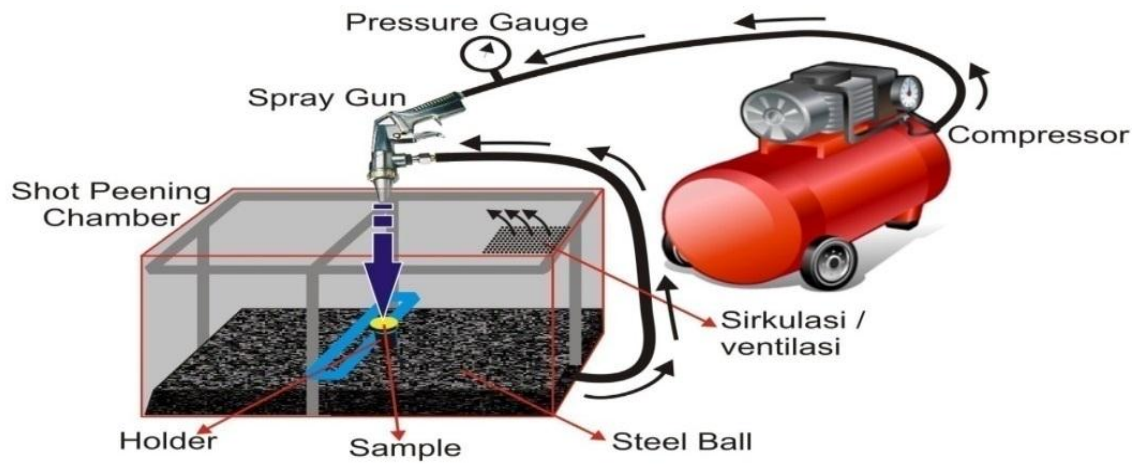


LAMPIRAN

Lampiran 1 : Skema alat *shot peening*

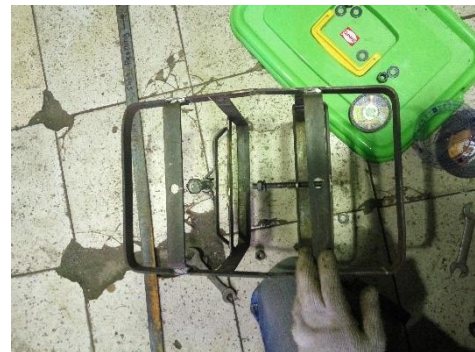


Gambar 1 : Skema Proses Perlakuan *Shot Peening*

Lampiran 2 : Proses Modifikasi Alat *Shot peening*



Proses pembuatan rangka *shot peening*



Rangka box *shot peening*



Box *shot peening* siap digunakan

Lampiran 3 : proses *shot peening*



Proses mengubah ukuran sudut holder box shot peening



Proses pemasangan sampel dalam box *shot peening*



Sampel setelah perlakuan *shot peening*



Proses perlakuan *shot peening*

Lampiran 4 : Alat pengujian**Gambar 2 Alat Uji struktur mikro****Gambar 3 Alat pengujian ketebalan**



Gambar 4 Alat pengujian kekasaran

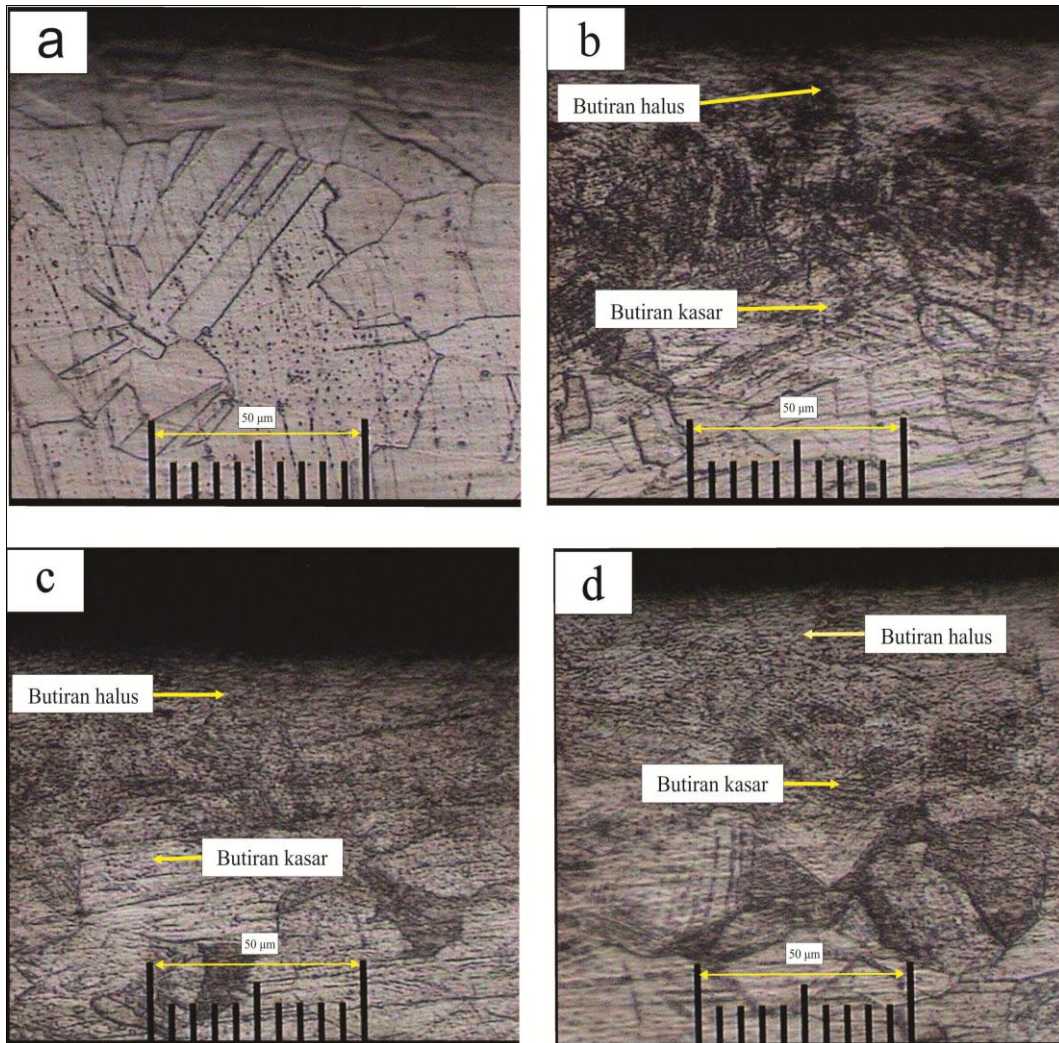


Gambar 5 Alat pengujian kekerasan



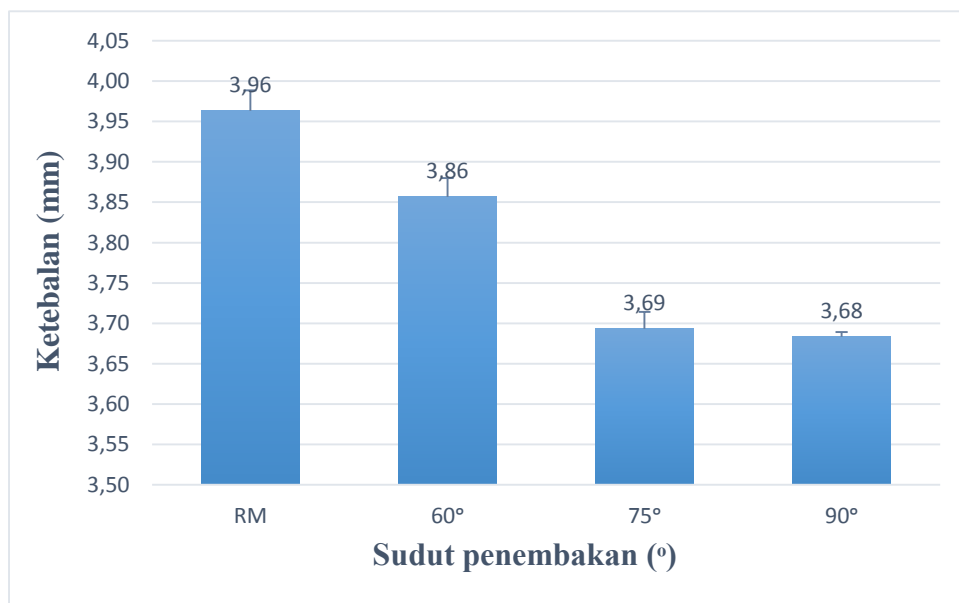
Gambar 6 Alat pengujian laju korosi

Lampiran 5 Hasil *shot peening***Raw material****Variasi 60°****Variasi 75°****Variasi 90°**

Lampiran 6 Hasil pengujian struktur mikro

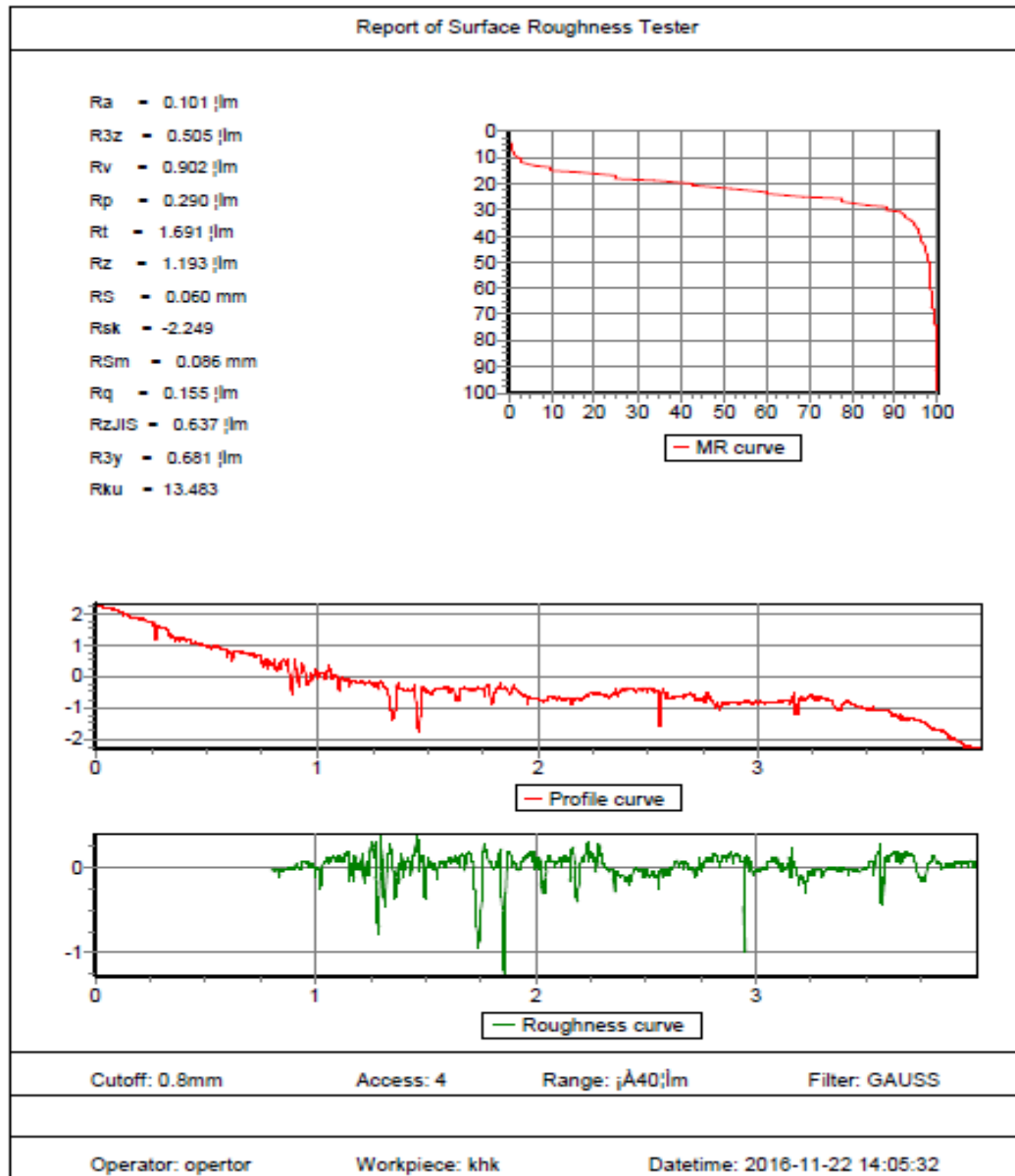
Lampiran 7 Hasil Pengujian ketebalan sampel

Variasi	Titik 1	Titik 2	Titik 3	Rata-rata	Simpangan
RM	3.96	3.99	3.94	3.96	0.03
60°	3.87	3.83	3.87	3.86	0.023
75°	3.71	3.70	3.67	3.69	0.021
90°	3.68	3.69	3.68	3.68	0.006

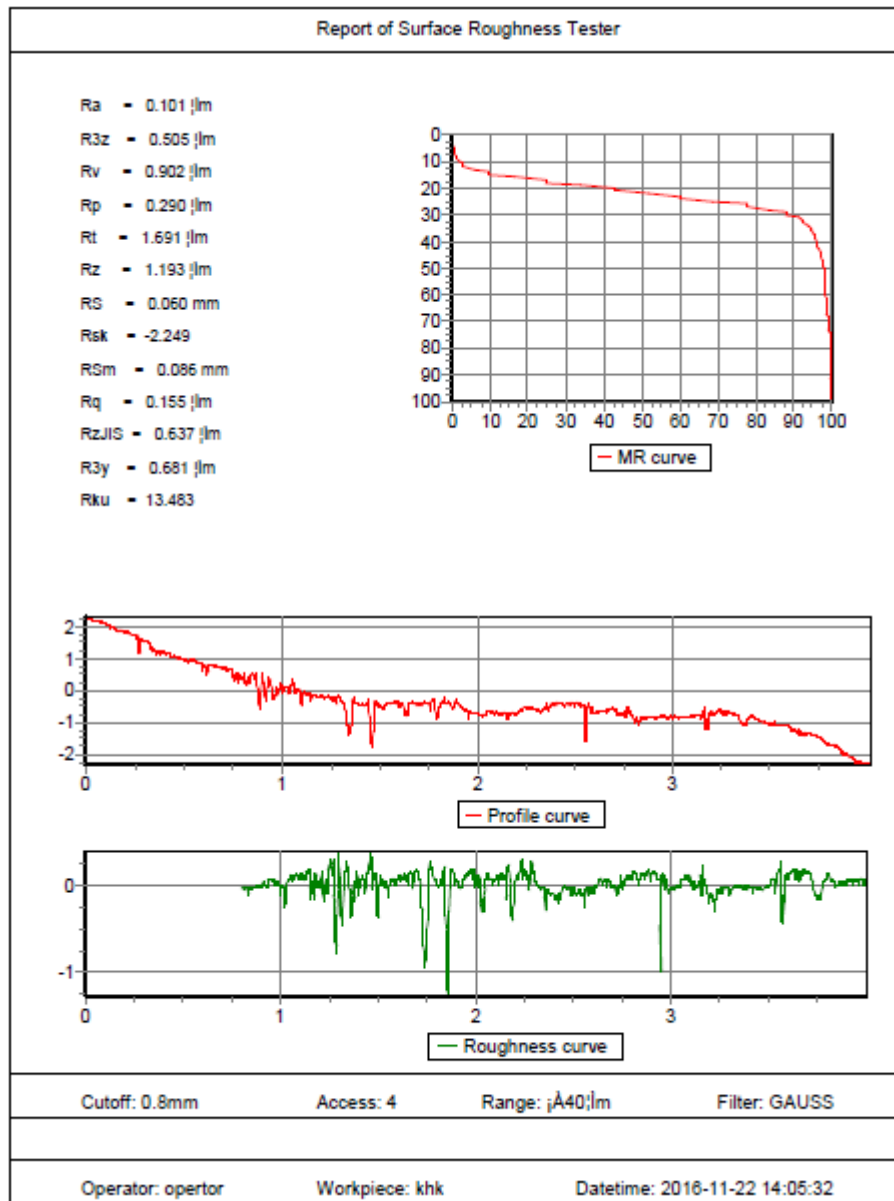


Grafik ketebalan sampel

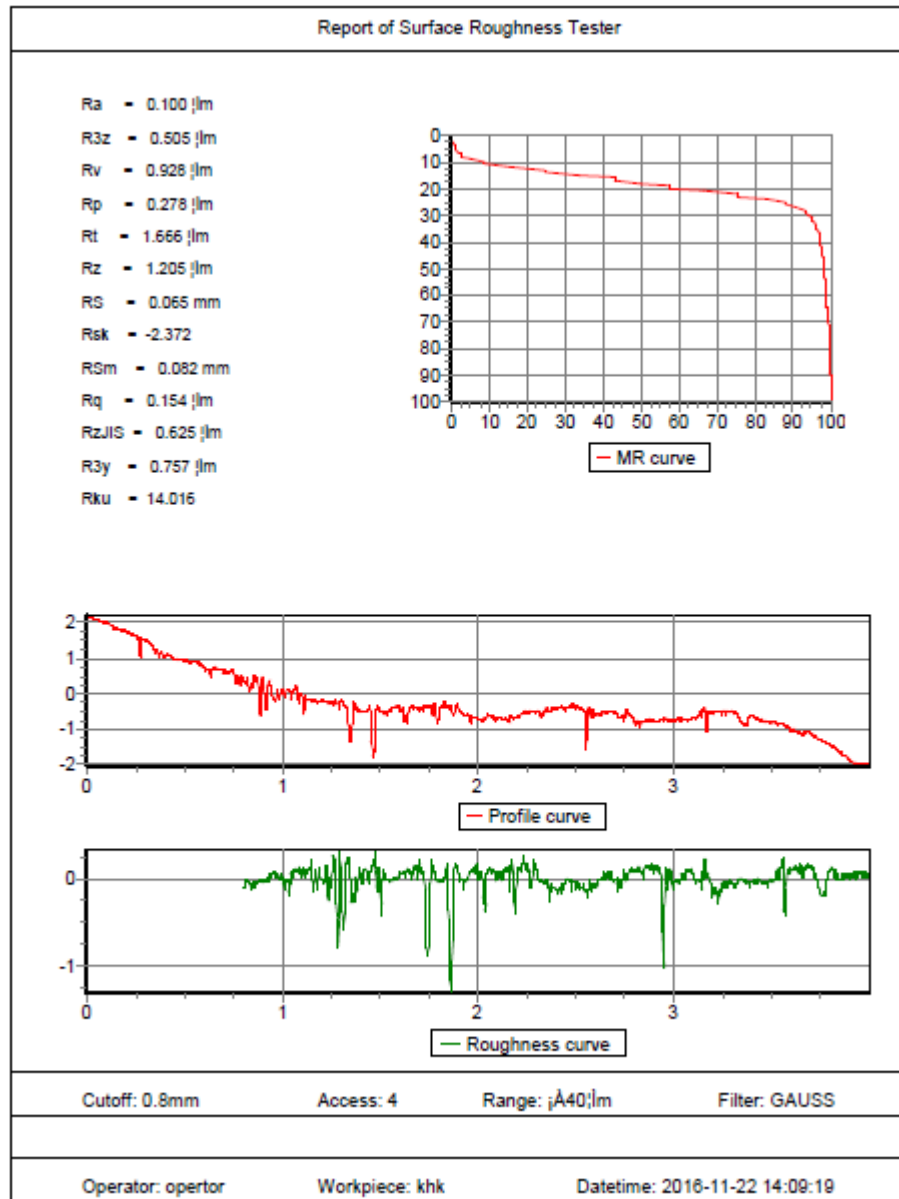
Lampiran 8 Hasil pengujian kekasaran



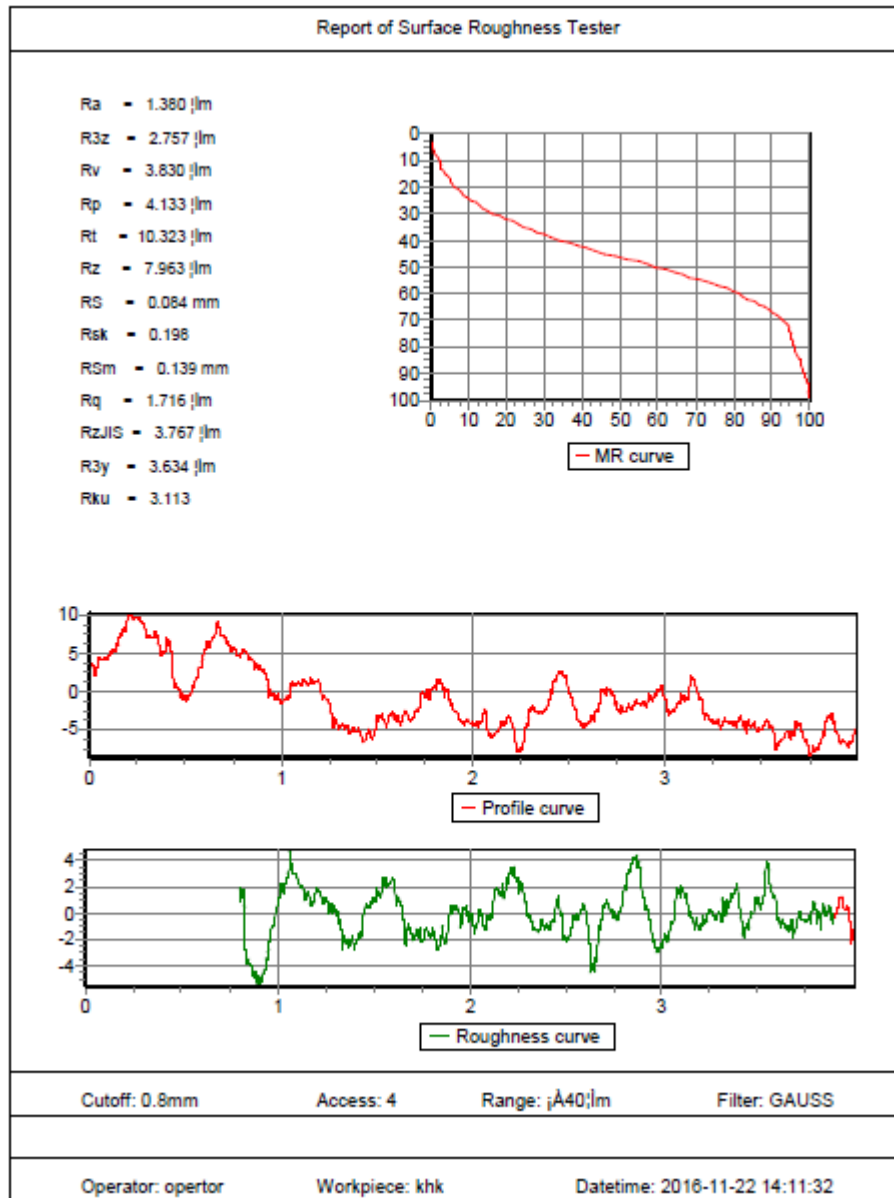
Gambar 1. Hasil pengujian Kekasaran *raw material* sampel *stainless steel* AISI 304.



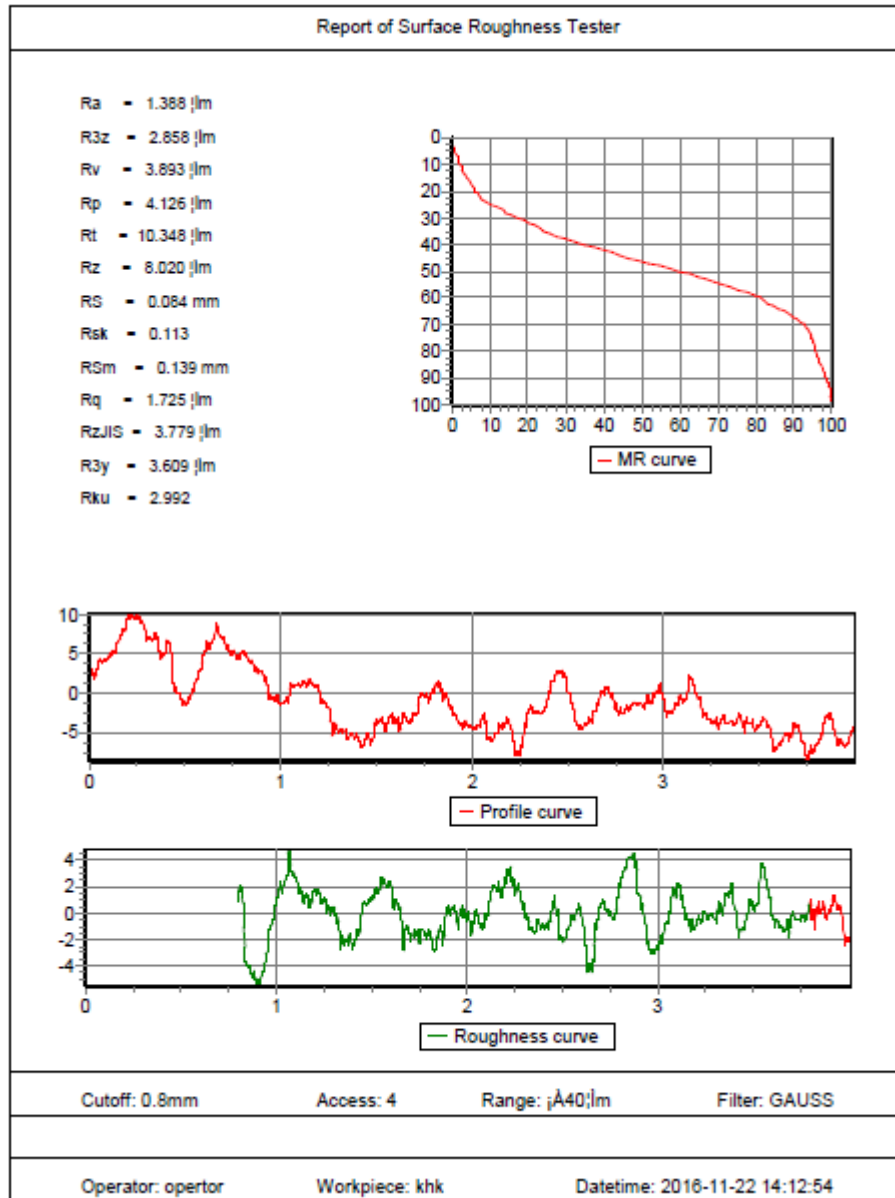
Gambar 2. Hasil pengujian Kekasaran *raw material* sampel *stainless steel* AISI 304.



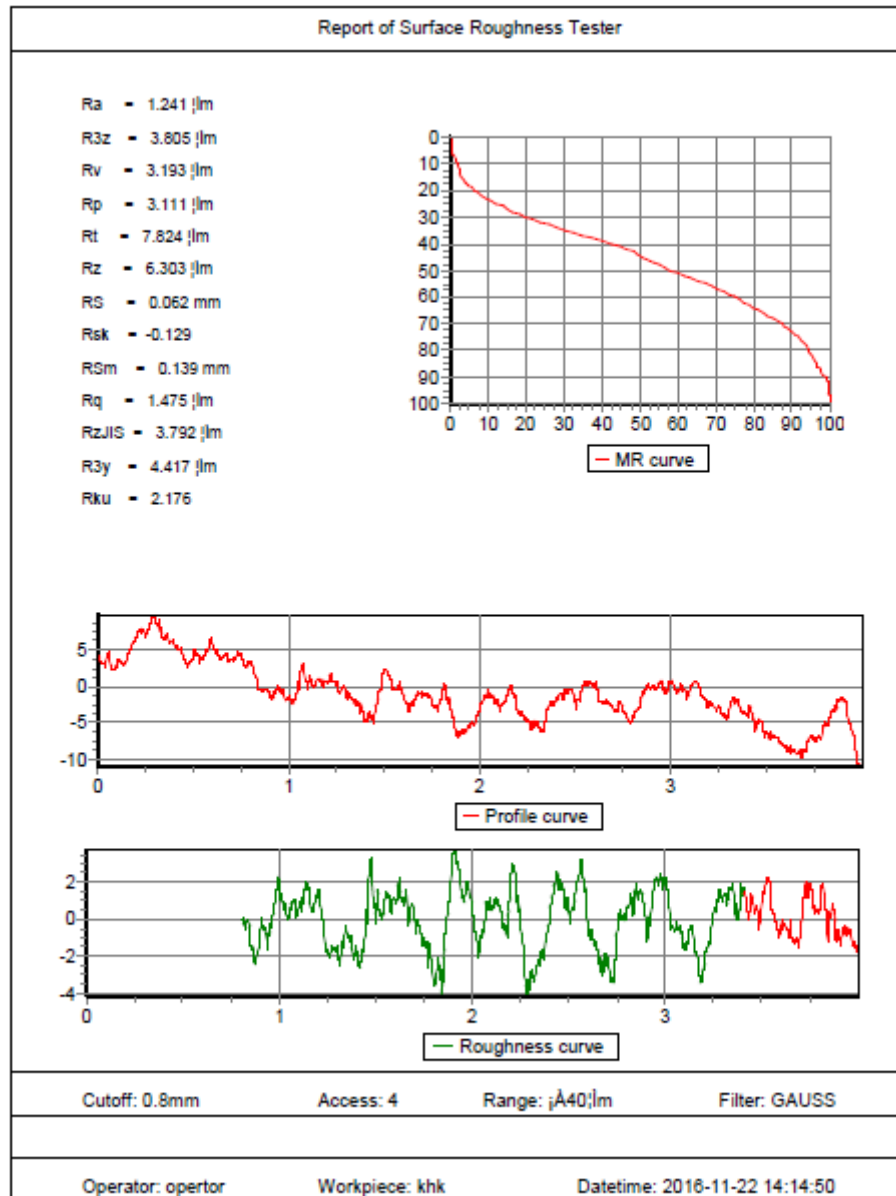
Gambar 3. Hasil pengujian Kekasaran *raw material* sampel *stainless steel* AISI 304.



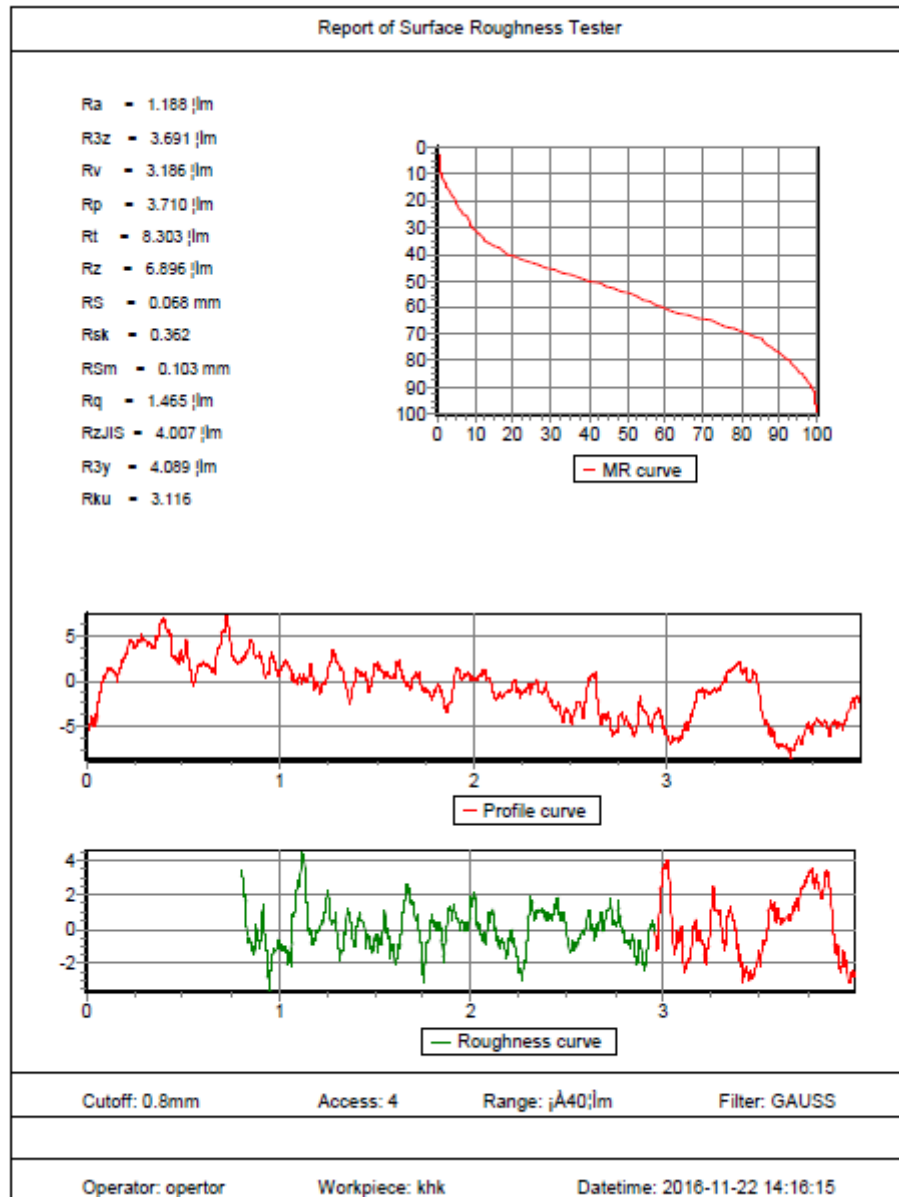
Gambar 4. Hasil pengujian Kekasaran sudut 60° sampel *stainless steel* AISI 304.



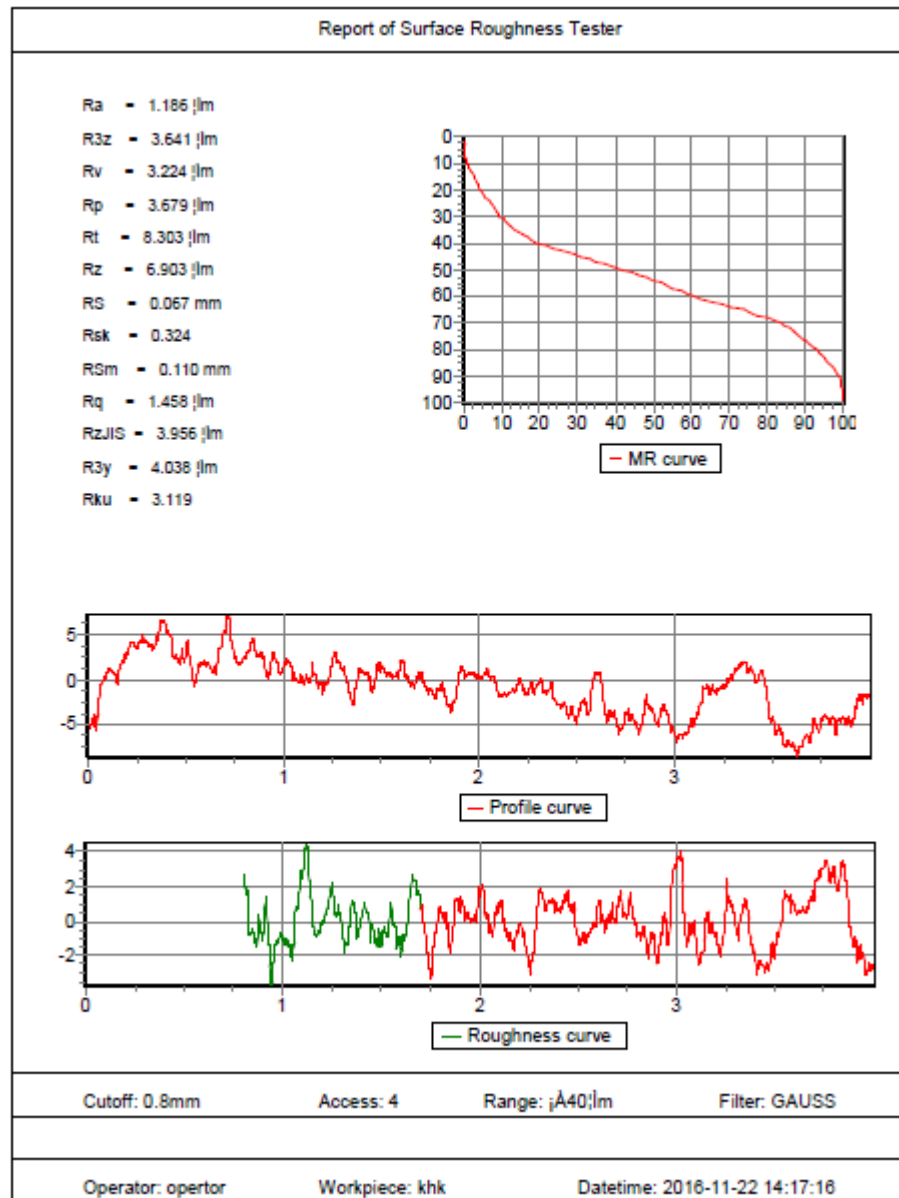
Gambar 5. Hasil pengujian Kekasaran sudut 60° sampel *stainless steel* AISI 304.



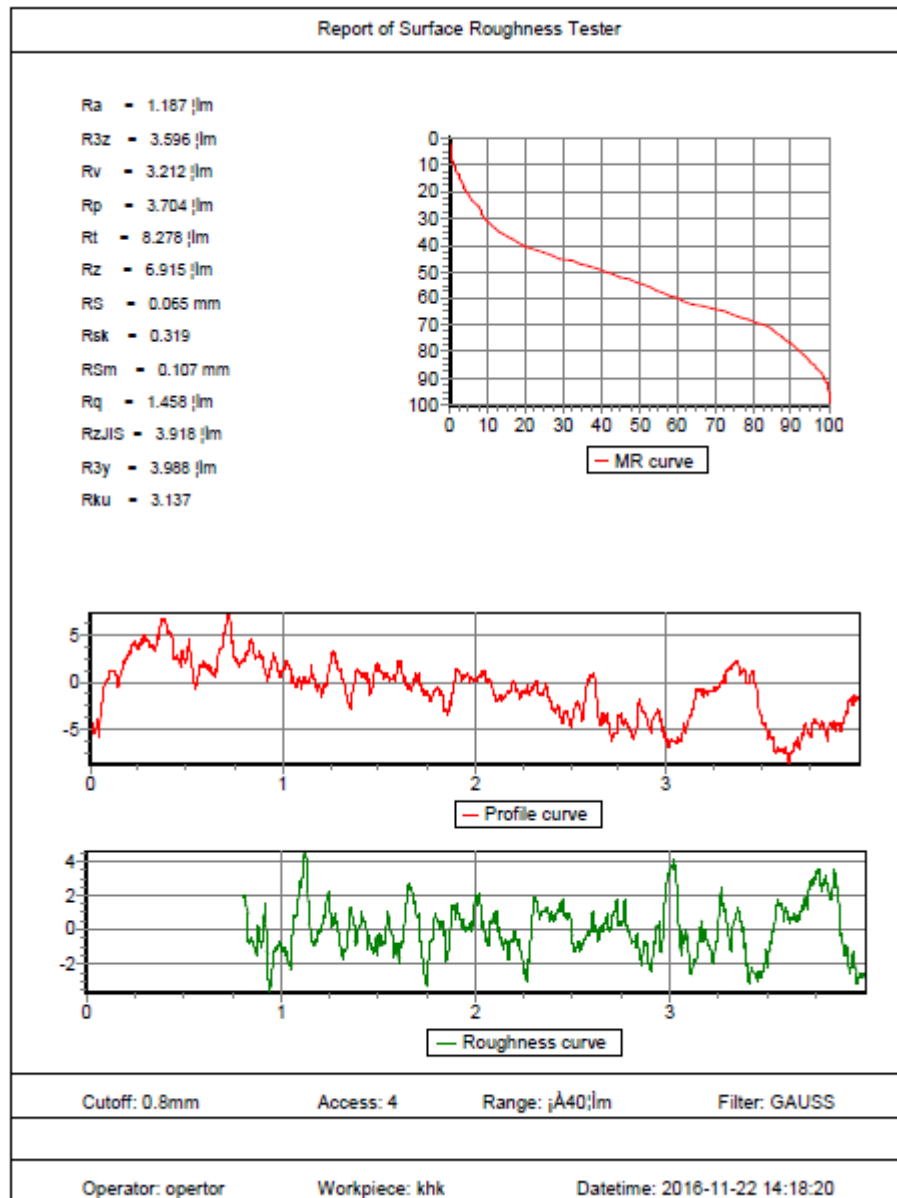
Gambar 6. Hasil pengujian Kekasaran sudut 60° sampel *stainless steel* AISI 304.



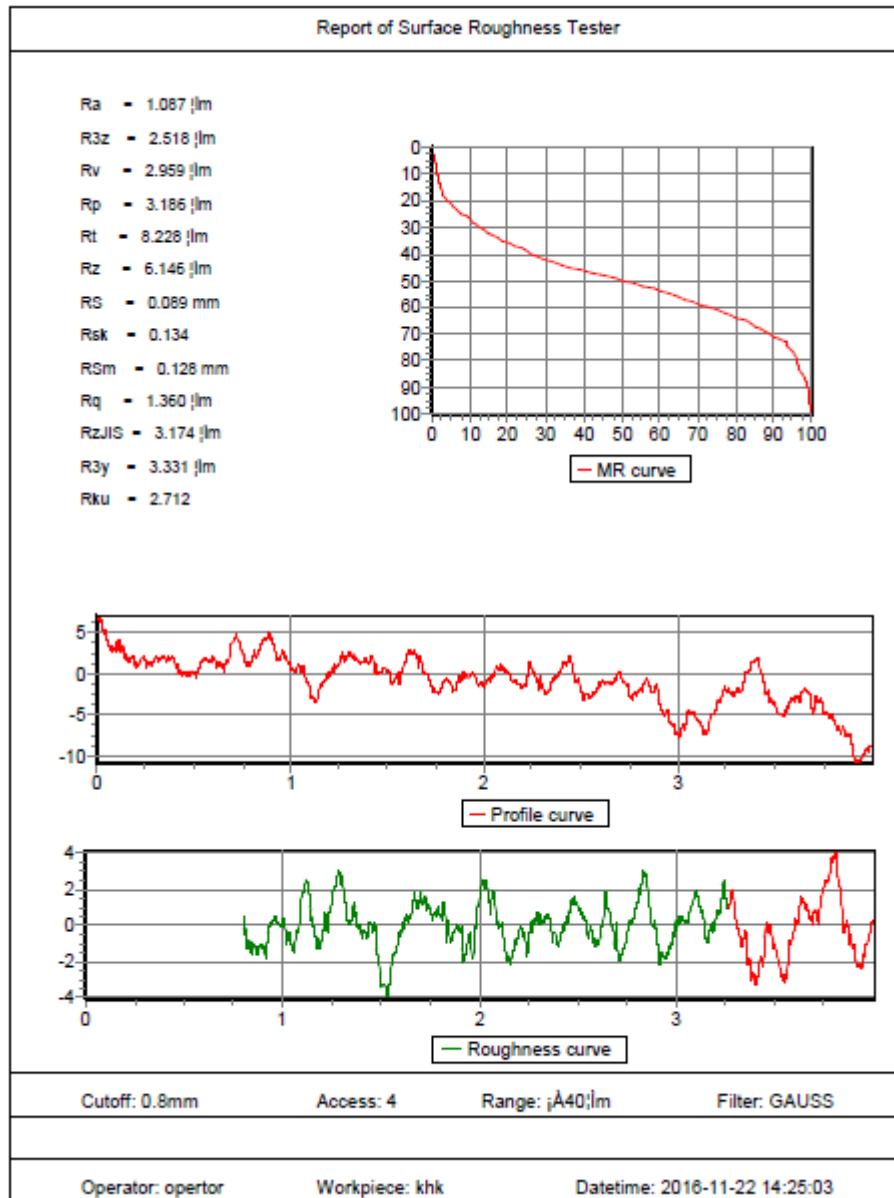
Gambar 7. Hasil pengujian Kekasaran sudut 75° sampel *stainless steel* AISI 304.



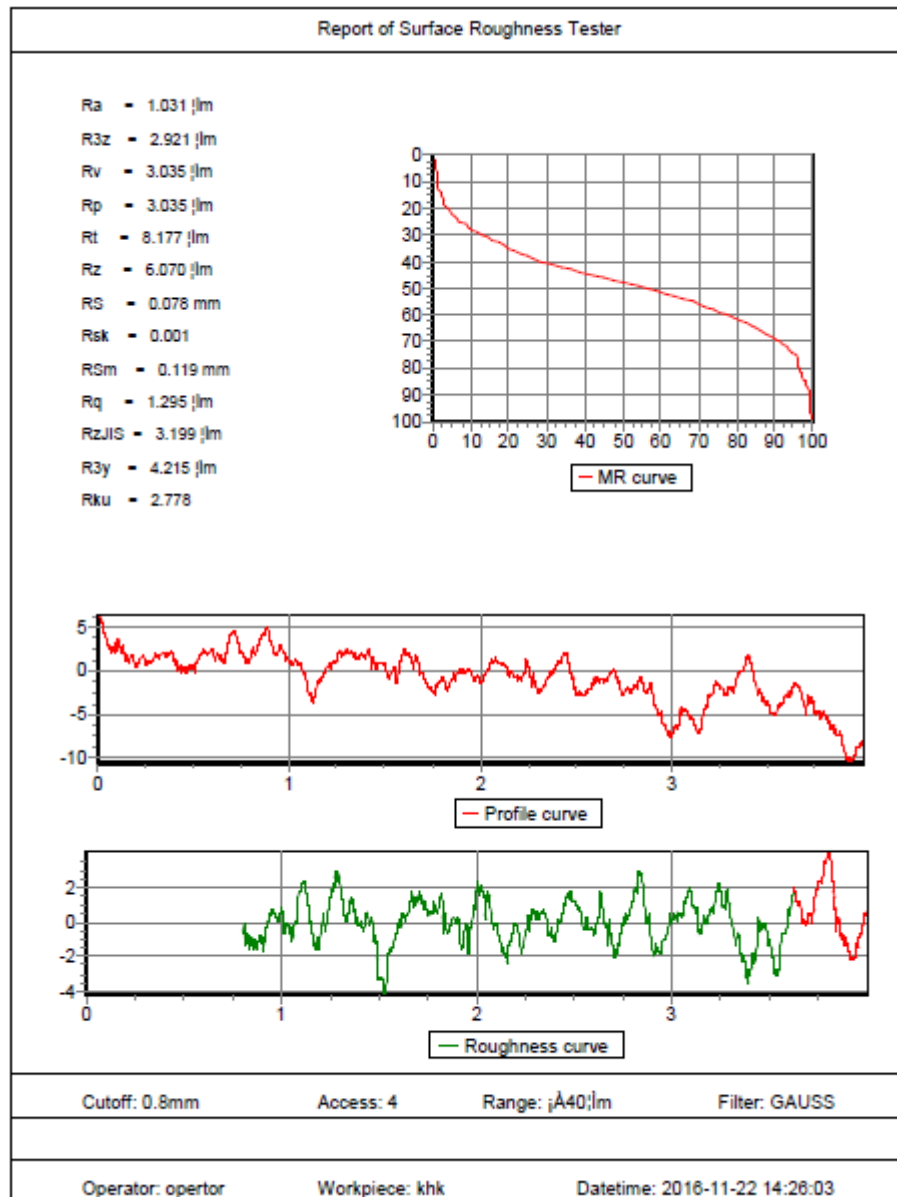
Gambar 8. Hasil pengujian Kekasaran sudut 75° sampel *stainless steel* AISI 304.



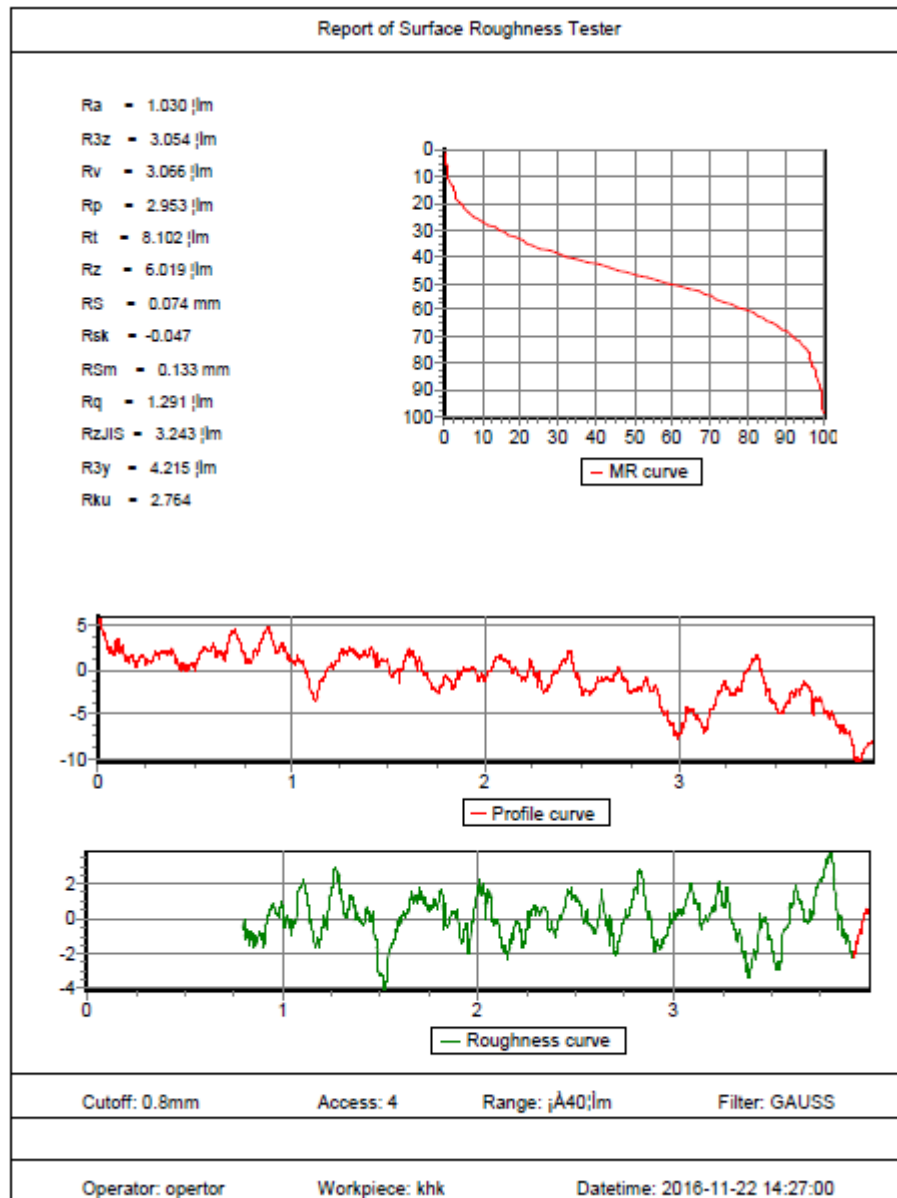
Gambar 9. Hasil pengujian Kekasaran sudut 75° sampel *stainless steel* AISI 304.



Gambar 10. Hasil pengujian Kekasaran sudut 90° sampel *stainless steel* AISI 304.



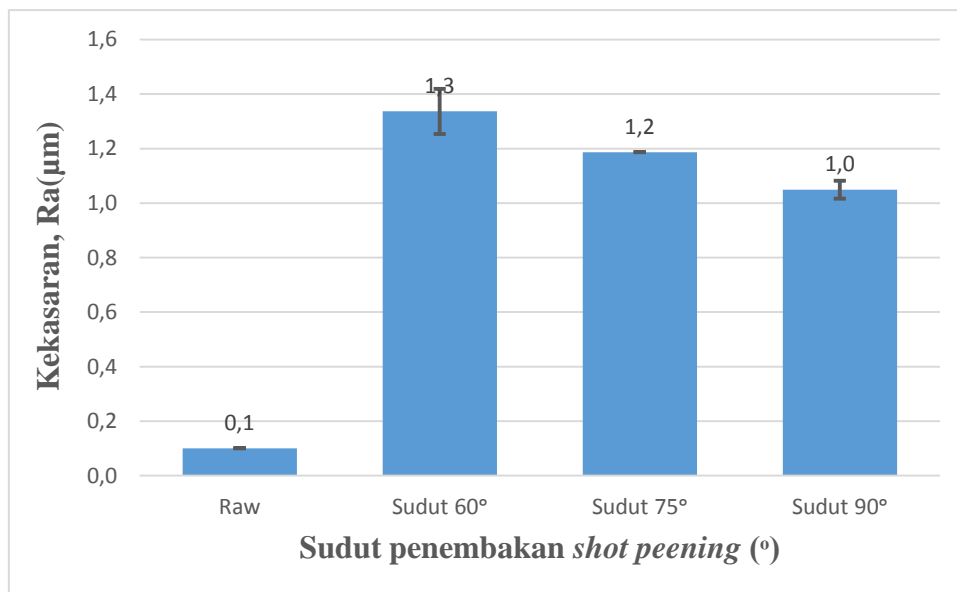
Gambar 11. Hasil pengujian Kekasaran sudut 90° sampel *stainless steel* AISI 304.



Gambar 12. Hasil pengujian Kekasaran sudut 90° sampel *stainless steel* AISI 304.

Hasil perhitungan pengujian kekasaran

Kode	Variasi (°)	Rata-rata Ra (μm)
RM	0	0.1
Sudut 60°	60	1.3
Sudut 75°	75	1.2
Sudut 90°	90	1



Grafik kekasaran

Data Pengujian Kekasaran


Kode	sampel	Durasi (menit)	Variasi (°)	Tekanan (bar)	Ra (μm)	Rq (μm)	Rz (μm)
RM	1	0	0	6	0.101	0.155	1.193
	2	0	0	6	0.101	0.155	1.193
	3	0	0	6	0.1	0.154	1.205
	Average				0.101	0.155	1.197

Kode	sampel	Durasi (menit)	Variasi (°)	Tekanan (bar)	Ra (μm)	Rq (μm)	Rz (μm)
Sudut 60°	1	10	60	6	1.38	1.716	7.963
	2	10	60	6	1.38	1.725	8.02
	3	10	60	6	1.24	1.475	6.303
	Average				1.33	1.639	7.429

Kode	sampel	Durasi (menit)	Variasi (°)	Tekanan (bar)	Ra (μm)	Rq (μm)	Rz (μm)
Sudut 75°	1	10	75	6	1.18	1.465	6.896
	2	10	75	6	1.18	1.458	6.903
	3	10	75	6	1.18	1.458	6.915
	Average				1.180	1.46	6.905

Kode	sampel	Durasi (menit)	Variasi (°)	Tekanan (bar)	Ra (μm)	Rq (μm)	Rz (μm)
Sudut 90°	1	10	90	6	1.08	1.36	6.145
	2	10	90	6	1.03	1.295	6.07
	3	10	90	6	1.3	1.291	6.019
	Average				1.137	1.315	6.078

Lampiran 9 Hasil Pengujian Kekerasan


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Bagian Permukaan

No	Variasi Spesimen	d ₁	d ₂	d _{rata-rata}	Kekerasan (VHN)
1	Raw	40.0	40.0	40.0	231.8
2		40.0	40.5	40.3	228.9
3		40.5	40.0	40.3	228.9
4	Sudut 60° (A)	30.0	30.0	30.0	412.1
5		30.5	30.0	30.3	405.3
6		29.5	30.5	30.0	412.1
7	Sudut 60° (B)	28.0	29.5	28.8	448.7
8		30.0	30.0	30.0	412.1
9		30.0	30.5	30.3	405.3
10	Sudut 75° (A)	24.0	25.0	24.5	617.9
11		25.0	24.5	24.8	605.5
12		26.5	25.0	25.8	559.3
13	Sudut 75° (B)	24.0	24.5	24.3	630.7
14		25.0	24.5	24.8	605.5
15		25.0	24.0	24.5	617.9
16	Sudut 90° (A)	25.0	24.0	24.5	617.9
17		24.0	24.5	24.3	630.7
18		24.0	24.5	24.3	630.7
19	Sudut 90° (B)	25.0	24.5	24.8	605.5
20		24.0	24.5	24.3	630.7
21		24.5	24.0	24.3	630.7

Lembar asli, tidak untuk digandakan

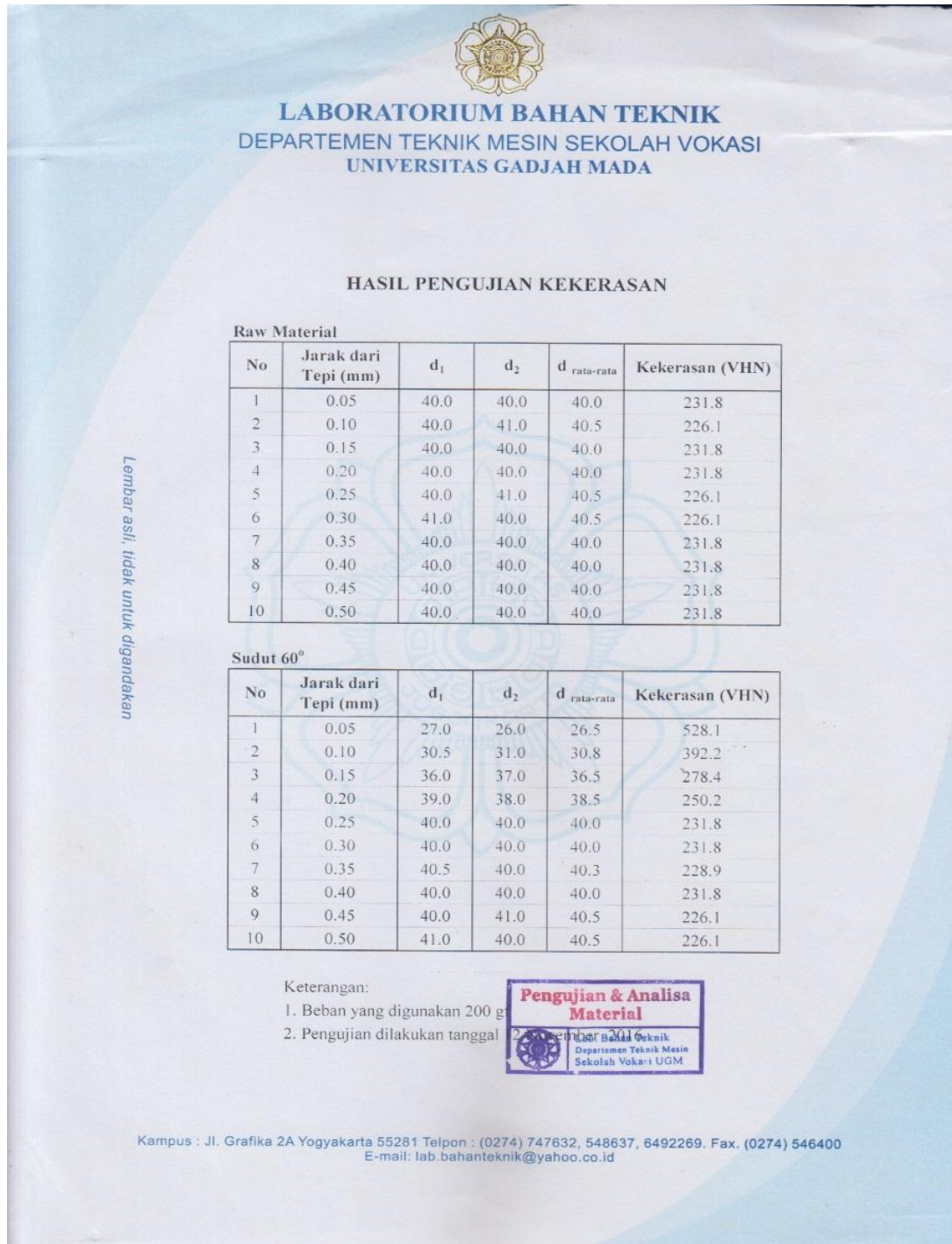
Keterangan:

1. Beban yang digunakan 200 g
2. Pengujian dilakukan tanggal 29 Oktober 2016



Kampus : Jl. Grafika 2A Yogyakarta 55281 Telpn : (0274) 747632, 548637, 6492269. Fax. (0274) 546400
 E-mail: lab.bahanteknik@yahoo.co.id

Gambar 1. Hasil pengujian kekerasan permukaan sampel *stainless steel* AISI 304 *shot peening raw material*, sudut 60°, 75°, dan 90°



Gambar 2 Hasil pengujian distribusi kekerasan sampel *stainless steel* AISI 304 *shot peening raw material* dan variasi sudut 60°



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Sudut 75°

No	Jarak dari Tepi (mm)	d ₁	d ₂	d _{rata-rata}	Kekerasan (VHN)
1	0.05	28.0	29.0	28.5	456.6
2	0.10	35.5	35.0	35.3	298.5
3	0.15	37.5	38.0	37.8	260.3
4	0.20	40.0	40.0	40.0	231.8
5	0.25	40.0	40.5	40.3	228.9
6	0.30	40.0	40.0	40.0	231.8
7	0.35	40.0	41.0	40.5	226.1
8	0.40	41.0	41.0	41.0	220.6
9	0.45	40.0	40.0	40.0	231.8
10	0.50	40.0	41.0	40.5	226.1

Sudut 90°

No	Jarak dari Tepi (mm)	d ₁	d ₂	d _{rata-rata}	Kekerasan (VHN)
1	0.05	25.5	26.0	25.8	559.3
2	0.10	27.0	27.5	27.3	499.5
3	0.15	33.0	31.0	32.0	362.2
4	0.20	35.0	40.0	37.5	263.7
5	0.25	40.0	40.0	40.0	231.8
6	0.30	40.0	40.0	40.0	231.8
7	0.35	41.0	40.5	40.8	223.3
8	0.40	40.0	41.0	40.5	226.1
9	0.45	40.0	40.0	40.0	231.8
10	0.50	40.0	40.0	40.0	231.8

Keterangan:

1. Beban yang digunakan 200 g
2. Pengujian dilakukan tanggal

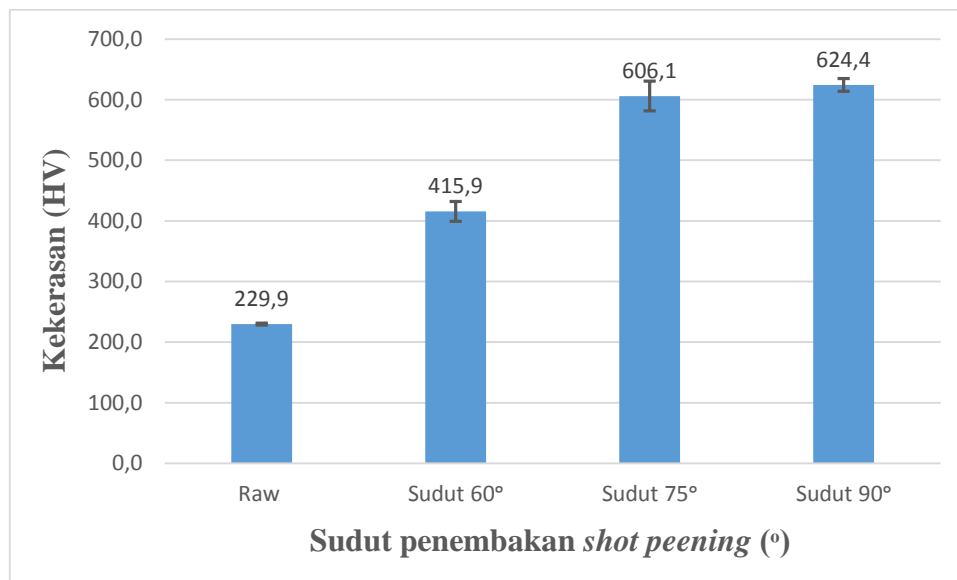


Lembar asli, tidak untuk digandakan

Gambar 2.1 Hasil pengujian distribusi kekerasan sampel *stainless steel* AISI 304 *shot peening raw* variasi sudut 75° dan 90°

Tabel nilai rata-rata kekerasan permukaan

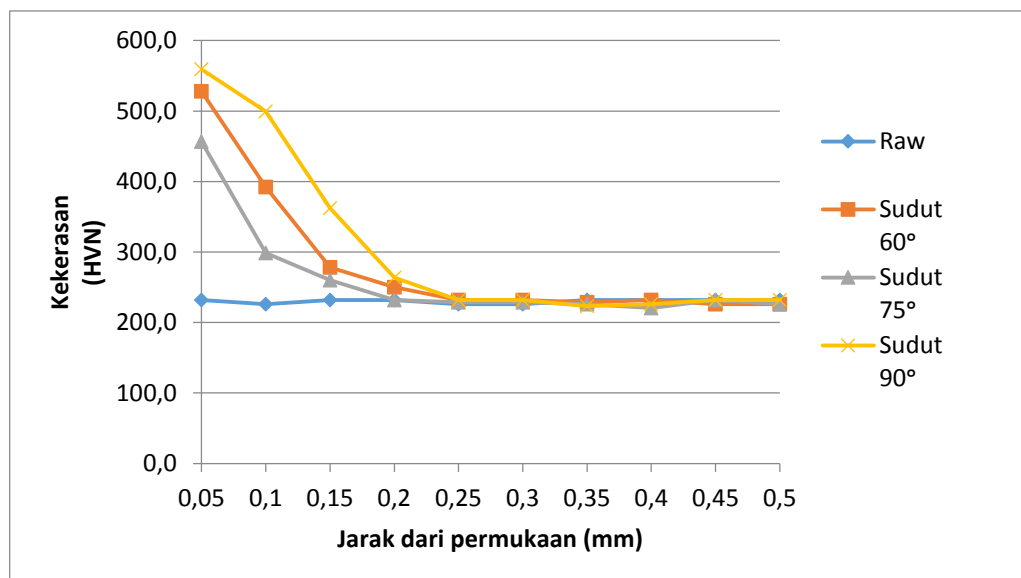
Spesimen	Variasi	Kekerasan (VHN)
Raw	0	229.9
Sudut 60°	60	415.9
Sudut 75°	75	606.1
Sudut 90°	90	624.3



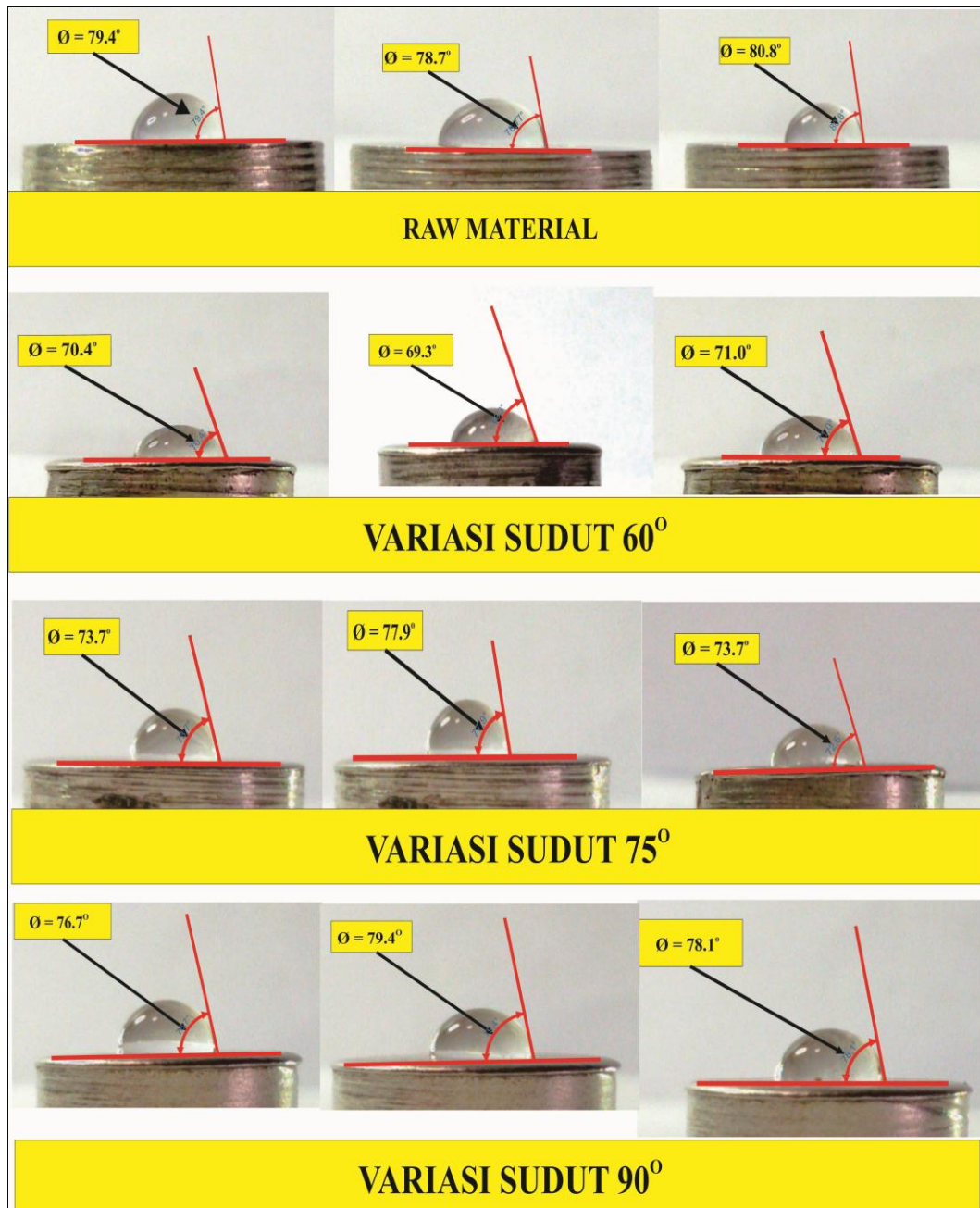
Grafik nilai kekerasan permukaan

Tabel nilai rata-rata distribusi kekerasan

Jarak dari tepi (mm)	Raw material	Sudut 60°	Sudut 75°	Sudut 90°
0.05	231.8	528.1	456.6	559.3
0.10	226.1	392.2	298.5	499.5
0.15	231.8	278.4	260.3	362.2
0.20	231.8	250.2	231.8	263.7
0.25	226.1	231.8	228.9	231.8
0.30	226.1	231.8	228.9	231.8
0.35	231.8	228.9	226.1	223.3
0.40	231.8	231.8	220.6	226.1
0.45	231.8	226.1	231.8	231.8
0.50	231.8	226.1	226.1	231.8

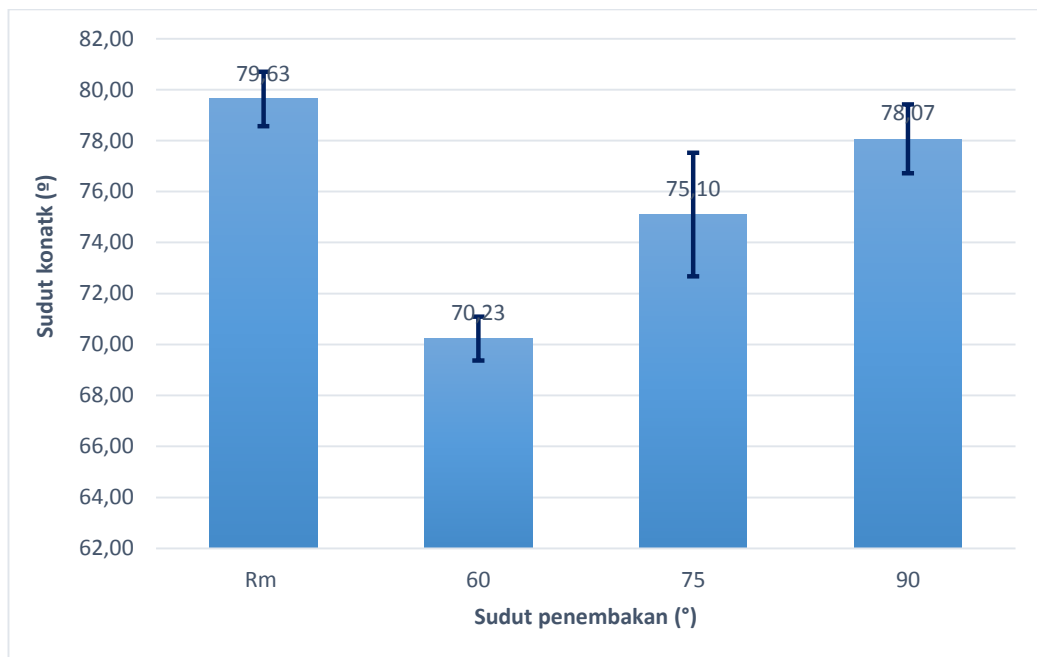


Grafik distribusi kekerasan

Lampiran 10 Hasil pengujian wettability

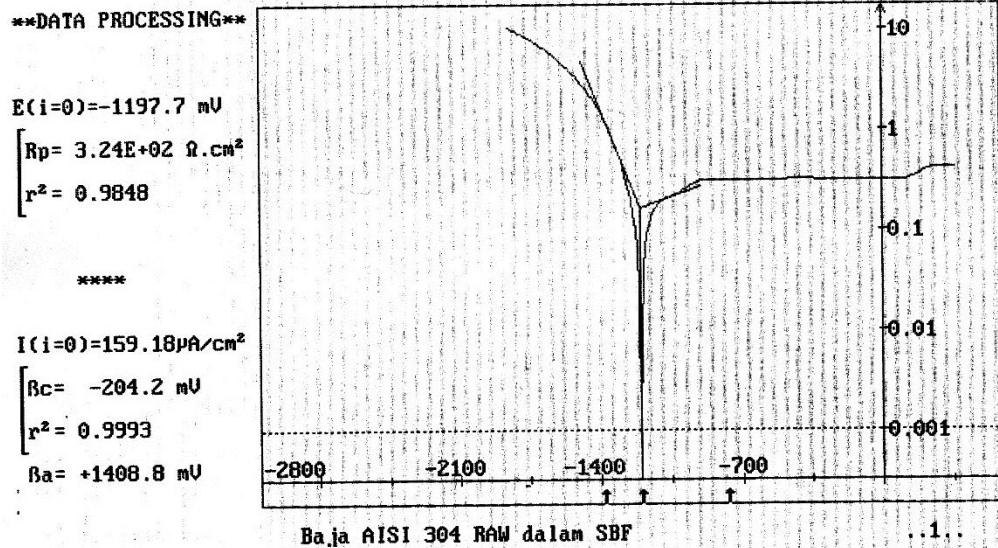
Hasil pengujian *wettability*

Kode	variasi	kontak sudut			Rata-rata	SD
		Tetes 1 (°)	Tetes 2 (°)	Tetes 3 (°)		
Rm	0	79,4	80,8	78,7	79,63	1,07
60	60°	69,3	70,4	71	70,23	0,86
75	75°	73,7	77,9	73,7	75,10	2,42
90	90°	76,7	79,4	78,1	78,07	1,35

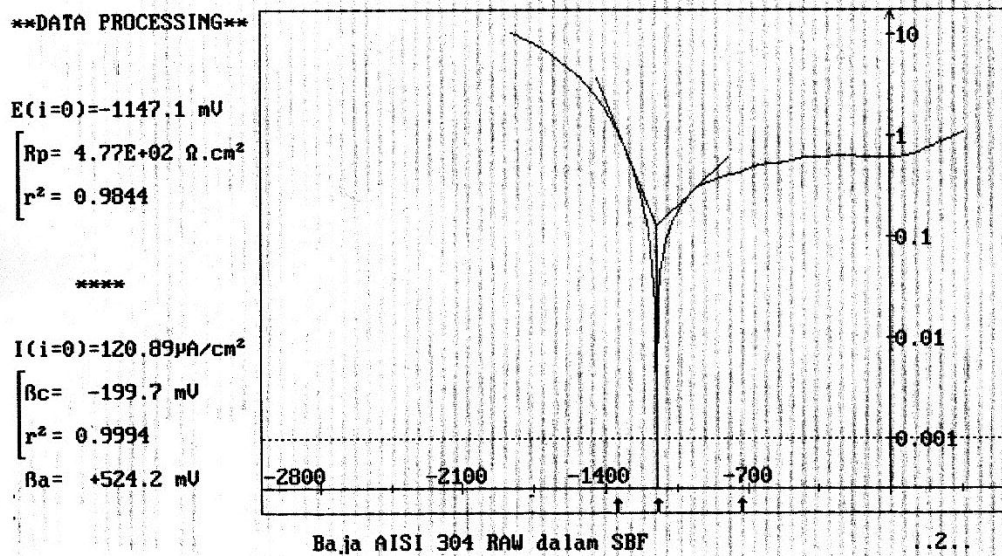


Grafik hubungan *wettability*

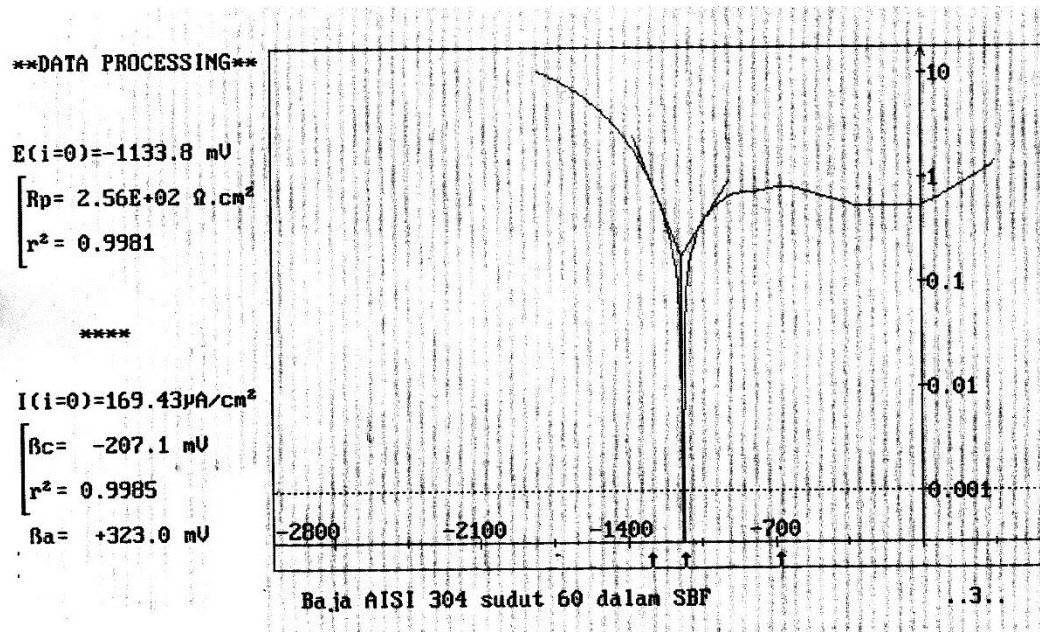
Lampiran 11 Hasil pengujian laju korosi



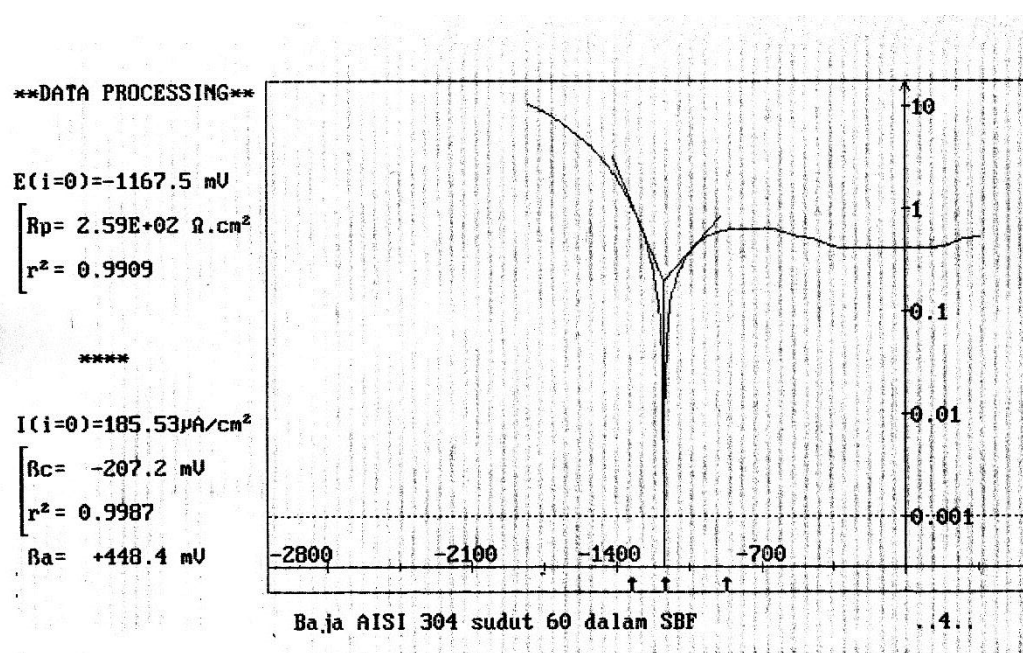
Gambar 1 Grafik *tafel stainless steel AISI 304* tanpa perlakuan *shot peening (raw material)* dengan larutan SBF (No. 01).



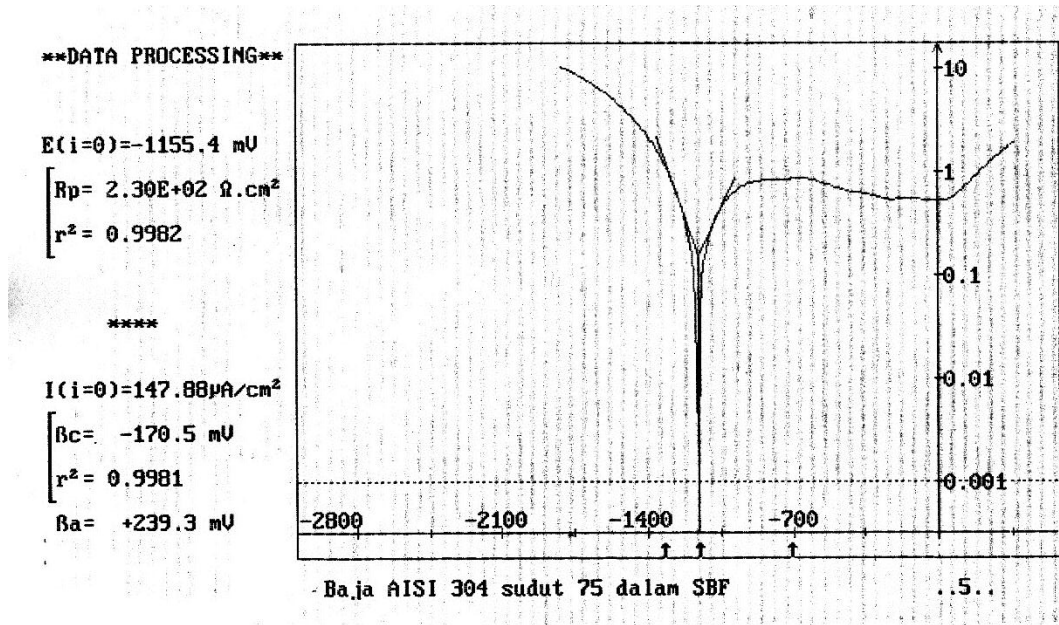
Gambar 2 Grafik *tafel stainless steel AISI 304* tanpa perlakuan *shot peening (raw material)* dengan larutan SBF (No. 02).



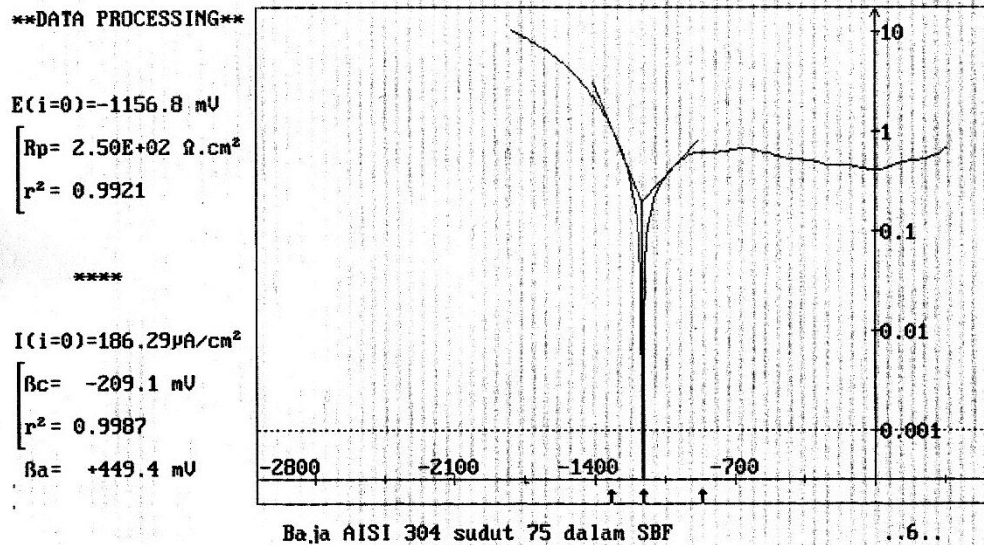
Gambar 3 Grafik *tafel stainless steel AISI 304* variasi sudut 60° dengan larutan SBF (No. 01).



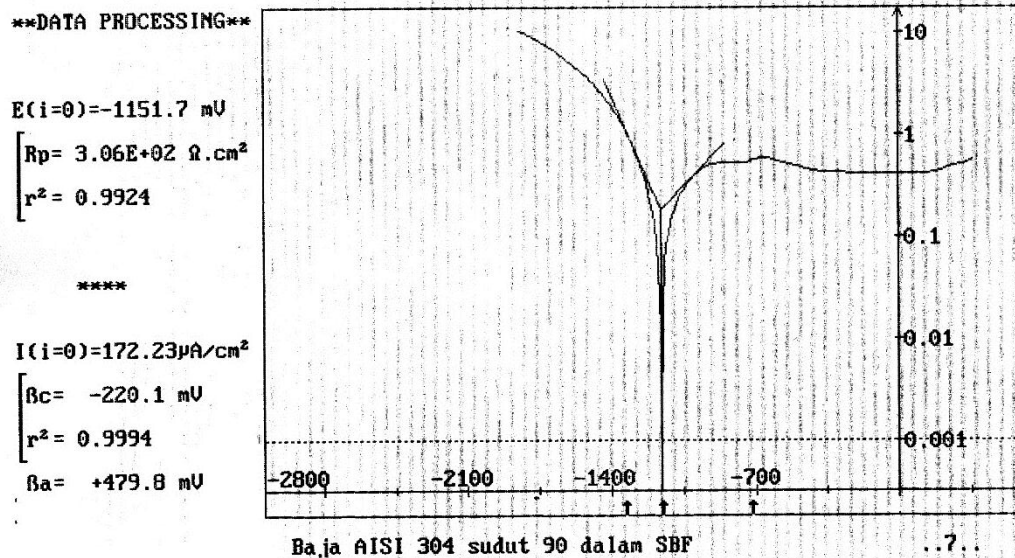
Gambar 4 Grafik *tafel stainless steel AISI 304* variasi sudut 60° dengan larutan SBF (No. 02).



Gambar 5 Grafik *tafel stainless steel AISI 304* variasi sudut 75° dengan larutan SBF (No. 01).



Gambar 6 Grafik *tafel stainless steel AISI 304* variasi sudut 75° dengan larutan SBF (No. 02).



Gambar 7 Grafik *tafel stainless steel AISI 304* variasi sudut 90° dengan larutan SBF (No. 01).

****DATA PROCESSING****

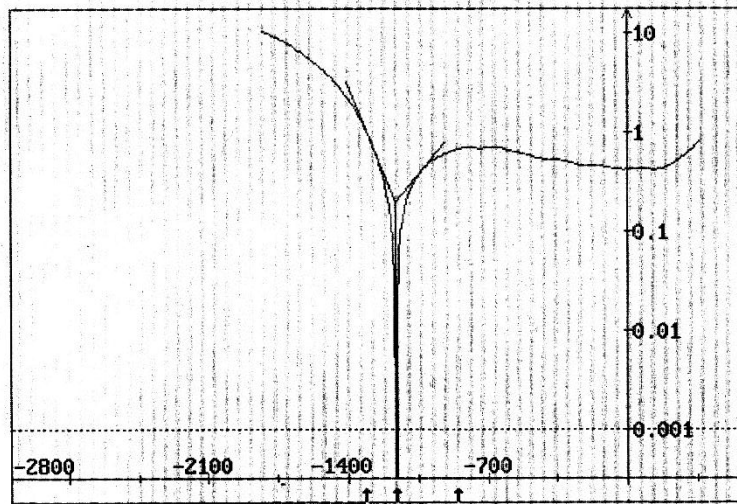
$$E(i=0) = -1157.8 \text{ mV}$$

$$\left[\begin{array}{l} R_p = 2.42E+02 \ \Omega \cdot \text{cm}^2 \\ r^2 = 0.9936 \end{array} \right.$$

$$I(i=0) = 186.38 \mu\text{A}/\text{cm}^2$$

$$\left[\begin{array}{l} \beta_c = -207.4 \text{ mV} \\ r^2 = 0.9992 \end{array} \right.$$

$$\beta_a = +408.6 \text{ mV}$$



Baja AISI 304 sudut 90 dalam SBF

Gambar 8 Grafik *tafel stainless steel AISI 304* variasi sudut 90° dengan larutan SBF (No. 02).

Perhitungan nilai laju korosi

Tabel Komposisi Unsur Sampel *Stainless Steel AISI 304*

Unsur	A _i (Massa Atom)	ω _i (Berat %)	ρ _i (Massa Jenis) (gr/cm ³)	n (Elektron Valensi)
Fe	55,85	64,41	7,86	2
C	12,01	0,069	2,26	4
Si	28,09	0,57	2,33	4
Mn	54,94	1,28	7,43	2
Cr	52,00	24,64	7,19	3
Ni	58,69	8,12	8,9	2
Mo	95,94	0,21	10,2	2
Cu	63,55	0,57	8,94	2

$$r = 0,129 \frac{i(EW)}{D} \quad (1)$$

Berat ekuivalen (EW) dari AISI 304, yaitu :

$$EW = N_{EQ}^{-1} \quad (2)$$

$$N_{EQ} = \sum \left(\frac{\omega_i}{a_i/n_i} \right) = \sum \left(\frac{\omega_i \cdot n_i}{a_i} \right) \quad (3)$$

Dengan :

r = Laju korosi (mpy)

D = Berat jenis campuran (gr/cm³)

i	=	Icorr
EW	=	Berat equivalen
N_{EQ}	=	Nilai equivalen total
ω_i	=	Fraksi berat
a_i	=	Nomor massa atom
n_i	=	Valensi atom

❖ **Massa jenis campuran (D)**

$$\frac{1}{\rho} = \sum \omega_i \frac{1}{\rho}$$

$$\frac{1}{\rho} = \left(\frac{0,6441}{7,86} + \frac{0,00069}{2,26} + \frac{0,0057}{2,33} + \frac{0,0128}{7,43} + \frac{0,2464}{7,19} + \frac{0,0812}{8,9} + \frac{0,0021}{10,2} + \frac{0,0057}{8,94} \right)$$

$$\frac{1}{\rho} = 0,13066$$

$$\rho = 7,653 \text{ gr/cm}^3$$

$$\text{Jadi, massa jenis campuran (D)} = 7,653 \frac{\text{gr}}{\text{cm}^3}$$

❖ **Berat Equivalen (EW) dari sampel**

$$EW = N_{EQ}^{-1}$$

$$N_{EQ} = \sum \left(\frac{\omega_i}{a_i/n_i} \right) = \sum \left(\frac{\omega_i \cdot n_i}{a_i} \right)$$

$$N_{EQ} = \left(\frac{0,6441(2)}{55,85} + \frac{0,00069(4)}{12,01} + \frac{0,0057(4)}{28,09} + \frac{0,0128(2)}{54,94} + \frac{0,2464(3)}{52,00} + \frac{0,0812(2)}{58,69} + \frac{0,0021(2)}{95,93} + \frac{0,0057(2)}{63,55} \right)$$

$$N_{EQ} = 0,04177$$

Berat ekuivalennya adalah :

$$EW = N_{EQ}^{-1}$$

$$EW = (0,04177)^{-1}$$

$$EW = 23,938$$

❖ **Laju Korosi Sampel Raw Material (Sampel No. 01)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(159,18 \frac{\mu A}{cm^2}) (23,938)}{7,653 \text{ gr/cm}^3}$$

$$r = 64.23 \text{ mpy}$$

❖ **Laju Korosi Sampel Raw Material (Sampel No. 02)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(120,89 \frac{\mu A}{cm^2}) (23,938)}{7,653 \text{ gr/cm}^3}$$

$$r = 48.78 \text{ mpy}$$

❖ **Laju Korosi Variasi sudut 60° (Sampel No. 01)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(169,43 \frac{\mu A}{cm^2}) (23,938)}{7,653 \frac{gr}{cm^3}}$$

$$r = 68.37 \text{ mpy}$$

❖ **Laju Korosi Variasi sudut 60° (Sampel No. 02)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(185,53 \frac{\mu A}{cm^2}) (23,938)}{7,653 \frac{gr}{cm^3}}$$

$$r = 74.86 \text{ mpy}$$

❖ **Laju Korosi Variasi sudut 75° (Sampel No. 01)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(147,88 \frac{\mu A}{cm^2}) (23,938)}{7,653 \text{ gr/cm}^3}$$

$$r = 59.67 \text{ mpy}$$

❖ **Laju Korosi Variasi sudut 75° (Sampel No. 02)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(186,29 \frac{\mu A}{cm^2}) (23,938)}{7,653 \text{ gr/cm}^3}$$

$$r = 75.17 \text{ mpy}$$

❖ **Laju Korosi Variasi sudut 90° (Sampel No. 01)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(172,23 \frac{\mu A}{cm^2}) (23,938)}{7,653 \frac{\text{gr}}{\text{cm}^3}}$$

$$r = 69.5 \text{ mpy}$$

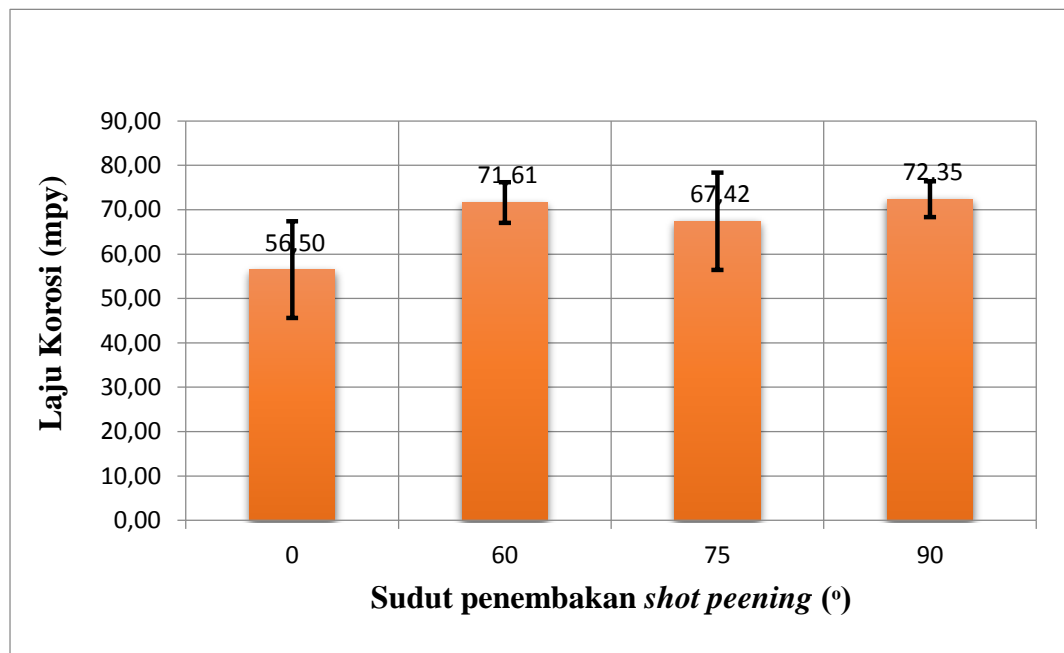
❖ **Laju Korosi Variasi sudut 90° (Sampel No. 02)**

$$r = 0,129 \frac{i(EW)}{D}$$

$$r = 0,129 \frac{(186,38 \frac{\mu A}{cm^2}) (23,938)}{7,653 \frac{\text{gr}}{\text{cm}^3}}$$


$$r = 75.2 \text{ mpy}$$

Kode	Variasi	I _{corr} (μA/cm ²)	E (mV)	Laju Korosi (mpy)	Rata-Rata Laju Korosi (mpy)
RM	0	159.18	1197.70	64.23	56.50
		120.89	1147.1	48.78	
60	60	169.43	1133.8	68.37	71.61
		185.53	1167.5	74.86	
75	75	147.88	1155.4	59.67	67.42
		186.29	1156.8	75.17	
90	90	172.23	1151.7	69.50	72.35
		186.38	1113.3	75.20	



Grafik laju korosi

Lampiran 12 Sertifikat Stainless Steel AISI 304

Certificate No. F111110005		檢驗證明書 MILL'S TEST CERTIFICATE																				
Date: NOV 08, 2011																						
Customer		Invoice No. 20112760		Contract No.		L/C No.		規格		ASTM A240/A480-10		Page: 1 of 1										
Description		Item No.	產品尺寸 Size	鋼種 Type	爐號 Heat No.	重量 GTY(PC)	重量 Weight(MT)	熱處理 (°C) Heat Treatment Water Quenched	表面處理 Finish	水壓試驗 Hydrostatic Test (Mpa)	備註 Remark											
HOT ROLLED STAINLESS STEEL PLATE		1	4.0MM X 1220 X 2440MM NO.1	304	AVK050278	107.000	9.828			NO1												
		2	5.0MM X 1220 X 2440MM NO.1	304	AVM050336	170.000	19.380			NO1												
		3	6.0MM X 1220 X 2440MM NO.1	304	AVT050430	140.000	19.650			NO1												
化學成分 Chemical Composition (%)												機械試驗 Mechanical Test										
Item No.	C	Si	Mn	P	S	Cr	Ni	Mo	N	其他	抗拉強度 Tensile (N/mm ²)	降伏強度 0.2% Yield (N/mm ²)	伸長率 % Elongation	Direction	Elongation	Gauge Length	硬度試驗 Hardness HRB	壓扁試驗 Flattening Test	彎曲試驗 Bend Test	缺口試驗 Flaring Test		
Min.						17.50	8.00				515.00	205.00	40.00	L-T	mm	mm						
Max.	0.70	750	2.00	0.45	0.30	19.50	10.50														No Crack	No Crack
1	0.22	530	1.03	0.43	0.03	18.34	8.01				659.00	304.00	53.00									
2	0.23	510	.88	0.37	0.05	18.23	8.05				673.00	302.00	52.00									
3	0.22	456	1.40	0.36	0.05	18.02	8.04				619.00	288.00	54.00									
<p>WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREON HAS BEEN MANUFACTURED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATIONS SPECIFIED BY YOU THAT IT SATISFIES THE REQUIREMENT FOR THE MANUFACTURE OF SEAMLESS PIPE & TUBE THAT WE ARE A STAINLESS STEEL PIPE & TUBE MANUFACTURER CERTIFIED WITH ISO 9001 OR ISO 14001 ENVIRONMENTAL MANAGEMENT SYSTEM.</p>												 QA Manager / Work										