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## LAMPIRAN

### 1. Data Hasil Uji Kekerasan Pengelasan Logam Berbeda Elektroda E308L-16 dan E309Mo-17

#### 1.1 Hasil Uji Kekerasan Elektroda E308L-16

Logam Las		E308L16																									
Titik Pengujian		Base Metal A36						rata-rata	HAZ A36			rata-rata	WELD METAL			rata-rata	HAZ 316L			rata-rata	Base Metal 316L						rata-rata
Specimen		-10	-9	-8	-7	-6	-5		-4	-3	-2		-1	0	1		2	3	4		5	6	7	8	9	10	
Tanpa PWHT	A1	84.50	85.30	86.60	86.30	84.90	83.30	85.15	84.10	85.30	82.90	84.10	131.30	134.90	134.80	133.67	123.90	125.10	124.00	124.33	140.00	135.40	136.80	136.40	134.60	136.50	136.62
	A2	87.60	87.80	88.70	84.00	82.80	85.50	86.0667	84.80	84.00	84.20	84.33	137.50	137.00	137.10	137.20	131.80	129.90	130.00	130.57	135.70	134.20	134.20	134.60	135.80	135.70	135.03
	A3	82.20	83.00	83.60	81.90	84.50	81.90	82.85	83.20	82.60	81.80	82.53	105.10	104.50	102.40	104.00	118.10	114.50	118.70	117.10	119.90	124.40	121.80	119.80	114.40	118.50	119.80
	Rata-rata	84.77	85.37	86.30	84.07	84.07	83.57	84.69	84.03	83.97	82.97	83.66	124.63	125.47	124.77	124.96	124.60	123.17	124.23	124.00	131.87	131.33	130.93	130.27	128.27	130.23	130.48
	Deviasi	2.21	1.96	2.09	1.80	0.91	1.48		0.65	1.10	0.98		14.04	14.85	15.84		5.61	6.43	4.62		8.64	4.93	6.54	7.44	9.82	8.30	
PWHT 400 °C	B1	91.7	95.00	91.8	93.7	93.9	99.7	94.30	91.6	86.3	87.4	88.43	122.4	128.1	125.6	125.37	116	119.1	113.6	116.23	131.5	133.1	133.7	139.8	141.7	140.1	136.65
	B2	89.70	86.60	84.20	83.20	82.50	78.20	84.07	88.10	91.00	89.20	89.43	121.60	117.30	122.40	120.43	125.10	121.20	123.70	123.33	113.8	110.50	117.70	102.7	107.40	104.70	109.47
	B3	84.50	84.10	85.60	83.80	83.40	85.40	84.47	81.70	78.60	79.00	79.77	117.70	120.80	118.80	119.10	112.80	113.80	112.20	112.93	126.4	124.20	128.00	109.2	112.90	110.90	118.60
	Rata-rata	88.63	88.57	87.20	86.90	86.60	87.77	87.61	87.13	85.30	85.20	85.88	120.57	122.07	122.27	121.63	117.97	118.03	116.50	117.50	123.90	122.60	126.47	117.23	120.67	118.57	121.57
	Deviasi	3.03	4.66	3.30	4.81	5.17	8.94		4.10	5.11	4.45		2.05	4.50	2.78		5.21	3.11	5.12		7.44	9.30	6.62	16.18	15.04	15.44	
PWHT 600 °C	C1	83.80	83.80	83.80	83.90	83.80	83.80	83.82	83.40	83.40	83.60	83.47	116.40	121.80	116.70	118.30	115.60	117.80	115.50	116.30	113.30	113.30	113.30	113.30	114.10	115.10	113.73
	C2	78.50	78.40	80.60	78.20	75.90	77.80	78.23	72.50	73.10	70.90	72.17	113.60	113.30	112.10	113.00	99.00	100.90	102.20	100.70	117.00	119.50	119.10	112.20	112.40	114.30	115.75
	C3	78.00	76.60	77.50	75.60	76.20	74.40	76.38	67.40	66.80	70.40	68.20	86.90	88.90	90.50	88.77	94.90	94.50	97.40	95.60	100.80	103.40	103.90	99.50	95.20	98.40	100.20
	Rata-rata	80.10	79.60	80.63	79.23	78.63	78.67	79.48	74.43	74.43	74.97	74.61	105.63	108.00	106.43	106.69	103.17	104.40	105.03	104.20	110.37	112.07	112.10	108.33	107.23	109.27	109.89
	Deviasi	2.62	3.06	2.57	3.47	3.66	3.89		6.67	6.84	6.11		13.30	13.94	11.42		8.95	9.83	7.66		6.93	6.63	6.26	6.26	8.54	7.69	
PWHT 900 °C	D1	87.9	88.50	90.30	89.3	89.40	85.80	88.53	77.6	78.00	78.10	77.90	85.4	85.00	86.70	85.70	71.2	75.00	71.80	72.67	72.5	70.90	73.00	71.6	70.40	69.10	71.25
	D2	92.7	93.20	94.50	81.6	85.80	82.30	88.35	84.0	83.60	84.90	84.17	77.8	79.80	78.00	78.53	66.2	68.80	67.40	67.47	74.4	75.70	76.40	82.6	83.10	82.70	79.15
	D3	74.9	72.60	71.80	69.8	72.60	72.20	72.32	70.7	72.10	70.30	71.03	91.0	92.40	89.00	90.80	88.1	87.60	89.40	88.37	82.5	82.10	83.10	93.2	92.00	91.00	87.32
	Rata-rata	85.17	84.77	85.53	80.23	82.60	80.10	83.07	77.43	77.90	77.77	77.70	84.73	85.73	84.57	85.01	75.17	77.13	76.20	76.17	76.47	76.23	77.50	82.47	81.83	80.93	79.24
	Deviasi	7.52	8.81	9.86	8.02	7.22	5.77		5.43	4.70	5.97		5.41	5.17	4.74		9.37	7.82	9.51		4.34	4.59	4.20	8.82	8.86	9.03	

## 1.2 Hasil Uji Kekerasan Elektroda E309Mo-17

Logam Las		E309Mo-17																									
Titik Pengujian		Base Metal A36						rata-rata	HAZ A36			rata-rata	WELD METAL			rata-rata	HAZ 316L			rata-rata	Base Metal 316L						rata-rata
Specimen		-10	-9	-8	-7	-6	-5		-4	-3	-2		-1	0	1		2	3	4		5	6	7	8	9	10	
Tanpa PWHT	A1	79.60	79.10	81.30	80.7	82.40	80.10	80.53	89.8	88.40	88.20	88.80	119	123.60	117.70	120.10	126.2	127.10	126.20	126.50	111.9	113.70	109.40	97.6	98.20	100.20	105.17
	A2	87.10	87.80	86.00	86.6	85.80	86.90	86.70	92	95.30	100.50	95.93	148.4	146.40	142.90	145.90	122.3	119.60	119.80	120.57	124.4	120.50	124.70	119.4	120.50	123.70	122.20
	A3	76.90	77.60	76.40	75.7	73.50	76.60	76.12	80.8	81.50	80.90	81.07	126.4	127.20	128.80	127.47	109.6	107.60	105.80	107.67	110.4	112.80	108.30	115.3	115.40	114.30	112.75
	Rata-rata	81.20	81.50	81.23	81.00	80.57	81.20	81.12	87.53	88.40	89.70	88.60	131.27	132.40	129.80	131.16	119.37	118.10	117.27	118.24	115.57	115.67	114.13	110.77	111.37	112.73	113.37
	Deviasi	4.32	4.50	3.92	4.45	5.19	4.28		4.85	5.63	8.09		12.49	10.01	10.31		7.09	8.03	8.52		6.28	3.44	7.49	9.46	9.54	9.66	
PWHT 400°C	B1	78.60	77.2	77.5	83	87.1	84	81.23	85.8	82.4	81.6	83.27	114.4	117.2	114.9	115.50	113.1	114.8	114.6	114.17	105.5	113	111.1	103.9	105.5	110.8	108.30
	B2	81.30	80.5	84.4	79	80.5	79.2	80.82	76.4	71.9	74.5	74.27	124.9	126.8	126.2	125.97	116.4	115.00	114.80	115.40	113.6	111.20	113.70	108.6	111.90	115.80	112.47
	B3	79.60	81.50	80.80	79.8	78.90	79.90	80.08	77.8	77.90	79.00	78.23	134.8	132.80	135.60	134.40	108.2	110.40	106.30	108.30	107.4	109.70	109.50	102.5	102.00	104.90	106.00
	Rata-rata	79.83	79.73	80.90	80.60	82.17	81.03	80.71	80.00	77.40	78.37	78.59	124.70	125.60	125.57	125.29	112.57	113.40	111.90	112.62	108.83	111.30	111.43	105.00	106.47	110.50	108.92
	Deviasi	1.11	1.84	2.82	1.73	3.55	2.12		4.14	4.30	2.93		8.33	6.42	8.46		3.37	2.12	3.96		3.46	1.35	1.73	2.61	4.10	4.45	
PWHT 600°C	C1	88.40	83.7	89.2	88.7	86.4	83.4	86.63	86.5	84.6	87	86.03	121.9	121.4	122.9	122.07	121.1	118.6	118.7	119.47	125.1	133.3	132	137.8	136.6	135.6	133.40
	C2	77.90	74.40	76.80	79.1	79.60	79.20	77.83	76	77.80	73.70	75.83	117	122.10	121.60	120.23	110	113.4	109.9	111.10	108.1	110.60	110.30	114.3	112.70	115.90	111.98
	C3	74.00	74.40	74.10	72.5	74.30	73.90	73.87	70.8	72.50	72.80	72.03	123.8	124.60	123.10	123.83	103.9	104.10	102.00	103.33	116.1	114.60	115.70	113	111.50	111.80	113.78
	Rata-rata	80.10	77.50	80.03	80.10	80.10	78.83	79.44	77.77	78.30	77.83	77.97	120.90	122.70	122.53	122.04	111.67	112.03	110.20	111.30	116.43	119.50	119.33	121.70	120.27	121.10	119.72
	Deviasi	6.08	4.38	6.57	6.65	4.95	3.89		6.53	4.95	6.49		2.86	1.37	0.66		7.12	6.00	6.82		6.94	9.89	9.22	11.40	11.56	10.39	
PWHT 900°C	D1	74.50	77.00	77.50	75.9	78.70	77.20	76.80	74.3	77.30	78.00	76.53	104.4	105.40	109.60	106.47	81.1	80.70	80.70	80.83	80	81.00	77.90	93.8	90.40	90.30	85.57
	D2	81.10	81.40	80.00	79.9	77.50	78.90	79.80	73.8	72.60	73.90	73.43	110.3	110.00	111.20	110.50	92.3	90.60	93.50	92.13	99.8	100.20	98.10	94.4	96.10	97.90	97.75
	D3	76.80	76.60	78.00	74.5	73.20	73.70	75.47	67.5	68.80	68.80	68.37	114.9	116.20	116.70	115.93	85.1	83.80	83.20	84.03	79.6	79.40	80.00	84.1	82.10	84.40	81.60
	Rata-rata	77.47	78.33	78.50	76.77	76.47	76.60	77.36	71.87	72.90	73.57	72.78	109.87	110.53	112.50	110.97	86.17	85.03	85.80	85.67	86.47	86.87	85.33	90.77	89.53	90.87	88.31
	Deviasi	2.74	2.17	1.08	2.29	2.36	2.16		3.09	3.48	3.76		4.30	4.43	3.04		4.63	4.13	5.54		9.43	9.45	9.07	4.72	5.75	5.53	

## 2. Data Hasil Uji Impak Pengelasan Logam Berbeda Elektroda E308L-16 dan E309Mo-17

### 2.1 Tabel hasil uji impak Logam Induk

Jenis Logam	W (mm)	H (mm)	A (mm <sup>2</sup> )	$\beta$ (°)	Ust (J)	U1 (J/mm)
ASTM A36	5,11	7,93	5,11	84	38	0,94
ASTM A240 tipe 316L	5,09	7,98	5,09	60	30	0,74

























## 2.2 Tabel hasil uji impak Logam Las

Logam Las		E308L-16					
Titik Pengujian		V_Notch_Center Weld					
Specimen		W	H	A	$\beta$	Ust	U1
Tanpa PWHT	A1	5.05	8.00	40.40	122.40	50.00	1.24
	A2	5.00	8.00	40.00	121.60	52.00	1.30
	A3	4.94	7.98	39.42	123.20	45.00	1.14
Rata-rata		5.00	7.99	39.94	122.40	49.00	1.23
Deviasi		0.01	0.00	0.13	0.22	0.98	0.02
PWHT 400°C	B1	5.00	7.98	39.90	122.00	51.00	1.28
	B2	5.03	7.98	40.14	121.20	54.00	1.35
	B3	4.97	8.00	39.76	122.00	52.00	1.31
Rata-rata		5.00	7.99	39.93	121.73	52.33	1.31
Deviasi		0.01	0.00	0.05	0.13	0.13	0.01
PWHT 600°C	C1	4.94	7.90	39.03	127.20	40.00	1.02
	C2	5.07	7.96	40.36	119.20	52.00	1.29
	C3	5.06	8.00	40.48	122.00	46.00	1.14
Rata-rata		5.02	7.95	39.95	122.80	46.00	1.15
Deviasi		0.02	0.01	0.22	1.10	1.63	0.04
PWHT 900°C	D1	5.07	8.00	40.56	127.60	38.00	0.94
	D2	4.99	8.00	39.92	126.40	41.00	1.03
	D3	4.97	7.96	39.56	123.60	44.00	1.11
Rata-rata		5.01	7.99	40.01	125.87	41.00	1.03
Deviasi		0.01	0.01	0.14	0.56	0.82	0.02

Logam Las		E309Mo-17					
Titik Pengujian		V_Notch_Center Weld					
Specimen		W	H	A	$\beta$	Ust	U1
Tanpa PWHT	A1	5.06	8.00	40.48	128.00	38.00	0.94
	A2	5.03	8.02	40.34	125.00	38.00	0.94
	A3	5.07	7.98	40.46	124.40	44.00	1.09
Rata-rata		5.05	8.00	40.43	125.80	40.00	0.99
Deviasi		0.01	0.01	0.02	0.52	0.94	0.02
PWHT 400°C	B1	5.13	7.90	40.53	124.40	45.00	1.11
	B2	5.10	7.96	40.60	125.60	40.00	0.99
	B3	5.06	7.90	39.97	126.00	39.00	0.98
Rata-rata		5.10	7.92	40.37	125.33	41.33	1.02
Deviasi		0.01	0.01	0.09	0.23	0.87	0.02
PWHT 600°C	C1	5.03	8.00	40.24	129.20	35.00	0.87
	C2	5.04	8.08	40.72	127.60	39.00	0.96
	C3	5.07	8.06	40.86	126.40	42.00	1.03
Rata-rata		5.05	8.05	40.61	127.73	38.67	0.95
Deviasi		0.01	0.01	0.09	0.38	0.96	0.02
PWHT 900°C	D1	4.94	7.96	39.32	140.00	11.00	0.28
	D2	5.02	8.04	40.36	140.40	11.00	0.27
	D3	5.05	7.96	40.20	141.60	9.00	0.22
Rata-rata		5.00	7.99	39.96	140.67	10.33	0.26
Deviasi		0.02	0.01	0.15	0.23	0.31	0.01



2.2 Foto specimen uji Impak

Logam Las E308L-16				Logam Las E309Mo-17							
Tanpa PWHT	A1		PWHT 600°C	C1		Tanpa PWHT	A1		PWHT 600°C	C1	
	A2			C2			A2			C2	
	A3			C3			A3			C3	
PWHT 400°C	B1		PWHT 900°C	D1		PWHT 400°C	B1		PWHT 900°C	D1	
	B2			D2			B2			D2	
	B3			D3			B3			D3	

### 3. Data Heat input pengelasan DMW

Pengelasan metode SMAW

Efisiensi pengelasan 0,8

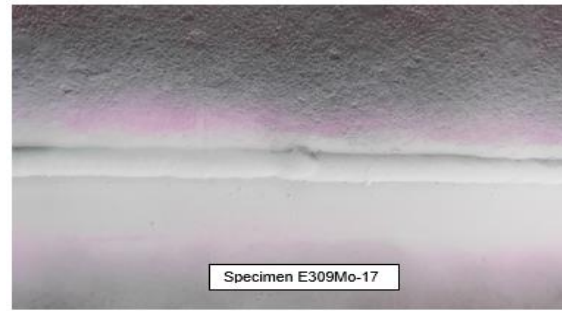
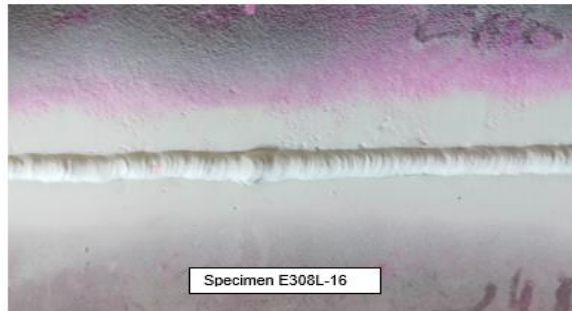
Posisi pengelasan 1G

Sambungan V groove

Sampel	Weld Pass	Arus (A)	Tegangan (V)	Panjang Lasan (mm)	Waktu (dtk)	Kecepatan las (mm/dtk)	Masukan Panas/pass (kj/mm)	Rata -rata			
								Arus (A)	Tegangan (V)	Kecepatan Pengelasan (mm/dtk)	Masukan Panas (kj/mm)
E308L-16	1	70	27	1170	515,43	2,27	0,67	70	27	2,47	0,63
	2	70	27	1200	402,69	2,98	0,51				
	3	70	27	1190	553,82	2,15	0,70				

Sampel	Weld Pass	Arus (A)	Tegangan (V)	Panjang Lasan (mm)	Waktu (dtk)	Kecepatan las (mm/dtk)	Masukan Panas/pass (kj/mm)	Rata -rata			
								Arus (A)	Tegangan (V)	Kecepatan Pengelasan (mm/dtk)	Masukan Panas (kj/mm)
E309Mo-17	1	70	27	1200	374,56	3,20	0,47	70	27	3,69	0,44
	2	70	27	1190	235,36	5,06	0,30				
	3	70	27	1200	425,55	2,82	0,54				

4. Dokumentasi hasil uji *Non Destructive Test* (NDT)





5. Dokumentasi hasil uji Korosi  $\text{FeCl}_3$

Spesimen E308L-16 Tanpa PWHT	Spesimen E308L-16 Tanpa PWHT
Spesimen E309Mo-17 Tanpa PWHT	Spesimen E309Mo-17 TPWHT

#### 4. SERTIFIKAT WELDER

5314360



BADAN NASIONAL  
SERTIFIKASI PROFESI  
INDONESIAN PROFESSIONAL  
CERTIFICATION AUTHORITY

**SERTIFIKAT KOMPETENSI**  
**CERTIFICATE OF COMPETENCE**

No. 00289.0721.0008832.2020

Dengan ini menyatakan bahwa,  
*This is to certify that,*

**Vasko Marthom**  
No. Reg. JIP.024.0000213.2020

Telah kompeten pada Bidang :  
*Is competent in the area of :*

**Jasa Industri Pengelasan**  
Dengan Kualifikasi / Kompetensi :  
*With Qualification/Competency :*


Proses Las : **6G SMAW**  
*Welding Process*

Transkrip Unit Kompetensi dapat dilihat disebelah  
*For Transcript of Competency Units, see beside*



Sertifikat ini berlaku untuk : 3 (tiga) tahun  
*This certificate is valid for : 3 (three) years*

Jakarta, 28 April 2020

A.a. BADAN NASIONAL SERTIFIKASI PROFESI  
DIREKTUR LEMBAGA SERTIFIKASI PROFESI LAS  
O.b. NATIONAL BOARD FOR PROFESSIONAL CERTIFICATION  
DIRECTOR OF PROFESSIONAL CERTIFYING BODY FOR WELDING



Dr. Budi Setyo Utomo, M.M.



## 5. Komposisi logam indukA36

Oxford Instruments Analytical GmbH Sample Testing of different Qualities

### Chemical Result

Probe Nr. / sample ID :

Grundwerkstoff / material :

Kunde / customer :  
Abd. Wahab

Abmessung / dimension :

Kom.-Nr. / commision :

Zusatzwerkstoff / filler metals :

Labor Nr. / lab-no.  
M.Ansar

Wärmebehandlung / heat treatment :

PTQ-Nr. / PTQ-no. :

Schmelze-Nr. / heat-no. :

Spektralanalyse FMX      Werkstoff / grade :

	Fe	C	Si	Mn	P	S	Cr	Mo
Min		0.130		0.600	0.0000	0.0000	0.0000	0.0000
Ma		0.180		0.900	0.0300	0.0500	0.150	0.0600
x								
1	98.6	H 0.195	0.248	0.675	0.0103	0.0028	0.0148	0.0029
2	98.6	H 0.180	0.294	0.711	0.0108	0.0039	0.0178	0.0047
3	98.7	0.158	0.241	0.670	0.0103	0.0020	0.0146	0.0029
Ave	98.6	0.178	0.261	0.685	0.0104	0.0029	0.0157	0.0035

	Ni	Al	Co	Cu	Nb	Ti	V	W
Min	0.0000			0.200				
Ma	0.200			100.				
x								
1	0.0128	0.0355	0.0031	L 0.0137	< 0.0005	0.0064	0.0023	0.0644
2	0.0170	0.0395	0.0047	L 0.0131	< 0.0005	0.0050	0.0019	0.0661
3	0.0141	0.0341	0.0091	L 0.0144	< 0.0005	0.0045	0.0013	0.0504
Ave	0.0147	0.0364	0.0056	L 0.0137	< 0.0005	0.0053	0.0018	0.0603

	Pb	Sn	B	Ca	Zr	Zn	Bi	As
Min	0.150		0.0005					
Ma	0.350		0.0030					
x								
1	L 0.0144	< 0.0010	0.0006	> 0.0080	0.0012	< 0.0005	0.0126	0.0017
2	L 0.0139	< 0.0010	0.0011	> 0.0080	< 0.0005	0.0006	0.0120	0.0017
3	L 0.0146	< 0.0010	0.0007	0.0075	0.0016	< 0.0005	0.0119	0.0021
Ave	L 0.0143	< 0.0010	0.0008	> 0.0080	0.0011	0.0005	0.0121	0.0018

Ort / town

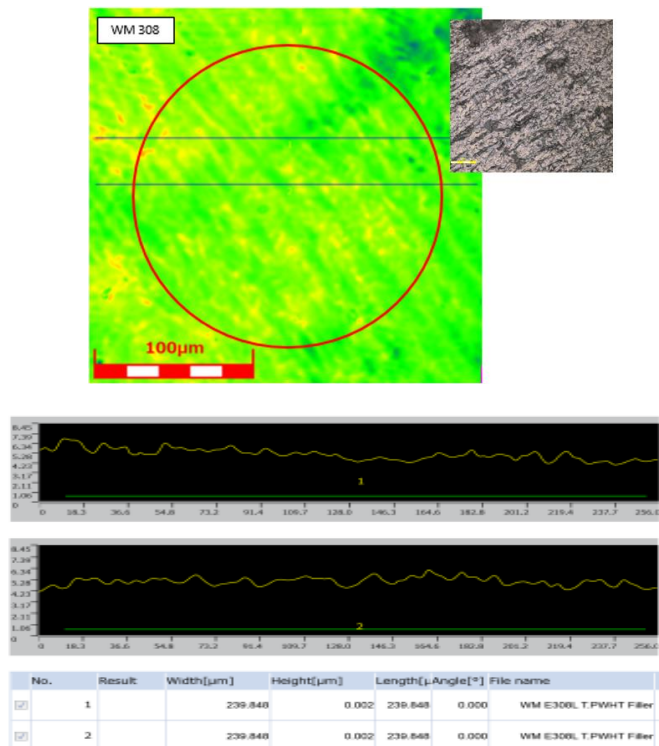
Se

Datum / date  
Sachverständiger / engineer  
Sb 06/09/2021

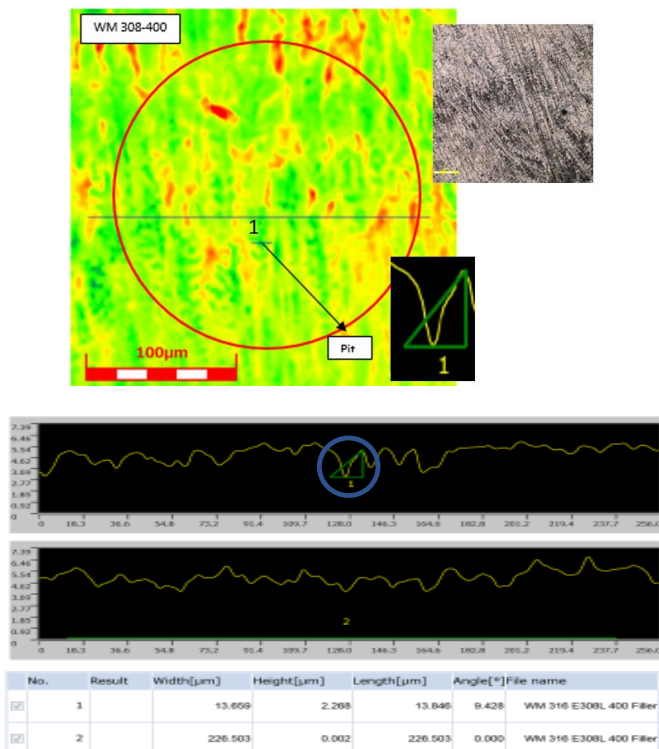
Prüfer / tester

## 6. Pengamatan Uji Pitting Korosi Tanpa Perlakuan Korosi

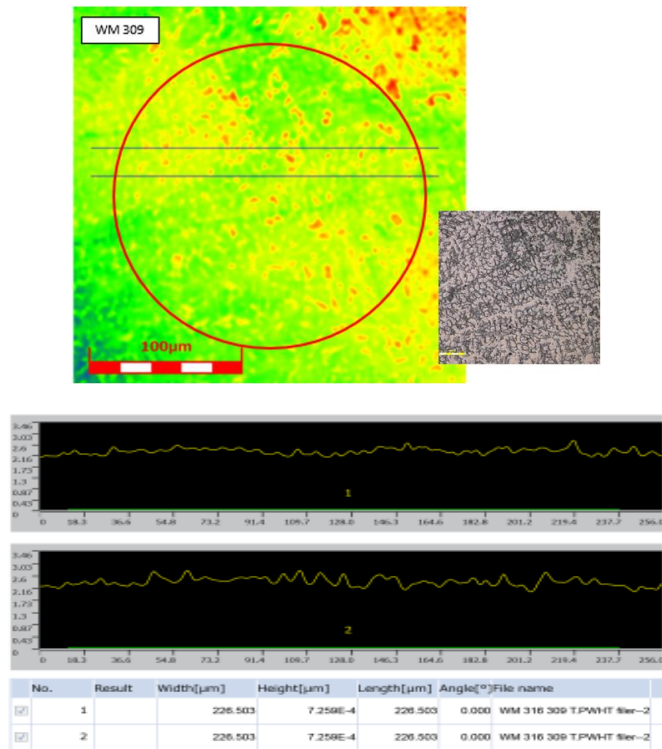
### 6.1 Spesimen WM E308L-16 tanpa PWHT



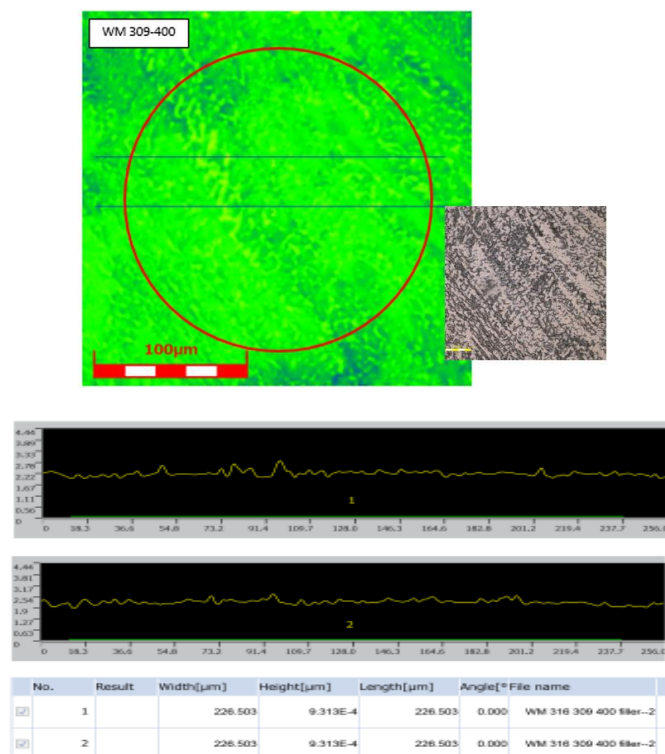
### 6.2 Spesimen WM E308L-16 PWHT 400



### 6.3 Spesimen WM E309Mo-17 tanpa PWHT

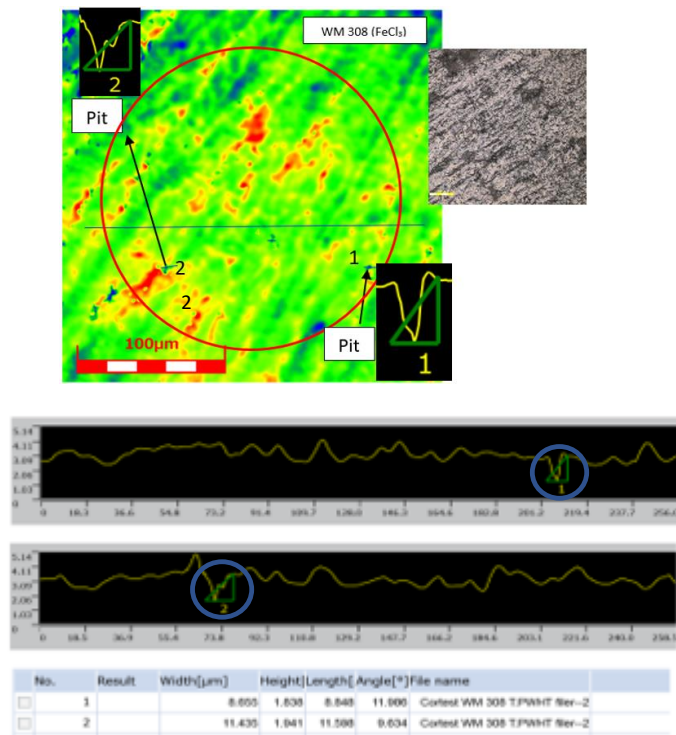


### 6.4 Spesimen WM E309Mo-17 PWHT 400

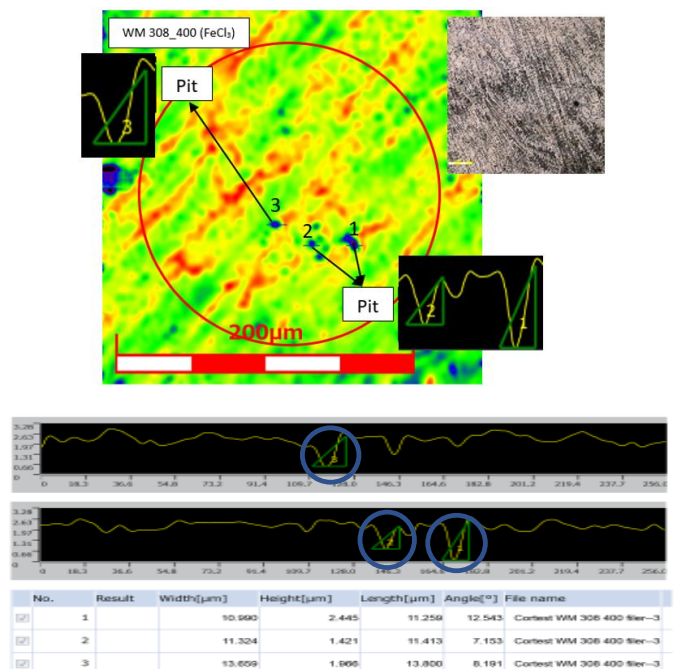


## 7. Data Pengamatan Uji Pitting Korosi dengan larutan $\text{FeCl}_3$

### 7.1 Spesimen WM E308L-16 Tanpa PWHT

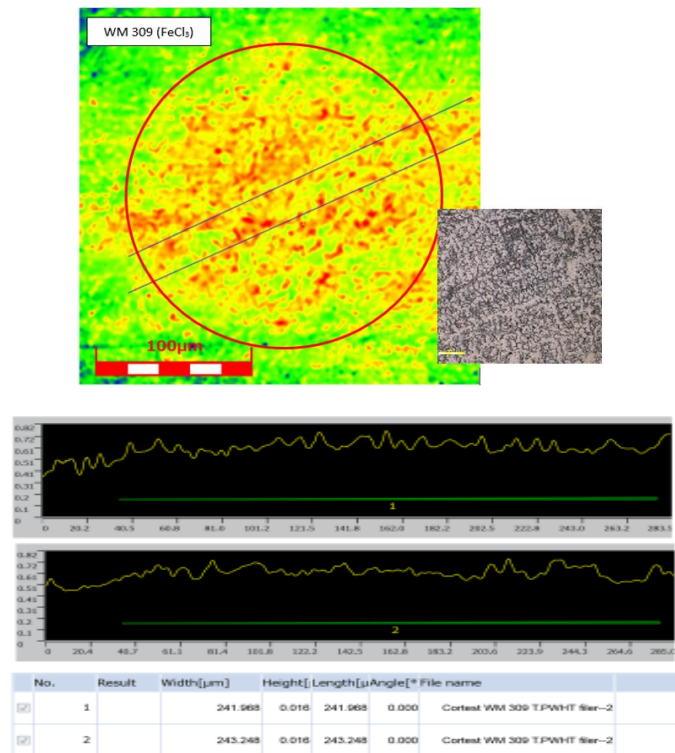


### 7.2 Spesimen WM E308L-16 PWHT 400

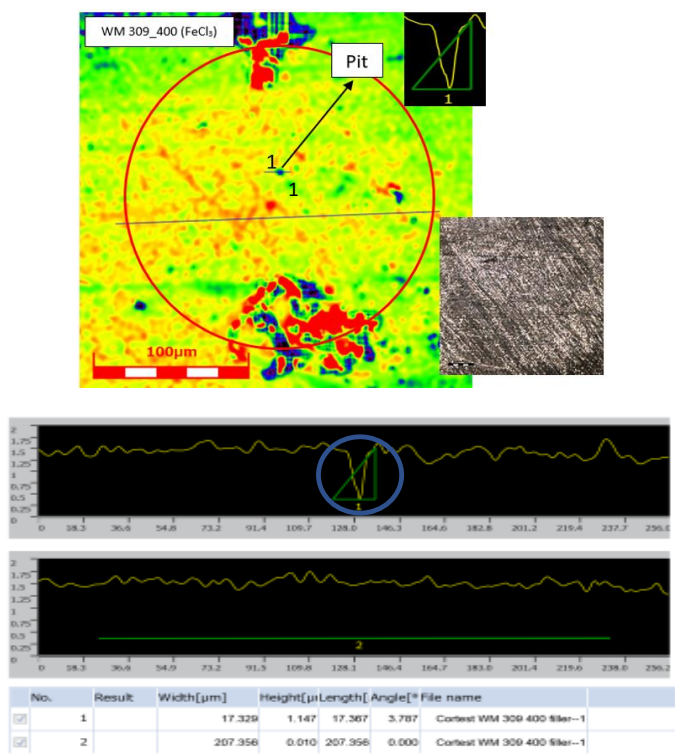




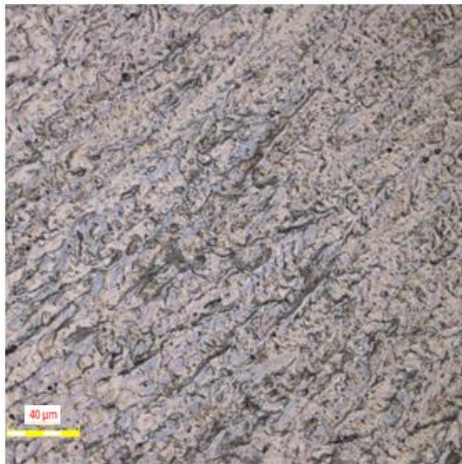
### 7.3 Spesimen WM E309Mo-17 Tanpa PWHT



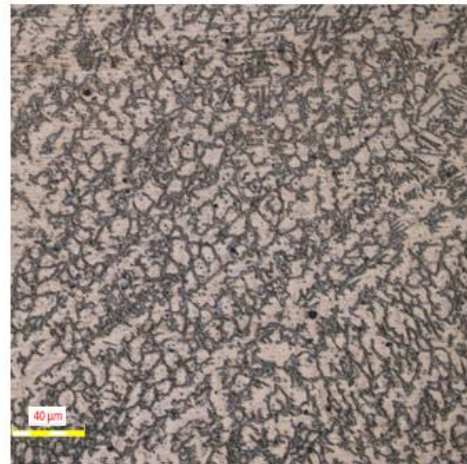
### 7.4 Spesimen WM E309Mo-17 PWHT 400



## 8. Struktur mikro logam las PWHT 600 dan 900°C

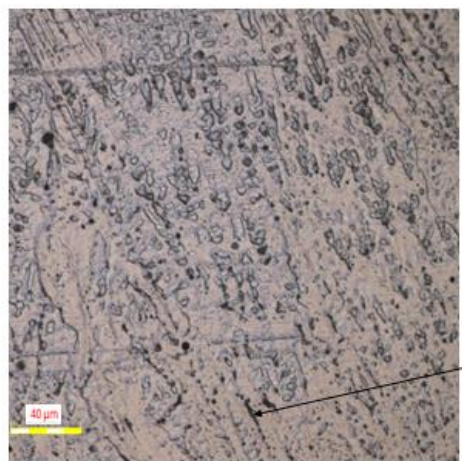


(a)

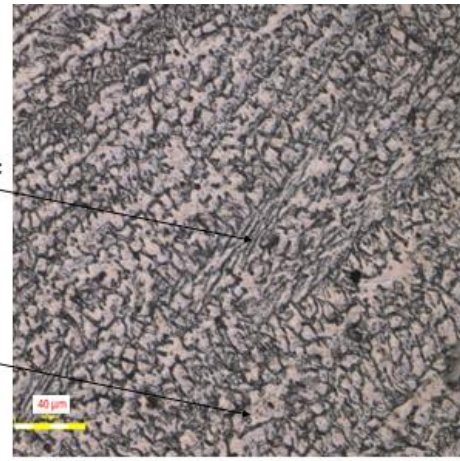


(b)

(a) Struktur mikro logam las E308L-16 dengan PWHT 600°C, (b) Struktur mikro logam las E309Mo-17 dengan PWHT 600°C



(a)



(b)

(a) Struktur mikro logam las E308L-16 dengan PWHT 900°C, (b) Struktur mikro logam las E309Mo-17 dengan PWHT 900°C