LAPORAN ESTIMASI KETIDAKPASTIAN PENGUKURAN BOD DENGAN PENGENCERAN

1	PARAMETER	:	BOD DALAM AIR LIMBAH
2	METODE	:	SNI 6989-72 2009
3	NAMA ALAT/MEREK/TIPE	:	PIPET UKUR
4	KODE ALAT	:	-
5	TANGGAL KALIBRASI	:	18 April 2016
6	KODE KALIBRASI ALAT	:	EKI-160154 HK
7	TANGGAL PENGUJIAN	:	18 OKTOBER 2018
8	TANGGAL PERHITUNGAN	:	24 OKTOBER 2018
9	NAMA ANALIS	:	Dian Fisti A, S.Si
10	NAMA PENYELIA	:	Epi Dinasari S.Si
11	LAPORAN KADAR BOD	:	6,10 ± 0.03 mg/l

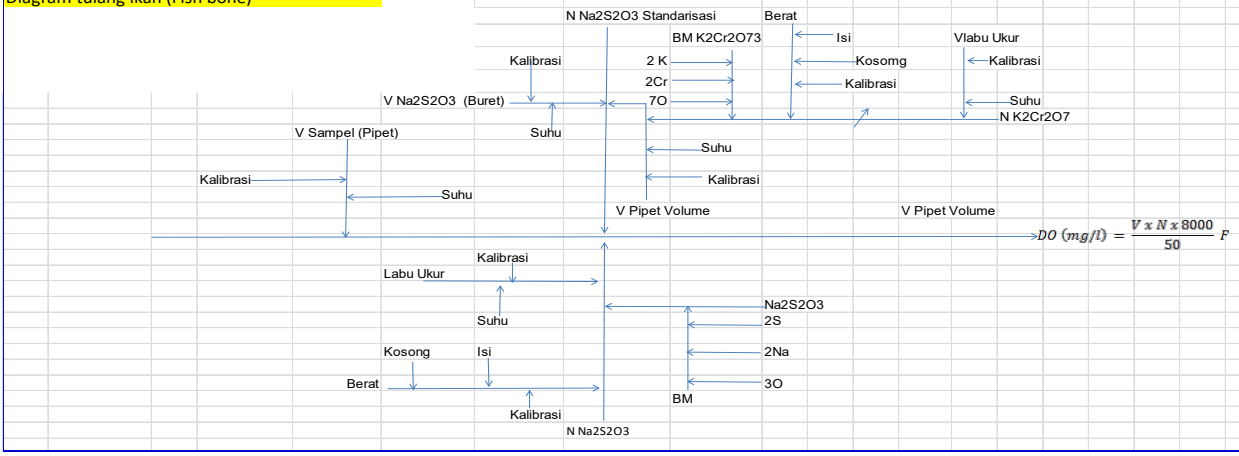
A. PENETAPAN OKSIGEN TERLARUT

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

V = ml Na2S2O3
N = Normalitas Na2S2O3
F = Faktor (Volume Botol dibagi volume botol di kurangi volume pereaksi MnSO4 dan alkali iodida azida)

2. Identifikasi sumber – sumber ketidakpastian

Diagram tulang ikan (Fish bone)



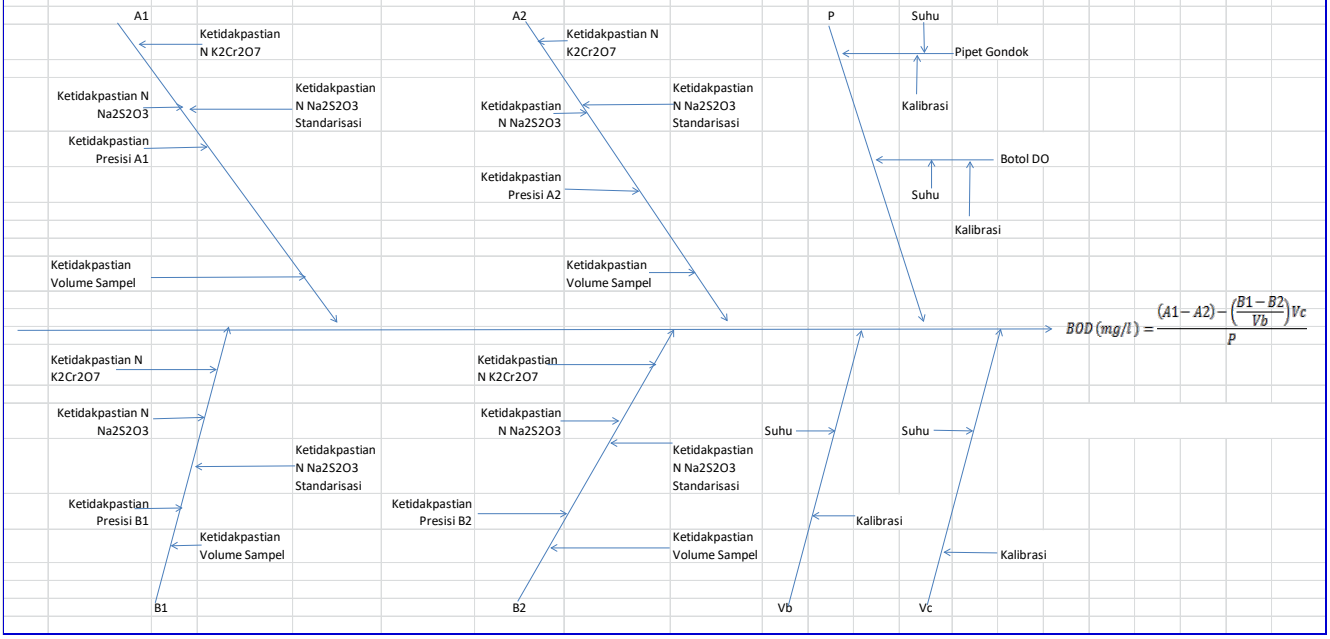
B. PENETAPAN BOD

BOD_5	=	Kadar BOD 5 sampel (mg/l)
A1	=	Kadar oksigen terlarut sampel sebelum inkubasi (0 hari) (mg/l)
A2	=	Kadar oksigen terlarut sampel setelah inkubasi (5 hari) (mg/l)
B1	=	Kadar oksigen terlarut blanko sebelum inkubasi (0 hari) (mg/l)
B2	=	Kadar oksigen terlarut blanko ssetelah inkubasi (5 hari) (mg/l)
Vb	=	Volume suspensi mikroba (ml) dalam botol DO blanko
Vc	=	Volume suspensi mikroba (ml) dalam botol DO sampel
P	=	Perbandingan volume V1 sampel per volume total V2

$$BOD\ (mg/l) = \frac{(A1 - A2) - \left(\frac{B1 - B2}{Vb}\right) Vc}{P}$$

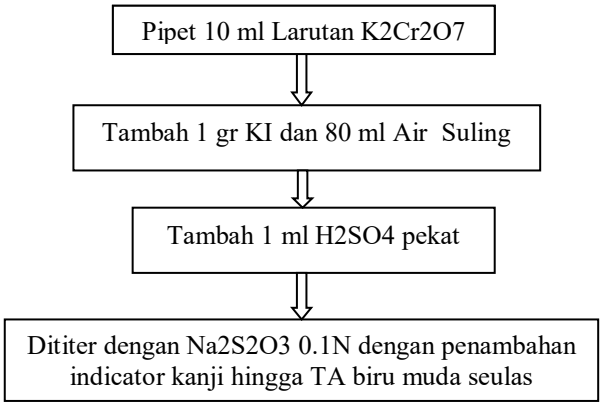
2. Identifikasi sumber – sumber ketidakpastian

Diagram tulang ikan (Fish bone)

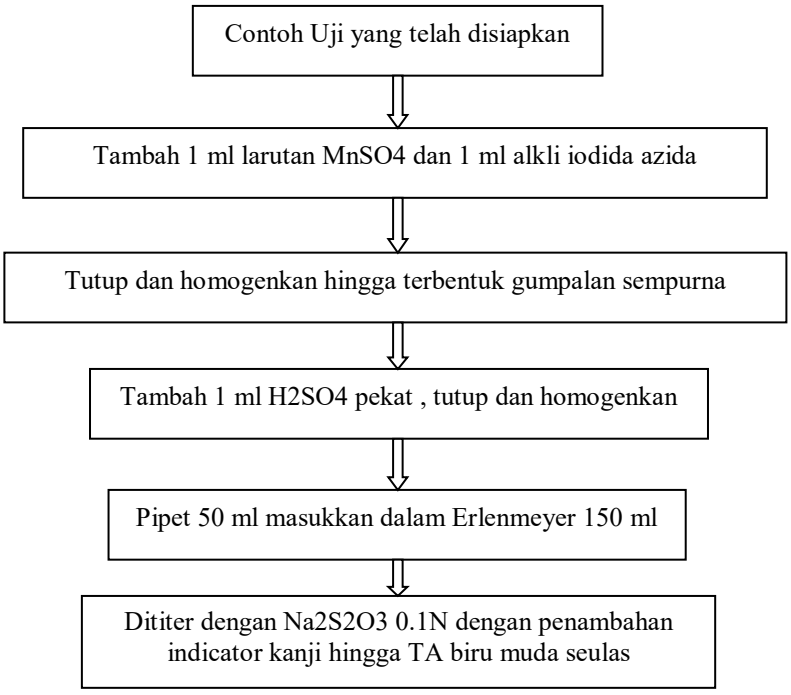


LANGKAH MEMBUAT MODEL PENGUJIAN

a. Normalisasi Na2S2O3



b. Penentuan Kadar Oksigen terlarut



1. KETIDAKPASTIAN NORMALITASTAS K2Cr2O7

$$NK2Cr2O7 = \frac{g}{BE\ 2Cr2O7.V}$$

a. Berat K2Cr2O7 = 1.226 gram ± U timbangan
Ketidakpastian kalibrasi timbangan EKI-180256 C

U95% timbangan ± 0.001 mg
K= 1,96

U timbangan $= \sqrt{\left(\frac{U95\%}{k}\right)^2}$

$= \sqrt{\left(\frac{0.001}{1,96}\right)^2}$

$= \sqrt{(0.0005)^2}$

$= 0.00051$

Berat K2Cr2O7 = 1.226 ± 0,00051 gram

b. Berat Molekul K2Cr2O7 (BM K2Cr2O7)

K = 2 x 39.0983 = 78.1996 ± $^2U_{Ca}$ = 2 x 0.0001= 0.0002
Cr = 2 x 51.9961= 103.992 ± $^2U_{Cr}$ = 2 x 0.0006= 0.0012
O = 7 x 15,9994 = 111.996 ± ^7U_O = 7 x 0.0003= 0.0021
= 294,185 ± 0,0014

Ketidakpastian BM K2Cr2O7 $= \sqrt{\left(\frac{2UK}{\sqrt{3}}\right)^2 + \left(2\frac{UCr}{\sqrt{3}}\right)^2 + \left(\frac{73UO}{\sqrt{3}}\right)^2}$

$= \sqrt{\left(\frac{0,0002}{\sqrt{3}}\right)^2 + \left(\frac{0.0012}{\sqrt{3}}\right)^2 + \left(\frac{0.0021}{\sqrt{3}}\right)^2}$

$= \sqrt{(0,00011547)^2 + (0,00068)^2 + (0,0012)^2}$
$= \sqrt{0,0000000133 + 0,00000046 + 0,00000144}$
$= \sqrt{0,00000196}$
$= 0,0014$

Berat Molekul K2Cr2O7 = 294,185 ± 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 ± 0,183 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,75 ml
K= 1,96

U Labu Ukur= $\left(\frac{U95\%}{k}\right)2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)2}$

$= \left(\frac{0,75}{1,96}\right)^2 + \sqrt{\left(\frac{999,25\ x\ (21 - 20,7) x\ 0,00021}{\sqrt{3}}\right)^2}$

$$= (0{,}382633061)^2 + \sqrt{\left(\frac{0{,}063}{1{,}732}\right)^2}$$

$$= 0{,}14642365 + \sqrt{0{,}00129}$$

$$= 0{,}147 + 0{,}036$$

$$= 0{,}183$$

d. Normalitas $K2Cr2O7 = \frac{Berat\ K2Cr2O7}{(BE\ K2Cr2O7\ x\ V\frac{terkoreksi}{1000})} \pm N\ K2Cr2O7\ x \sqrt{\left(\frac{Mtimbang}{Utimbaang}\right)^2 + \left(\frac{UBMK2Cr2O7}{MBMK2Cr2O7}\right)^2 + \left(\frac{M\ Labu\ ukur}{VKoreksi}\right)^2}$

$$= \frac{1.226}{(\frac{294{,}185}{6} x \frac{999{,}25}{1000})} \pm N\ CK2Cr2O7\ x \sqrt{\left(\frac{0{,}0005}{1.226}\right)^2 + \left(\frac{0{,}0014}{294{,}185}\right)^2 + \left(\frac{0{,}183}{999{,}25}\right)^2}$$

$$= 0.025 \pm 0.025\ x \sqrt{(\ (0{,}00040783)^2 + (0{,}0000047589)^2 + (0{,}000183)^2)}$$

$$= 0.025 \pm 0.025\ x \sqrt{(\ 0{,}000000166 + 0{,}0000000000226 + 0{,}0000000335)}$$

$$= 0.025 \pm 0.025\ x \sqrt{0{,}0000001995}$$

$$= 0.025 \pm (0.025\ x\ 0{,}000446)$$

Normalitas $K2Cr2O7 = 0.025 \pm 0{,}000011$

2. KETIDAKPASTIAN NORMALITAS Na2S2O3

$$MNa2S2O3 = \frac{g}{BM\ Na2S2O3}$$

a. Berat $Na2S2O3$ = 6.205 gram ± U timbangan
Ketidakpastian kalibrasi timbangan EKI-180256 C
U95% timbangan ± 0.001 mg
K= 1,96

U timbangan = $\sqrt{\left(\frac{U95\%}{k}\right)^2}$

$$= \sqrt{\left(\frac{0.001}{1{,}96}\right)^2}$$

$$= \sqrt{(0.0005)^2}$$

$$= 0.00051$$

Berat $Na2S2O3$ = 6.205 ± 0,00051 gram

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

2Na = 2 x 22,98976928= 45,97953856 ± $^{2}U_{Na}$ = 2 x 0.00000002= 0,00000004
2S = 2 x 32,065 = 64,13 ± $^{2}U_{S}$ = 2 x 0.0025= 0,005
10H = 10 x 1,00794= 10,0794 ± $^{10}U_{H}$ = 10 x 0,00007= 0,0007
8O = 8 x 15,9994 = 127,9952 ± $^{8}U_{O}$ = 8 x 0.0003= 0.0024
= 248,1841386 ± 0.003227486

Ketidakpastian BM $Na2S2O3 = \sqrt{\left(\frac{2UNa}{\sqrt{3}}\right)^2 + \left(\frac{10UH}{\sqrt{3}}\right)^2 + \left(\frac{2US}{\sqrt{3}}\right)^2 + \left(\frac{8UO}{\sqrt{3}}\right)^2}$

$= \sqrt{\left(\frac{0,00000004}{\sqrt{3}}\right)^2 + \left(\frac{0.0007}{\sqrt{3}}\right)^2 + \left(\frac{0,005}{\sqrt{3}}\right)^2 + \left(\frac{0.0024}{\sqrt{3}}\right)^2}$

$= \sqrt{(0.00000002309)^2 + (0,00040414)^2 + (0,0028867)^2 + (0,00138564)^2}$
$= \sqrt{5,3315\ E-16 + 1,6\ E-7 + 8,33\ E-6 + 1,92\ E-6}$
$= \sqrt{0,00001041}$
= 0,0032

Berat Molekul $Na2S2O3$ = 248,184 ± 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 ± 0,183 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,75 ml
K= 1,96

U Labu Ukur= $\left(\frac{U95\%}{k}\right)2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)2}$

$= \left(\frac{0,75}{1,96}\right)^2 + \sqrt{\left(\frac{999,25\ x\ (21-20,7)x\ 0,00021}{\sqrt{3}}\right)^2}$

$= (0,382633061)^2 + \sqrt{\left(\frac{0,063}{1,732}\right)^2}$

$= 0,14642365 + \sqrt{0,00129}$

$= 0,147 + 0,036$

= 0,183

c. Normalitas $Na2S2O3 = \frac{Berat\ Na2S2O3}{(BE\ Na2S2O3\ x\ V\frac{terkoreksi}{1000})} \pm NNa2S2O3\ x\sqrt{\left(\frac{Mtimbang}{Utimbaang}\right)^2 + \left(\frac{UBMENa2S2O3}{MBMa2S2O3}\right)^2 + \left(\frac{M\ Labu\ ukur}{VKoreksi}\right)^2}$

$$= \frac{6.205}{(248{,}184x\frac{999{,}25}{1000})} \pm NNa2S2O3\ x\ \sqrt{\left(\frac{0{,}00051}{6.205}\right)^2 + \left(\frac{0{,}0032}{248{,}184}\right)^2 + \left(\frac{0{,}183}{999{,}25}\right)^2}$$

$$= 0{,}025\ \pm\ 0{,}025\ x\ \sqrt{(\ (0{,}0000822)^2 + (0{,}0000128936)^2 + (0{,}000183)^2)}$$

$$= 0{,}025 \pm\ 0{,}025x\ \sqrt{(\ 0{,}00000000676 + 0{,}00000000016624 + 0{,}0000000335)}$$

$$= 0{,}025 \pm\ 0{,}025\ x\ \sqrt{0{,}0000000104}$$

$$= 0{,}025\ \pm (0{,}025\ x\ 0{,}0002)$$

$Normalitas\ Na2S2O3 =$ **$0{,}025\ \pm\ 0{,}000005$**

3. KETIDAKPASTIAN STANDARISASI Na2S2O7

a. Ketidakpastian V K2Cr2O7 Menggunakan Pipet Gondok Kalibrasi EKI-160154 FP

Volume Pipet Volume = 10 ml
V Koreksi= 0.03 ml
V Terkoreksi= 9,97 ± 0,00101 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet Volume} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0{,}03}{1{,}96}\right)^2 + \sqrt{\left(\frac{9{,}97\ x\ (21 - 20{,}7)x0{,}00021}{\sqrt{3}}\right)^2}$$

$$= (0{,}02551)^2 + \sqrt{\left(\frac{0{,}00063}{1{,}732}\right)^2}$$

$$= 0{,}00065 + \sqrt{(0{,}000036)^2}$$

$$= 0{,}00065 + 0{,}00036$$

$$= 0{,}00101$$

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

Volume Buret = 10 ml
V Koreksi= 0.07 ml

V Terkoreksi= 9,93 ± 0,00223 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,07 ml
K= 1,96

$$\text{U Buret} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0{,}07}{1{,}96}\right)^2 + \sqrt{\left(\frac{9{,}93\ x\ (21-20{,}2)x0{,}00021}{\sqrt{3}}\right)^2}$$

$$= (0{,}0357)^2 + \sqrt{\left(\frac{0{,}00167}{1{,}732}\right)^2}$$

$$= 0{,}00127 + \sqrt{(0{,}00096)^2}$$

$$= 0{,}00127 + 0{,}00096$$

$$= 0{,}00223$$

c. Normalitas Na2S2O3 Standarisasi $= \frac{N\ \text{Na2S2O3}\ X\ V\ terkoreksi}{Vterkoreksi\ Buret} \pm$

$$N\ \text{Na2S2O3}\ Standarisasi\ x \sqrt{\left(\frac{UN\text{Na2S2O3}}{N\ \text{Na2S2O3}}\right)^2 + \left(\frac{UVterkoreksi\ pipet}{Vterkoreksi\ pipet}\right)^2 + \left(\frac{UVterkoreksi\ buret}{Vterkoreksi\ Buret}\right)^2}$$

$$= \frac{0{,}025\ x\ 9{,}93}{9{,}93} \pm 0{,}025\ x \sqrt{\left(\frac{0{,}000005}{0{,}025}\right)^2 + \left(\frac{0{,}00101}{9{,}97}\right)^2 + \left(\frac{0{,}00223}{9{,}93}\right)^2}$$

$$= 0{,}025 \pm 0{,}025\ x \sqrt{(0{,}0002)^2 + (0{,}0000101)^2 + (0{,}000224)^2)}$$

$$= 0{,}025 \pm 0{,}025\ x \sqrt{(0{,}0000004 + 0{,}000000000102 + 0{,}00000005)}$$

$$= 0{,}025 \pm 0{,}025\ x \sqrt{0{,}00000045}$$

$$= 0{,}025 \pm (0{,}025\ x\ 0{,}00067)$$

Normalitas Na2S2O3 Standarisasi = 0,025 ± 0,000017

4. 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= 21 oC

Koefisien muai= 0,00021/oC
U95%= 0,05 ml
K= 1,96

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

$$= \left(\frac{0{,}05}{1{,}96}\right)^2 + \sqrt{\left(\frac{49{,}95\ x\ (21 - 20{,}7) x 0{,}00021}{\sqrt{3}}\right)^2}$$

$$= (0{,}02551)2 + \sqrt{\left(\frac{0{,}0031}{1{,}732}\right)^2}$$

$$= 0{,}00065 + \sqrt{(0{,}0018)^2}$$

$$= 0{,}00065 + 0{,}0018$$

$$= 0{,}00247$$

5. KETIDAKPASTIAN OKSIGEN TERLARUT BLANKO NOL HARI (B1)

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

Volume Pipet Ukur = 0,6 ml
V Koreksi= 0.03 ml
V Terkoreksi= 0,57 ± 0,000285 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0{,}03}{1{,}96}\right)^2 + \sqrt{\left(\frac{057\ x\ (21 - 20{,}2)\ x\ 0{,}00021}{\sqrt{3}}\right)^2}$$

$$= (0{,}0153)^2 + \sqrt{\left(\frac{0{,}000096}{1{,}732}\right)^2}$$

$$= 0{,}00023 + \sqrt{(0{,}000055)^2}$$

$$= 0{,}00023 + \sqrt{0.0000000003}$$

$$= 0{,}00023 + 0{,}000055$$

$$= 0{,}000285$$

b. OKSIGEN TERLARUT BLANKO (B1)

Oksigen Terarut $= \frac{V\ terkoreksi\ x\ UNa2S2O3\ Staandarisasi\ x8000}{50}\ x\ F$

$$= \frac{0,57\ x\ 0,025\ x\ 8000}{50}\ x\ (\frac{300}{298})$$

$$= 2,28\ x\ 1,0067$$

= 2,295 mg/l

c. KETIDAKPASTIAN OKSIGEN TERLARUT BLANKO NOL HARI (B1)

$$= Oksigen\ Terlarut\ x\sqrt{\left(\frac{UVsampel}{Vsampel}\right)^2 + \left(\frac{UN\ Na2S2O3\ \ Standarisasi}{N\ Na2S2O3\ Standarisasi}\right)^2 + \left(\frac{UN\ Na2S2O3}{N\ Na2S2O3}\right)^2 + \left(\frac{UK2Cr2O7}{NK2CrO7}\right)^2 + \left(\frac{UV\ Titrasi}{V\ Titrasi}\right)^2}$$

$$= 2,295\ x\sqrt{\left(\frac{0,00247}{49,95}\right)^2 + \left(\frac{0,000017}{0.025}\right)^2 + \left(\frac{0,000005}{0.025}\right)^2 + \left(\frac{0,00001}{0,025}\right)^2 + \left(\frac{0.000285}{0,57}\right)^2}$$

$$= 2,295\ x\sqrt{(0,000049)^2 + (0,00068)^2 + (0,0002)^2 + (0,0004)^2\ + (0,0005)^2}$$

$$= 2,295\ \ x\sqrt{0,0000000024 + 0,00000046 + 0,0000004\ \ +\ 0.00000016 +\ 0.00000025}$$

$$= 2,295\ \ x\sqrt{0,00000127}$$

$$= 2,295\ \ x\ 0,0011$$

$$= 0,0024$$

6. **OKSIGEN TERLARUT** BLANKO LIMA HARI (B2)

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

Volume Pipet Ukur = 0,45 ml
V Koreksi= 0.03 ml
V Terkoreksi= 0.43 ± 0,00024 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$U\ Pipet\ = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{0.43\ x\ (21 - 20,2)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0153)^2 + \sqrt{\left(\frac{0,000027}{1,732}\right)^2}$$

$$= 0{,}00023 + \sqrt{(0{,}0000156)^2}$$
$$= 0{,}00023 + \sqrt{0.000000000224}$$
$$= 0{,}00023 + 0{,}0000156$$
$$= 0{,}00024$$

b. Oksigen Terarut B2 $= \frac{V\ terkoreksi\ x\ UNa2S2O3\ Staandarisasi\ x8000}{50}\ x\ F$

$$= \frac{0,542\ x\ 0,025\ x\ 8000}{50}\ x\ \left(\frac{300}{298}\right)$$

$$= 1,68\ x\ 1,0067$$

= 1,70 mg/l

c. KETIDAKPASTIAN OKSIGEN TERLARUT BLANKO LIMA HARI (B2)

$$= Oksigen\ Terlarut\ x\sqrt{\left(\frac{UVsampel}{Vsampel}\right)^2 + \left(\frac{UN\ Na2S2O3\ \ Standarisasi}{N\ Na2S2O3\ Standarisasi}\right)^2 + \left(\frac{UN\ Na2S2O3}{N\ Na2S2O3}\right)^2 + \left(\frac{UK2Cr2O7}{NK2CrO7}\right)^2 + \left(\frac{UV\ Titrasi}{V\ Titrasi}\right)^2}$$

$$= 1,70\ X\ \sqrt{\left(\frac{0{,}00247}{49{,}95}\right)^2 + \left(\frac{0{,}000017}{0.025}\right)^2 + \left(\frac{0{,}000005}{0.025}\right)^2 + \left(\frac{0{,}000001}{0{,}025}\right)^2 + \left(\frac{0.00028}{0.42}\right)^2}$$

$$= 1,70\ \ x\sqrt{(0{,}000049)^2 + (0{,}00068)^2 + (0{,}0002)^2 + (0{,}00004)^2\ + (0{,}00057)^2}$$

$$= 1,70\ \ x\sqrt{0{,}0000000024 + 0{,}00000046 + 0{,}0000004\ +\ 0.00000016 +\ 0.00000033}$$

$$= 1,70\ \ x\sqrt{0{,}000000127}$$

$$= 1,70\ \ x\ 0{,}0011$$

$$= 0{,}00187$$

7. KETIDAKPASTIAN OKSIGEN TERLARUT SAMPEL NOL HARI (A1) SAMPEL NO :145/AL/DLHK/X/2018

d. V Na2S2O3 Untuk Titrasi Sampel Kalibrasi EKI-160154 HK
Volume Pipet Ukur = 1,0 ml
V Koreksi= 0.03 ml
V Terkoreksi= 0,97 ± 0,000265 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$U\ Pipet\ = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0{,}03}{1{,}96}\right)^2 + \sqrt{\left(\frac{097\ x\ (21-20{,}2)\ x\ 0{,}00021}{\sqrt{3}}\right)^2}$$

$$= (0{,}0153)^2 + \sqrt{\left(\frac{0{,}00006}{1{,}732}\right)^2}$$

$$= 0{,}00023 + \sqrt{(0{,}000035)^2}$$
$$= 0{,}00023 + \sqrt{0.000000000123}$$
$$= 0{,}00023 + 0{,}000035$$
$$= 0{,}000265$$

e. OKSIGEN TERLARUT SAMPEL (A1)

Oksigen Terarut $= \frac{V\ terkoreksi\ x\ UNa2S2O3\ Staandarisasi\ x8000}{50}\ x\ F$

$$= \frac{0{,}59\ x\ 0{,}025\ x\ 8000}{50}\ x\ \left(\frac{300}{298}\right)$$

$$= 3{,}88\ x\ 1{,}0067$$

= 3,906 mg/l

f. KETIDAKPASTIAN OKSIGEN TERLARUT SAMPEL NOL HARI (A1)

$$= Oksigen\ Terlarut\ x\sqrt{\left(\frac{UVsampel}{Vsampel}\right)^2 + \left(\frac{UN\ Na2S2O3\ \ Standarisasi}{N\ Na2S2O3\ Standarisasi}\right)^2 + \left(\frac{UN\ Na2S2O3}{N\ Na2S2O3}\right)^2 + \left(\frac{UK2Cr2O7}{NK2CrO7}\right)^2 + \left(\frac{UV\ Titrasi}{V\ Titrasi}\right)^2}$$

$$= 3{,}906x\sqrt{\left(\frac{0{,}00247}{49{,}95}\right)^2 + \left(\frac{0{,}000017}{0.025}\right)^2 + \left(\frac{0{,}000005}{0.025}\right)^2 + \left(\frac{0{,}00001}{0{,}025}\right)^2 + \left(\frac{0.000265}{0{,}97}\right)^2}$$

$$= 3{,}906\ x\sqrt{(0{,}000049)^2 + (0{,}00068)^2 + (0{,}0002)^2 + (0{,}0004)^2\ + (0{,}00027)^2}$$

$$= 3{,}906\ x\sqrt{0{,}0000000024 + 0{,}00000046 + 0{,}0000004\ +\ 0.00000016 +\ 0.0000000737}$$

$$= 3{,}906\ x\sqrt{0{,}000000109}$$

$$= 3{,}906\ x\ 0{,}0011$$

$$= 0{,}0043$$

8. **OKSIGEN TERLARUT** SAMPEL LIMA HARI (A2)

d. V Na2S2O3 Untuk Titrasi Sampel Kalibrasi EKI-160154 HK

Volume Pipet Ukur = 0,6 ml

V Koreksi= 0.03 ml

V Terkoreksi= 0.57 ± 0,00025 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{0.57\ x\ (21-20,2)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0153)^2 + \sqrt{\left(\frac{0,000036}{1,732}\right)^2}$$

$$= 0,00023 + \sqrt{(0,0000207)^2}$$
$$= 0,00023 + \sqrt{0.0000000004289}$$
$$= 0,00023 + 0,00002$$
$$= 0,00025$$

e. Oksigen Terarut B2 $= \frac{V\ terkoreksi\ x\ UNa2S2O3\ Staandarisasi\ x8000}{50}\ x\ F$

$$= \frac{\mathbf{0,57\ x\ 0,025\ x\ 8000}}{\mathbf{50}}\ \mathbf{x}\ \left(\frac{\mathbf{300}}{\mathbf{298}}\right)$$

$$= \mathbf{2,28\ x\ 1,0067}$$

= 2,295 mg/l

f. KETIDAKPASTIAN OKSIGEN TERLARUT BLANKO LIMA HARI (B2)

$$= Oksigen\ Terlarut\ x\sqrt{\left(\frac{UVsampel}{Vsampel}\right)^2 + \left(\frac{UN\ Na2S2O3\ \ Standarisasi}{N\ Na2S2O3\ Standarisasi}\right)^2 + \left(\frac{UN\ Na2S2O3}{N\ Na2S2O3}\right)^2 + \left(\frac{UK2Cr2O7}{NK2CrO7}\right)^2 + \left(\frac{UV\ Titrasi}{V\ Titrasi}\right)^2}$$

$$= \mathbf{2,295\ X}\sqrt{\left(\frac{0,00247}{49,95}\right)^2 + \left(\frac{0,000017}{0.025}\right)^2 + \left(\frac{0,000005}{0.025}\right)^2 + \left(\frac{0,000001}{0,025}\right)^2 + \left(\frac{0.00025}{0.57}\right)^2}$$

$$= \mathbf{2,295}\quad x\sqrt{(0,000049)^2 + (0,00068)^2 + (0,0002)^2 + (0,00004)^2\ + (0,00043)^2}$$

$$= \mathbf{2,295}\quad x\sqrt{0,0000000024 + 0,00000046 + 0,0000004\ +\ 0.00000016 +\ 0.00000019}$$

$$= \mathbf{2,295}\quad x\sqrt{0,0000012}$$

$$= \mathbf{2,295}\quad x\ 0,0011$$

$$= 0,0025$$

9. KETIDAKPASTIAN VOLUME SUSPENSI MIKROBA DALAM BOTOL DO BLANKO (VB)
Volume Pipet Ukur = 5 ml Kalibrasi EKI-160154 HK
V Koreksi= 0.03 ml
V Terkoreksi= 4,97 ± 0,0004 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{4,97\ x\ (21-20,7)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0153)^2 + \sqrt{\left(\frac{0,0003}{1,732}\right)^2}$$

$$= 0,00023 + \sqrt{(0,00018)^2}$$
$$= 0,00023 + \sqrt{0.0000000324}$$
$$= 0,00023 + 0,00018$$
$$= 0,0004$$

10. KETIDAKPASTIAN VOLUME SUSPENSI MIKROBA DALAM BOTOL DO BLANKO (VC)
Volume Pipet Ukur = 5 ml Kalibrasi EKI-160154 HK
V Koreksi= 0.03 ml
V Terkoreksi= 4,97 ± 0,0004 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{4,97\ x\ (21-20,7)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0153)^2 + \sqrt{\left(\frac{0,0003}{1,732}\right)^2}$$

$$= 0,00023 + \sqrt{(0,00018)^2}$$
$$= 0,00023 + \sqrt{0.0000000324}$$
$$= 0,00023 + 0,00018$$
$$= 0,0004$$

11. KETIDAKPASTIAN PERBANDINGAN VOLUME SAMPEL v1 PER VOLUME TOTAL V2 (P)

a. Volume Pipet Gondok = 50 ml Kalibrasi EKI-160154 EX

V Koreksi= 0.03 ml
V Terkoreksi= 49,97 ± 0,00203 ml
Suhu Kalibarsi= 20,7 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,03 ml
K= 1,96

$$\text{U Pipet} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,03}{1,96}\right)^2 + \sqrt{\left(\frac{49,97\ x\ (21-20,7)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0153)^2 + \sqrt{\left(\frac{0,0031}{1,732}\right)^2}$$

$$= 0,00023 + \sqrt{(0,00181)^2}$$
$$= 0,00023 + 0,0018$$
$$= 0,00203$$

b. Volume Botol BOD = 300 ml

V Koreksi= 0.05 ml
V Terkoreksi= 299,95 ± 0,02865 ml
Suhu Kalibarsi= 20,2 oC
Suhu Ruang Uji= 21 oC
Koefisien muai= 0,00021/oC
U95%= 0,05 ml
K= 1,96

$$\text{U Botol BOD} = \left(\frac{U95\%}{k}\right)^2 + \sqrt{\left(\frac{Vterkoreksi\ x\ (Suhu\ ruang\ uji - Suhu\ Kalibrasi)\ x\ Koefisiem\ muai)}{\sqrt{3}}\right)^2}$$

$$= \left(\frac{0,05}{1,96}\right)^2 + \sqrt{\left(\frac{299,95\ x\ (21-20,7)\ x\ 0,00021}{\sqrt{3}}\right)^2}$$

$$= (0,0255)^2 + \sqrt{\left(\frac{0,048}{1,732}\right)^2}$$

$$= 0,00065 + \sqrt{(0,028)^2}$$
$$= 0,00065 + \sqrt{0.000784}$$
$$= 0,00065 + 0,028$$
$$= 0,02865$$

c. KSTIDAKPASTIAN GABUNGAN (P)

$$= \sqrt{\left(\frac{UPipet\ Gondok}{VPipet\ Gondok}\right)^2 + \left(\frac{UBotol\ BOD}{V\ Botol\ BOD}\right)^2} = \sqrt{\left(\frac{0{,}00203}{49{,}97}\right)^2 + \left(\frac{0{,}02865}{299{,}95}\right)^2} = \sqrt{(0.00004)^2 + (0.0000955)^2}$$

$$= \sqrt{0.0000000016 + 0.000000009} = \sqrt{0.0000000106} = 0.0001$$

12. KETIDAKPASTIAN PRESISI METODE

No	Sample	Hasil Pengukuran (mg/l)
1	1	6.04
2	2	6.28
3	3	6.04
4	4	5.56
5	5	6.04
6	6	5.80
7	7	6.52
	Rerata	6.04
	SD	0.31
	% RSD	5.16
	µPM	0.12

13. BOD SAMPEL NO 145/AL/DLHK/X/2018

BOD 5 = Kadar BOD 5 sampel (mg/l)
A1 = Kadar Oksigen Terlarut sampel sebelum inkubasi (nol hari) (mg/l)
A1 = Kadar Oksigen Terlarut sampel setelah inkubasi (lima hari) (mg/l)
B1 = Kadar Oksigen Terlarut Blanko sebelum inkubasi (nol hari) (mg/l)
B2 = Kadar Oksigen Terlarut Blanko setelahinkubasi (lima hari) (mg/l)
VB = Volume suspensi mikroba (ml) dalam botol DO Blanko
VB = Volume suspensi mikroba (ml) dalam botol DO sampel
P = Perbandingan volume V1 sampel per volume total V2

$$BOD\ (mg/l) = \frac{(A1 - A2) - \left(\frac{B1 - B2}{VB}\right) VC}{P}$$

$$= \frac{(3{,}906 - 2{,}295) - \left(\frac{2{,}295 - 1{,}70}{4{,}97}\right) 4{,}97}{49.97/299{,}95}$$

$$= \frac{(3{,}906 - 2{,}295) - \left(\frac{2{,}295 - 1{,}70}{4{,}97}\right) 4{,}97}{49.97/299{,}95}$$

$$= \frac{(1{,}6115) - (0.595)}{0.1666} = 6{,}10\ \text{mg/l}$$

14. KETIDAKPASTIAN BOD GABUNGAN

$$= BOD\ X \sqrt{\left(\frac{U\ A1}{A1}\right)^2 + \left(\frac{UA2}{A2}\right)^2 + \left(\frac{U\ B1}{B1}\right)^2 + \left(\frac{UB2}{B2}\right)^2 + \left(\frac{U\ VB}{VB}\right)^2 + \left(\frac{UVC}{VC}\right)^2 + \left(\frac{UP}{VP}\right)^2 + \left(\frac{UPresisi}{Presisi}\right)^2}$$

$$= 6{,}10X \sqrt{\left(\frac{0.0043}{3{,}309}\right)^2 + \left(\frac{0{,}0025}{2{,}295}\right)^2 + \left(\frac{0{,}0024}{2{,}295}\right)^2 + \left(\frac{0.00187}{1{,}70}\right)^2 + \left(\frac{0{,}0004}{4{,}97}\right)^2 + \left(\frac{0{,}0004}{4{,}97}\right)^2 + \left(\frac{0{,}0001}{299{,}95}\right)^2 + \left(\frac{0{,}12}{6{,}04}\right)^2}$$

$$= 6{,}10\ x\ \sqrt{(0.00129)^2 + (0.00109)^2 + (0.00104)^2 + (0.0011)^2 + (0.00008)^2 + (0.00008)^2 + (0.0000003)^2 + (0.0198)^2}$$

$$= 6{,}10\ x\ \sqrt{0.00000017 + 0.0000012 + 0{,}0000011 + 0.0000012 + 0.0000000064 + 0{,}0000000064 + 0.00000088 + 0.9.e13 + 0{,}00039}$$

$$= 6{,}10\ x\ \sqrt{0.0000045}$$

$$= 6{,}10\ x\ 0{,}0021 = 0{,}013$$

Diperluas = 2 x 0,013 = 0.026 mg/l

Laporan BOD mg/l = 6.10 ± 0,03 mg/l