
	UNIT PELAKSANA TEKNIS LABORATORIUM LINGKUNGAN DINAS LINGKUNGAN HIDUP DAN KEHUTANAN	No. Dokumen : F-IK-EKP/ 5.4.6.3
	FORMULIR	Terbitan/ Tanggal : 1/14-02-2017 Revisi /Tanggal : 0/
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LAPORAN ESTIMASI KETIDAKPASTIAN PENGUKURAN OKSIGEN TERLARUT

1	PARAMETER	:	OKSIGEN TERLARUT
2	METODE	:	SNI 06 6989-14 2004
3	NAMA ALAT/MERKEK/TIPE	:	BURET
4	KODE ALAT	:	
5	TANGGAL KALIBRASI	:	18 April 2016
6	KODE KALIBRASI ALAT BURET	:	EKI-160154 IU
7	TANGGAL PENGUJIAN	:	18 OKTOBER 2018
8	TANGGAL PERHITUNGAN	:	22 OKTOBER 2018
9	NAMA ANALIS	:	Dian Fisti A, S.Si
10	NAMA PENYELIA	:	Epi Dinasari S.Si
11	LAPORAN OKSIGEN TERLARUT	:	4,301 ± 0.104 mg/l

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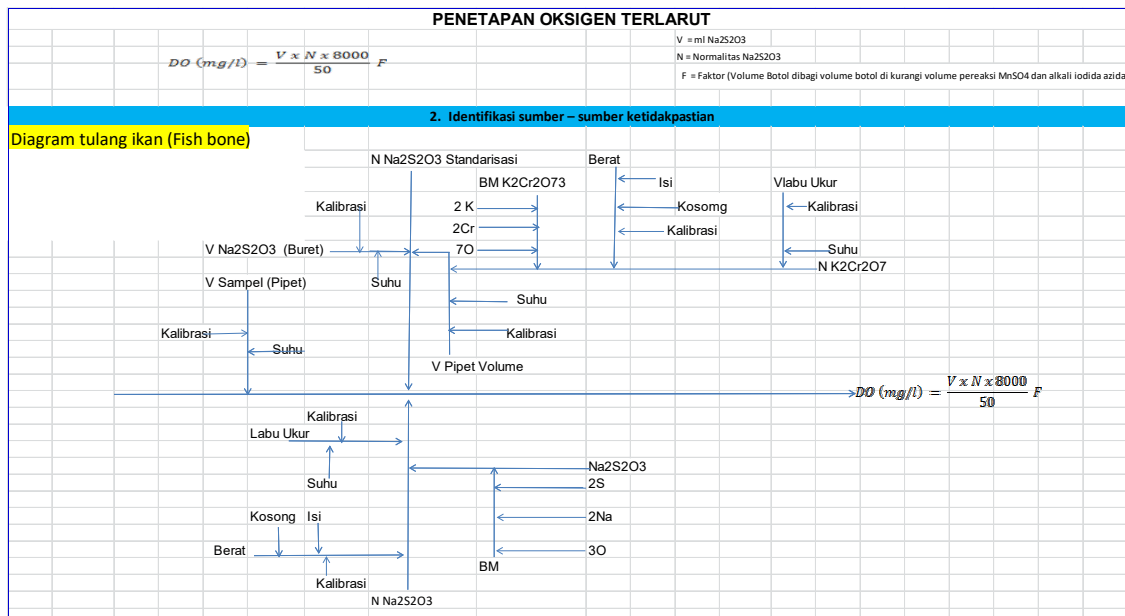
Rumus

$$DO (mg/l) = \frac{V \times N \times 8000}{50} F$$

V = ml Na₂S₂O₃

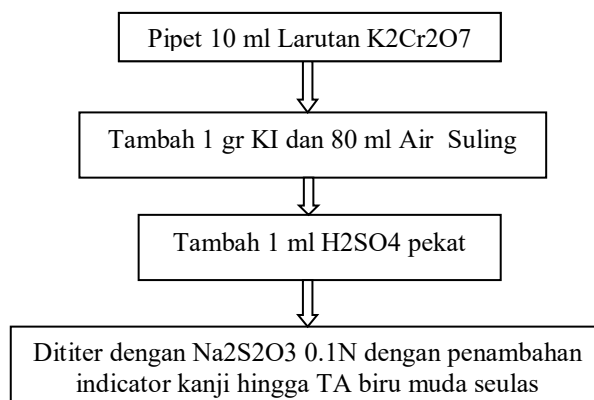
N = Normalitas Na₂S₂O₃


F = Faktor (Volume Botol dibagi volume botol di kurangi volume pereaksi MnSO₄ dan alkali iodida azida)



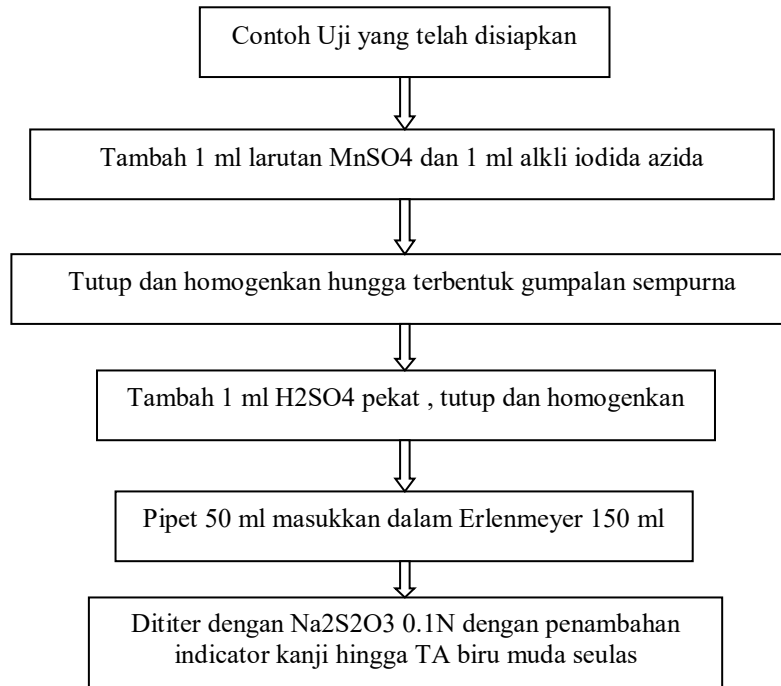
1. LANGKAH MEMBUAT MODEL PENGUJIAN

a. Normalisasi Na₂S₂O₃



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b. Penentuan Kadar Oksigen terlarut




2. KETIDAKPASTIAN NORMALITASTAS K₂Cr₂O₇

$$NK_{2Cr_{2}O_{7}} = \frac{g}{BE \ 2Cr_{2}O_{7}.V}$$

- a. Berat K₂Cr₂O₇ = 1.226 gram ± U timbangan
Ketidakpastian kalibrasi timbangan EKI-180256 C
U_{95%} timbangan ± 0.001 mg
K= 1,96

$$\begin{aligned}
 U \text{ timbangan} &= \sqrt{\left(\frac{U_{95\%}}{k}\right)^2} \\
 &= \sqrt{\left(\frac{0.001}{1,96}\right)^2} \\
 &= \sqrt{(0.0005)^2} \\
 &= 0.00051
 \end{aligned}$$

Berat K₂Cr₂O₇ = 1.226 ± 0,00051 gram

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- b. Berat Molekul K₂Cr₂O₇ (BM K₂Cr₂O₇)

$$K = 2 \times 39,0983 = 78,1996 \pm {}^2U_{Ca} = 2 \times 0,0001 = 0,0002$$

$$Cr = 2 \times 51,9961 = 103,992 \pm {}^2U_{Cr} = 2 \times 0,0006 = 0,0012$$

$$O = 7 \times 15,9994 = 111,996 \pm {}^7U_O = 7 \times 0,0003 = 0,0021$$

$$= 294,185 \pm 0,0014$$

$$\begin{aligned} \text{Ketidakpastian BM K}_2\text{Cr}_2\text{O}_7 &= \sqrt{\left(\frac{2UK}{\sqrt{3}}\right)^2 + \left(2\frac{UCr}{\sqrt{3}}\right)^2 + \left(\frac{73UO}{\sqrt{3}}\right)^2} \\ &= \sqrt{\left(\frac{0,0002}{\sqrt{3}}\right)^2 + \left(\frac{0,0012}{\sqrt{3}}\right)^2 + \left(\frac{0,0021}{\sqrt{3}}\right)^2} \\ &= \sqrt{(0,00011547)^2 + (0,00068)^2 + (0,0012)^2} \\ &= \sqrt{0,000000133 + 0,00000046 + 0,0000144} \\ &= \sqrt{0,0000196} \\ &= 0,0014 \end{aligned}$$

$$\text{Berat Molekul K}_2\text{Cr}_2\text{O}_7 = 294,185 \pm 0,0014$$

- c. Ketidakpastian labu ukur 1000 ml Kalibrasi labu Ukur EKI-160154 G

Volume Labu Ukur = 1000 ml

V Koreksi = 0,75

V Terkoreksi = 999,25 ± 0,425074 ml

Suhu Kalibrasi = 20,7 oC

Suhu Ruang Uji = 23 oC


Koefisien muai = 0,00021/oC

U_{95%} = 0,75 ml

K = 1,96

$$\begin{aligned} U \text{ Labu Ukur} &= \left(\frac{U_{95\%}}{k}\right)^2 + \sqrt{\left(\frac{V_{\text{terkoreksi}} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2} \\ &= \left(\frac{0,75}{1,96}\right)^2 + \sqrt{\left(\frac{999,25 \times (23 - 20,7) \times 0,00021}{\sqrt{3}}\right)^2} \\ &= (0,382633061)^2 + \sqrt{\left(\frac{0,48263775}{1,732}\right)^2} \\ &= 0,14642365 + \sqrt{0,27865} \\ &= 0,14642365 + 0,425074 \\ &= 0,425270 \end{aligned}$$

- d. Normalitas K₂Cr₂O₇ = $\frac{\text{Berat K}_2\text{Cr}_2\text{O}_7}{(\text{BE K}_2\text{Cr}_2\text{O}_7 \times V^{\frac{\text{terkoreksi}}{1000}})} \pm M \text{ K}_2\text{Cr}_2\text{O}_7 \times \sqrt{\left(\frac{M_{\text{timbang}}}{U_{\text{timbang}}}\right)^2 + \left(\frac{U_{\text{BMK}_2\text{Cr}_2\text{O}_7}}{M_{\text{BMK}_2\text{Cr}_2\text{O}_7}}\right)^2 + \left(\frac{M \text{ Labu ukur}}{V_{\text{Koreksi}}}\right)^2}$

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$$\begin{aligned}
&= \frac{1.226}{\left(\frac{294,185}{6} \times \frac{999,25}{1000}\right)} \pm N_{CK2Cr2O7} \times \sqrt{\left(\frac{0,0005}{1.226}\right)^2 + \left(\frac{0,0014}{294,185}\right)^2 + \left(\frac{0,425074}{999,25}\right)^2} \\
&= 0.025 \pm 0.025 \times \sqrt{(0,00040783)^2 + (0,0000047589)^2 + (0,000425)^2} \\
&= 0.025 \pm 0.025 \times \sqrt{(0,000000166 + 0,000000000226 + 0,000000005808)} \\
&= 0.025 \pm 0.025 \times \sqrt{0,0000001669} \\
&= 0.025 \pm (0.025 \times 0,000409)
\end{aligned}$$

Normalitas K₂Cr₂O₇ = 0.025 ± 0,0000102

3. KETIDAKPASTIAN NORMALITAS Na₂S₂O₃

$$MNa_2S_2O_3 = \frac{g}{BM Na_2S_2O_3}$$

- a. Berat Na₂S₂O₃ = 6.205 gram ± U timbangan
Ketidakpastian kalibrasi timbangan EKI-180256 C
U_{95%} timbangan ± 0.001 mg
K= 1,96


$$\begin{aligned}
U \text{ timbangan} &= \sqrt{\left(\frac{U_{95\%}}{k}\right)^2} \\
&= \sqrt{\left(\frac{0,001}{1,96}\right)^2} \\
&= \sqrt{(0,0005)^2} \\
&= 0.00051
\end{aligned}$$

Berat Na₂S₂O₃ = 6.205 ± 0,00051 gram

- b. Berat Molekul Na₂S₂O₃.5H₂O (BM Na₂S₂O₃.5H₂O)

$$\begin{aligned}
2Na &= 2 \times 22,98976928 = 45,97953856 \pm {}^2U_{Na} = 2 \times 0.00000002 = 0,00000004 \\
2S &= 2 \times 32,065 = 64,13 \pm {}^2U_S = 2 \times 0.0025 = 0,005 \\
10H &= 10 \times 1,00794 = 10,0794 \pm {}^{10}U_H = 10 \times 0,00007 = 0,0007 \\
8O &= 8 \times 15,9994 = 127,9952 \pm {}^8U_O = 8 \times 0.0003 = 0.0024 \\
&= 248,1841386 \pm 0.003227486
\end{aligned}$$

$$\begin{aligned}
\text{Ketidakpastian BM Na}_2\text{S}_2\text{O}_3 &= \sqrt{\left(\frac{2UNa}{\sqrt{3}}\right)^2 + \left(\frac{10UH}{\sqrt{3}}\right)^2 + \left(\frac{2US}{\sqrt{3}}\right)^2 + \left(\frac{8UO}{\sqrt{3}}\right)^2} \\
&= \sqrt{\left(\frac{0,00000004}{\sqrt{3}}\right)^2 + \left(\frac{0,0007}{\sqrt{3}}\right)^2 + \left(\frac{0,005}{\sqrt{3}}\right)^2 + \left(\frac{0,0024}{\sqrt{3}}\right)^2}
\end{aligned}$$

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$$\begin{aligned}
&= \sqrt{(0,00000002309)^2 + (0,00040414)^2 + (0,0028867)^2 + (0,00138564)^2} \\
&= \sqrt{5,3315 E - 16 + 1,6 E - 7 + 8,33 E - 6 + 1,92 E - 6} \\
&= \sqrt{0,00001041} \\
&= 0,0032
\end{aligned}$$

Berat Molekul $Na_2S_2O_3 = 248,184 \pm 0,003$

- e. Ketidakpastian labu ukur 1000 ml Kalibrasi labu Ukur EKI-160154 G

Volume Labu Ukur = 1000 ml

V Koreksi= 0.75

V Terkoreksi = 999,25 ± 0,425074 ml

Suhu Kalibrasi= 20,7 oC

Suhu Ruang Uji= 23 oC

Koefisien muai= 0,00021/oC

U95%= 0,75 ml


K= 1,96

$$\begin{aligned}
U \text{ Labu Ukur} &= \left(\frac{U_{95\%}}{k}\right)^2 + \sqrt{\left(\frac{V_{\text{terkoreksi}} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2} \\
&= \left(\frac{0,75}{1,96}\right)^2 + \sqrt{\left(\frac{999,25 \times (23 - 20,7) \times 0,00021}{\sqrt{3}}\right)^2} \\
&= (0,382633061)^2 + \sqrt{\left(\frac{0,48263775}{1,732}\right)^2} \\
&= 0,14642365 + \sqrt{0,27865} \\
&= 0,14642365 + 0,425074 \\
&= 0,425270
\end{aligned}$$

$$\begin{aligned}
c. \text{ Normalitas } Na_2S_2O_3 &= \frac{\text{Berat } Na_2S_2O_3}{(\text{BE } Na_2S_2O_3 \times V_{\text{terkoreksi}}^{1000})} \pm N Na_2S_2O_3 \times \sqrt{\left(\frac{M_{\text{timbang}}}{U_{\text{timbang}}}\right)^2 + \left(\frac{UBMENa_2S_2O_3}{MBMa_2S_2O_3}\right)^2 + \left(\frac{M \text{ Labu ukur}}{VKoreksi}\right)^2} \\
&= \frac{6,205}{(248,184 \times \frac{999,25}{1000})} \pm N Na_2S_2O_3 \times \sqrt{\left(\frac{0,00051}{6,205}\right)^2 + \left(\frac{0,0032}{248,184}\right)^2 + \left(\frac{0,425270}{999,25}\right)^2} \\
&= 0,025 \pm 0,025 \times \sqrt{((0,0000822)^2 + (0,0000128936)^2 + (0,000425)^2)} \\
&= 0,025 \pm 0,025 \times \sqrt{(0,00000000676 + 0,0000000016624 + 0,0000001806)} \\
&= 0,025 \pm 0,025 \times \sqrt{0,0000001875} \\
&= 0,025 \pm (0,025 \times 0,00043)
\end{aligned}$$

Normalitas $Na_2S_2O_3 = 0,025 \pm 0,00001075$

Kawasan Pusat Pemerintahan Provinsi Banten (KP3B)
Jl. Syech Nawawi Al Bantani, Palima Kota Serang Telp/Fax (0254) 267094

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4. KETIDAKPASTIAN STANDARISASI Na₂S₂O₇

- a. Ketidakpastian VEDTA Menggunakan Pipet Gondok Kalibrasi EKI-160154 FP

Volume Pipet Volume = 10 ml

V Koreksi= 0.03 ml

V Terkoreksi= 9,97 ± 0,00343 ml

Suhu Kalibrasi= 20,7 oC

Suhu Ruang Uji= 23 oC

Koefisien muai= 0,00021/oC

U95%= 0,03 ml

K= 1,96

$$\begin{aligned}
U \text{ Pipet Volume} &= \left(\frac{U_{95\%}}{k}\right)^2 + \sqrt{\left(\frac{V_{\text{terkoreksi}} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2} \\
&= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{9,97 \times (23 - 20,7) \times 0,00021}{\sqrt{3}}\right)^2} \\
&= (0,02551)^2 + \sqrt{\left(\frac{0,00483}{1,732}\right)^2} \\
&= 0,00065076 + \sqrt{(0,0027887)^2} \\
&= 0,00065076 + 0,0027887 \\
&= 0,00343
\end{aligned}$$

- b. Ketidakpastian V Na₂S₂O₃ Menggunakan Buret Kalibrasi EKI-160154 IU

Volume Buret = 10 ml

V Koreksi= 0.07 ml

V Terkoreksi= 9,93 ± 0,00404 ml

Suhu Kalibrasi= 20,2 oC


Suhu Ruang Uji= 23 oC

Koefisien muai= 0,00021/oC

U95%= 0,07 ml

K= 1,96

$$\begin{aligned}
U \text{ Buret} &= \left(\frac{U_{95\%}}{k}\right)^2 + \sqrt{\left(\frac{V_{\text{terkoreksi}} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2} \\
&= \left(\frac{0,07}{1,96}\right)^2 + \sqrt{\left(\frac{9,93 \times (23 - 20,2) \times 0,00021}{\sqrt{3}}\right)^2} \\
&= (0,02551)^2 + \sqrt{\left(\frac{0,005868}{1,732}\right)^2} \\
&= 0,00065076 + \sqrt{(0,004277)^2}
\end{aligned}$$

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$$= 0,00065076 + 0,065398777$$

$$= 0,00402$$

c. Normalitas Na₂S₂O₃ Standarisasi = $\frac{N \text{ Na}_2\text{S}_2\text{O}_3 \times V \text{ terkoreksi}}{V \text{ terkoreksi Buret}} \pm$

$$N \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standarisasi} \times \sqrt{\left(\frac{UN \text{ Na}_2\text{S}_2\text{O}_3}{N \text{ Na}_2\text{S}_2\text{O}_3}\right)^2 + \left(\frac{UV \text{ terkoreksi pipet}}{V \text{ terkoreksi pipet}}\right)^2 + \left(\frac{UV \text{ terkoreksi buret}}{V \text{ terkoreksi Buret}}\right)^2}$$

$$= \frac{0,025 \times 9,93}{9,93} \pm 0,025 \times \sqrt{\left(\frac{0,000043}{0,1}\right)^2 + \left(\frac{0,00343}{9,97}\right)^2 + \left(\frac{0,00402}{9,93}\right)^2}$$

$$= 0,025 \pm 0,025 \times \sqrt{(0,00043)^2 + (0,000344)^2 + (0,000404)^2}$$

$$= 0,025 \pm 0,025 \times \sqrt{(0,0000001849 + 0,0000001183 + 0,00000016377)}$$

$$= 0,025 \pm 0,025 \times \sqrt{0,000000467}$$

$$= 0,025 \pm (0,025 \times 0,0007)$$

Molaritas Na₂S₂O₃ Standarisasi = 0,025 ± 0,00002

5. KETIDAKPASTIAN VOLUME SAMPEL

Volume Sampel = 50 ml Kalibrasi EKI-160154EX

V Koreksi= 0.05 ml

V Terkoreksi= 49,95 ± 0,01 ml

Suhu Kalibarsi= 20,7 oC

Suhu Ruang Uji= 23 oC

Koefisien muai= 0,00021/oC

U95%= 0,05 ml

K= 1,96

$$U \text{ Pipet Gondok} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{V \text{ terkoreksi} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2}$$


$$= \left(\frac{0,05}{1,96}\right)^2 + \sqrt{\left(\frac{49,95 \times (23 - 20,7) \times 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,02551)^2 + \sqrt{\left(\frac{0,0241}{1,732}\right)^2}$$

$$= 0,00065 + \sqrt{(0,0139)^2}$$

$$= 0,00065 + 0,0139$$

$$= 0,01458$$

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6. KETIDAKPASTIAN PRESISI, AKURASI OKSIGEN TERLARUT

a. Presisi

Presisi Oksigen Terlarut	Sampel	146/AS/DLHK/X/2018
	No	Sample
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
	7	7
		Rerata
		SD
		% RSD
		µPM

7. KETIDAKPASTIAN OKSIGEN TERLARUT

a. V Na₂S₂O₃ Untuk Titration Sampel Kalibrasi EKI-160154 HK

Volume Pipet Ukur = 1,1 ml

V Koreksi= 0.03 ml

V Terkoreksi= 1,07 ± 0,00036 ml

Suhu Kalibrasi= 20,2 oC

Suhu Ruang Uji= 23 oC

Koefisien muai= 0,00021/oC

U95%= 0,03 ml


K= 1,96

$$\begin{aligned}
U \text{ Pipet} &= \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{V_{\text{terkoreksi}} \times (\text{Suhu ruang uji} - \text{Suhu Kalibrasi}) \times \text{Koefisien muai}}{\sqrt{3}}\right)^2} \\
&= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{1,07 \times (23 - 20,2) \times 0,00021}{\sqrt{3}}\right)^2} \\
&= (0,0153)^2 + \sqrt{\left(\frac{0,00060669}{1,732}\right)^2} \\
&= 0,00023 + \sqrt{(0,00035028)^2} \\
&= 0,00023 + \sqrt{0,000000122696} \\
&= 0,00023 + 0,00011 \\
&= 0,00034
\end{aligned}$$

b. OKSIGEN TERLARUR

$$\text{Oksigen Terlarut} = \frac{V_{\text{terkoreksi}} \times UNa_2S_2O_3 \text{ Standarisasi} \times 8000}{50} \times F$$

$$= \frac{1,07 \times 0,025 \times 8000}{50} \times \left(\frac{300}{298}\right)$$

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$$= 4,28 \times 1,0067$$

$$= 4,301 \text{ mg/l}$$

c. Ketidakpastian Oksigen Terlarut Sampel No :

$$\begin{aligned}
&= \text{Oksigen Terlarut} \times \sqrt{\left(\frac{UV_{\text{sampel}}}{V_{\text{sampel}}}\right)^2 + \left(\frac{UN \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standarisasi}}{N \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standarisasi}}\right)^2 + \left(\frac{UN \text{ Na}_2\text{S}_2\text{O}_3}{N \text{ Na}_2\text{S}_2\text{O}_3}\right)^2 + \left(\frac{UK2Cr2O7}{NK2CrO7}\right)^2 + \left(\frac{UV \text{ Titrasi}}{V \text{ Titrasi}}\right)^2 + \left(\frac{UPresisi}{Presisi}\right)^2} \\
&= 4,301 \times \sqrt{\left(\frac{0,01458}{49,95}\right)^2 + \left(\frac{0,00002}{0,025}\right)^2 + \left(\frac{0,00001085}{0,025}\right)^2 + \left(\frac{0,000015}{0,025}\right)^2 + \left(\frac{0,000015}{1,07}\right)^2 + \left(\frac{0,05}{4,40}\right)^2} \\
&= 4,301 \times \sqrt{(0,00029)^2 + (0,0008)^2 + (0,000434)^2 + (0,0006)^2 + (0,000014)^2 + (0,011)^2} \\
&= 4,301 \times \sqrt{0,00000000841 + 0,00000064 + 0,000000188 + 0,00000036 + 0,00000094 + 0,012} \\
&= 4,301 \times \sqrt{0,0146} \\
&= 4,301 \times 0,1209 \\
&= 0,052
\end{aligned}$$

$$\text{Diperluas} = 2 \times 0,052 = 0,104$$

Laporan Oksigen Terlarut = 4,301 ± 0,104 mg/l

$$\begin{aligned}
\% \text{RSU} &= 100 \times \frac{0,104}{4,301} \\
&= 100 \times 0,024 \\
&= 2,4
\end{aligned}$$

Uraian Koefisien Sensitifitas

$$V \text{ Sampel} = \frac{UV \text{ sampel}}{V \text{ Sampel}} = \frac{0,01458}{49,95} = 0,00029$$

$$V \text{ Na}_2\text{S}_2\text{O}_3 = \frac{UN \text{ Na}_2\text{S}_2\text{O}_3}{V \text{ Na}_2\text{S}_2\text{O}_3} = \frac{0,000015}{1,07} = 0,000014$$

$$N \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standar} = \frac{UN \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standar}}{N \text{ Na}_2\text{S}_2\text{O}_3 \text{ Standat}} = \frac{0,00002}{0,025} = 0,0008$$

$$N \text{ K}_2\text{Cr}_2\text{O}_7 = \frac{UBN \text{ K}_2\text{Cr}_2\text{O}_7}{BM \text{ K}_2\text{Cr}_2\text{O}_7} = \frac{0,000015}{0,025} = 0,0006$$

