 | 748 | 0,67 |
| 4 | Ni | 1,481 | 700 | 0,75 |
| 5 | Mo | 0,019 | 726 | 0,75 |

Pengaruh Unsur Paduan terhadap Suhu dan Komposisi Eutectoid

- Temperatur *Eutectoid*

$$TC = \frac{\sum_{C=A}^{\infty} (TCx\%C)}{\sum_{C=A}^{\infty} \%C}$$

$$= \frac{(725 \times 0,7) + (710 \times 0,72) + (748 \times 0,67) + (700 \times 0,75) + (726 \times 0,75)}{(0,7 + 0,72 + 0,67 + 0,75 + 0,75)}$$

$$= \frac{2589,36}{3,59}$$

$$= 721,27 \text{ } ^\circ\text{C}$$

- Komposisi *Eutectoid*

$$\%C = \frac{\sum_{C=A}^{\infty} (TCx\%C)}{\sum_{C=A}^{\infty} TC}$$

$$= \frac{(725 \times 0,7) + (710 \times 0,72) + (748 \times 0,67) + (700 \times 0,75) + (726 \times 0,75)}{(725 + 710 + 748 + 700 + 726)}$$

$$= \frac{2589,36}{3609}$$

$$= 0,71 \%$$

Pergeseran Titik Eutectoid

