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LAMPIRAN-LAMPIRAN

Lampiran 1 Perhitungan Ukuran Kristal dari Data XRD

Ukuran kristal dihitung menggunakan persamaan Scherrer (Persamaan 3.1), yaitu:

$$D = \frac{k\lambda}{\beta \cos\theta}$$

Keterangan:

D : Ukuran kristal (nm)

k : faktor ukuran dengan nilai 0,9

λ : panjang gelombang CuKα = 0,15406 nm

β : nilai FWHM (derajat)

θ : sudut Bragg (derajat)

Sebelum menggunakan persamaan di atas, nilai sudut Bragg dan FWHM dari Tabel 4.1 dikonversi ke radian, sehingga:

Sudut Bragg: $2\theta = 26{,}9682^{\circ} \longrightarrow = 13{,}4841^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 13{,}4841^{\circ} = 0{,}235341942$$

FWHM: $\theta = 0{,}3036^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 0{,}3036^{\circ} = 0{,}00529882$$

Sudut Bragg: $2\theta = 26{,}8057^{\circ} \longrightarrow = 13{,}40285^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 13{,}40285^{\circ} = 0{,}233923862$$

FWHM: $\theta = 0{,}3486^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 0{,}3486^{\circ} = 0{,}006084218$$

Sudut Bragg: $2\theta = 26{,}1416^{\circ} \longrightarrow = 13{,}0708^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 13{,}0708^{\circ} = 0{,}228128496$$

FWHM: $\theta = 0{,}6167^{\circ}$

$$rad = \frac{\pi}{180^{\circ}} \times 0{,}6167^{\circ} = 0{,}010763445$$

Setelah nilai radian dari dua variabel diperoleh, maka dapat dihitung ukuran kristal katalis pada 2θ tertentu, sebagai berikut:

$$D_{26{,}9682^\circ} = \frac{k\lambda}{\beta \cos\theta} = \frac{(0{,}9)(0{,}15406)}{(0{,}00529882)\cos(0{,}235341942)} = 26{,}9087 \text{ nm}$$

$$D_{26{,}8057^\circ} = \frac{k\lambda}{\beta \cos\theta} = \frac{(0{,}9)(0{,}15406)}{(0{,}006084218)\cos(0{,}233923862)} = 23{,}4272 \text{ nm}$$

$$D_{26{,}9682^\circ} = \frac{k\lambda}{\beta \cos\theta} = \frac{(0{,}9)(0{,}15406)}{(0{,}010763445)\cos(0{,}228128496)} = 13{,}2246 \text{ nm}$$

Lampiran 2 Perhitungan Nilai *Bandgap* Sampel

Nilai *bandgap* dihitung menggunakan persamaan (3.2), sebagai berikut:

$$\mathrm{E_g} = \frac{hc}{\lambda_{tepi}}$$

Keterangan:

$\mathrm{E_g}$: Energi *bandgap* (eV)

h : Konstanta Planck (4,1357x10^{-15} eV.s)

c : Kecepatan cahaya (2,998x10^{8} m/s)

λ_{tepi} : Panjang gelombang tepi absorpsi sampel (nm)

Merujuk pada nilai λ_{tepi} pada Tabel 4.2, diperoleh nilai $\mathrm{E_g}$ sebagai berikut:

GeO_2

$$\mathrm{E_g} = \frac{hc}{\lambda_{tepi}} = \frac{(4{,}1357 \times 10^{-15}\text{eV.s})(2{,}998 \times 10^{8}\ \text{m/s})}{314 \times 10^{-9}\ \text{m}} = 3{,}94 \text{ eV}$$

G-1

$$\mathrm{E_g} = \frac{hc}{\lambda_{tepi}} = \frac{(4{,}1357 \times 10^{-15}\text{eV.s})(2{,}998 \times 10^{8}\ \text{m/s})}{299 \times 10^{-9}\ \text{m}} = 4{,}14 \text{ eV}$$

G-3

$$\mathrm{E_g} = \frac{hc}{\lambda_{tepi}} = \frac{(4{,}1357 \times 10^{-15}\text{eV.s})(2{,}998 \times 10^{8}\ \text{m/s})}{307 \times 10^{-9}\ \text{m}} = 4{,}04 \text{ eV}$$

G-5

$$\mathrm{E_g} = \frac{hc}{\lambda_{tepi}} = \frac{(4{,}1357 \times 10^{-15}\text{eV.s})(2{,}998 \times 10^{8}\ \text{m/s})}{298 \times 10^{-9}\ \text{m}} = 4{,}16 \text{ eV}$$

Lampiran 3 Perhitungan Persentase Degradasi Polutan MB dan CR

Nilai persentase degradasi diperoleh menggunakan persamaan (3.3), sebagai berikut:

$$D(\%) = \frac{C_0 - C_t}{C_0} \times 100\%$$

Keterangan:

$D(\%)$: Persentase degradasi

C_0 : konsentrasi awal (mg/L) polutan.

C_t : konsentrasi setelah penyinaran (mg/L) pada waktu t

Berdasarkan data hasil uji UV-Vis, diperoleh nilai C_0 untuk polutan MB dan CR berturut-turut yaitu: 3,636 mg/L dan 1,0865 mg/L. Adapun nilai C_t dituliskan dalam tabel di bawah.

Sampel	**Polutan MB**					**Polutan CR**		
	C_1	C_2	C_3	C_4	C_5	C_{10}	C_{20}	C_{30}
G-0	0,127	0,05	0,043	0,034	0,033	0,03716	0,03455	0,03287
G-1	0,129	0,11	0,077	0,063	0,05	0,04316	0,03916	0,03681
G-3	0,099	0,093	0,071	0,044	0,042	0,03743	0,03697	0,03686
G-5	0,112	0,101	0,054	0,041	0,037	0,03271	0,03035	0,02818

Berdasarkan nilai C_0 dan C_t di atas, maka %D dapat dihitung sebagai berikut:

Untuk Polutan MB

G-0

$$D_1(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}1273\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 96{,}5072\%$$

$$D_2(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}05\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}6249\%$$

$$D_3(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}043\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}8174\%$$

$$D_4(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}034\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 99{,}0649\%$$

$$D_5(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}033\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 99{,}0924\%$$

G-1

$$D_1(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}129\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 96{,}4521\%$$

$$D_2(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}11\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 96{,}9747\%$$

$$D_3(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}077\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 97{,}8823\%$$

$$D_4(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}063\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}2673\%$$

$$D_5(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}05\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}6249\%$$

G-3

$$D_1(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}099\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 97{,}2772\%$$

$$D_2(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}093\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 97{,}4422\%$$

$$D_3(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}071\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}0473\%$$

$$D_4(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}044\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}7899\%$$

$$D_5(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}042\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}8449\%$$

G-5

$$D_1(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}112\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 96{,}9197\%$$

$$D_2(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}101\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 97{,}2222\%$$

$$D_3(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}054\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}5149\%$$

$$D_4(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}041\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}8724\%$$

$$D_5(\%) = \frac{3{,}636\ \text{mg/L} - 0{,}037\ \text{mg/L}}{3{,}636\ \text{mg/L}} \times 100\% = 98{,}9824\%$$

Untuk Polutan CR

G-0

$$D_{10}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03716\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}5798\%$$

$$D_{20}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03455\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}8201\%$$

$$D_{30}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03287\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}9747\%$$

G-1

$$D_{10}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}04316\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}0276\%$$

$$D_{20}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03916\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}3958\%$$

$$D_{30}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03681\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}6121\%$$

G-3

$$D_{10}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03743\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}555\%$$

$$D_{20}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03697\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}5973\%$$

$$D_{30}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03686\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}6075\%$$

G-5

$$D_{10}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03271\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 96{,}9894\%$$

$$D_{20}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}03035\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 97{,}2066\%$$

$$D_{30}(\%) = \frac{1{,}0865\ \text{mg/L} - 0{,}02818\ \text{mg/L}}{1{,}0865\ \text{mg/L}} \times 100\% = 97{,}4064\%$$

Lampiran 4 Perhitungan Kuantitas Adsorpsi Polutan MB dan CR

Nilai kuantitas adsorpsi diperoleh menggunakan persamaan (3.4), sebagai berikut:

$$Q_{ads} = (C_0 - C_t) \cdot \frac{V}{m}$$

Keterangan:

Q_{ads} : Kuantitas adsorpsi (mg/g)

C_0 : konsentrasi awal (mg/L) polutan.

C_t : konsentrasi setelah penyinaran (mg/L) pada waktu t

V : Volume larutan polutan (L)

m : Massa sampel (g)

Berdasarkan data hasil uji UV-Vis, diperoleh nilai C_0 untuk polutan MB dan CR berturut-turut yaitu: 3,636 mg/L dan 1,0865 mg/L. Adapun nilai C_t tercantum dalam tabel pada Lampiran 3. Volume larutan polutan untuk MB dan CR yaitu: 100 mL, dengan massa sampel 0,1 g. Berdasarkan nilai-nilai tersebut, maka kuantitas adsorpsi dapat dihitung dengan hasil sebagai berikut:

<u>Untuk Polutan MB</u>

G-0

$$Q_{ads_1} = (3{,}636\ \text{mg/L} - 0{,}1273\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}5087\ \text{mg/g}$$

$$Q_{ads_2} = (3{,}636\ \text{mg/L} - 0{,}05\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}586\ \text{mg/g}$$

$$Q_{ads_3} = (3{,}636\ \text{mg/L} - 0{,}043\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}593\ \text{mg/g}$$

$$Q_{ads_4} = (3{,}636\ \text{mg/L} - 0{,}034\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}602\ \text{mg/g}$$

$$Q_{ads_5} = (3{,}636\ \text{mg/L} - 0{,}033\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}603\ \text{mg/g}$$

G-1

$$Q_{ads_1} = (3{,}636\ \text{mg/L} - 0{,}129\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}507\ \text{mg/g}$$

$$Q_{ads_2} = (3{,}636\ \text{mg/L} - 0{,}11\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}526\ \text{mg/g}$$

$$Q_{ads_3} = (3{,}636\ \text{mg/L} - 0{,}077\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}559\ \text{mg/g}$$

$$Q_{ads_4} = (3{,}636\ \text{mg/L} - 0{,}063\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}573\ \text{mg/g}$$

$$Q_{ads_5} = (3{,}636\ \text{mg/L} - 0{,}05\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}586\ \text{mg/g}$$

G-3

$$Q_{ads_1} = (3{,}636\ \text{mg/L} - 0{,}099\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}537\ \text{mg/g}$$

$$Q_{ads_2} = (3{,}636\ \text{mg/L} - 0{,}093\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}543\ \text{mg/g}$$

$$Q_{ads_3} = (3{,}636\ \text{mg/L} - 0{,}071\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}565\ \text{mg/g}$$

$$Q_{ads_4} = (3{,}636\ \text{mg/L} - 0{,}044\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}592\ \text{mg/g}$$

$$Q_{ads_5} = (3{,}636\ \text{mg/L} - 0{,}042\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}594\ \text{mg/g}$$

G-5

$$Q_{ads_1} = (3{,}636\ \text{mg/L} - 0{,}112\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}524\ \text{mg/g}$$

$$Q_{ads_2} = (3{,}636\ \text{mg/L} - 0{,}101\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}535\ \text{mg/g}$$

$$Q_{ads_3} = (3{,}636\ \text{mg/L} - 0{,}054\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}582\ \text{mg/g}$$

$$Q_{ads_4} = (3{,}636\ \text{mg/L} - 0{,}041\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}595\ \text{mg/g}$$

$$Q_{ads_5} = (3{,}636\ \text{mg/L} - 0{,}037\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 3{,}599\ \text{mg/g}$$

Untuk Polutan CR

G-0

$$Q_{ads_{10}} = (1{,}0865\ \text{mg/L} - 0{,}03716\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04934\ \text{mg/g}$$

$$Q_{ads_{20}} = (1{,}0865\ \text{mg/L} - 0{,}03455\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}05195\ \text{mg/g}$$

$$Q_{ads_{30}} = (1{,}0865\ \text{mg/L} - 0{,}03287\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}05363\ \text{mg/g}$$

G-1

$$Q_{ads_{10}} = (1{,}0865\ \text{mg/L} - 0{,}04316\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04334\ \text{mg/g}$$

$$Q_{ads_{20}} = (1{,}0865\ \text{mg/L} - 0{,}03916\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04734\ \text{mg/g}$$

$$Q_{ads_{30}} = (1{,}0865\ \text{mg/L} - 0{,}03681\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04969\ \text{mg/g}$$

G-3

$$Q_{ads_{10}} = (1{,}0865\ \text{mg/L} - 0{,}03743\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04907\ \text{mg/g}$$

$$Q_{ads_{20}} = (1{,}0865\ \text{mg/L} - 0{,}03697\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04953\ \text{mg/g}$$

$$Q_{ads_{30}} = (1{,}0865\ \text{mg/L} - 0{,}03686\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}04964\ \text{mg/g}$$

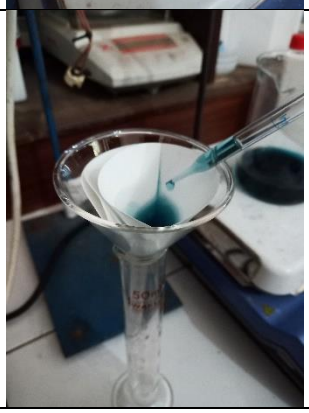
G-5

$$Q_{ads_{10}} = (1{,}0865\ \text{mg/L} - 0{,}03271\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}05379\ \text{mg/g}$$

$$Q_{ads_{20}} = (1{,}0865\ \text{mg/L} - 0{,}03035\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}05615\ \text{mg/g}$$

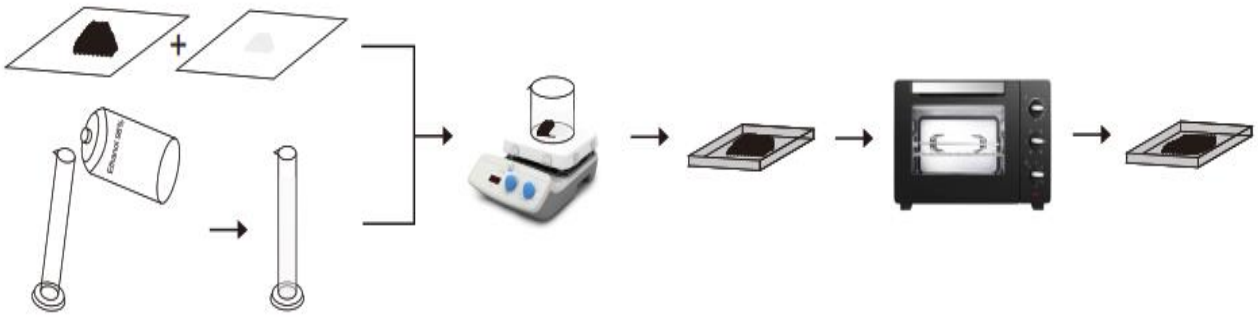
$$Q_{ads_{30}} = (1{,}0865\ \text{mg/L} - 0{,}02818\ \text{mg/L}) \cdot \frac{0{,}1\ \text{L}}{0{,}1\ \text{g}} = 1{,}05832\ \text{mg/g}$$

Lampiran 5 Dokumentasi Penelitian

Keterangan	Gambar
Bahan yang digunakan: Bubuk karbon aktif (warna hitam) dan bubuk GeO_2 (warna putih)	
Proses penyinaran menggunakan lampu halogen 300 watt	
Pengambilan sampel setelah iradiasi	
Penyaringan sampel menggunakan kertas saring nomor 42	

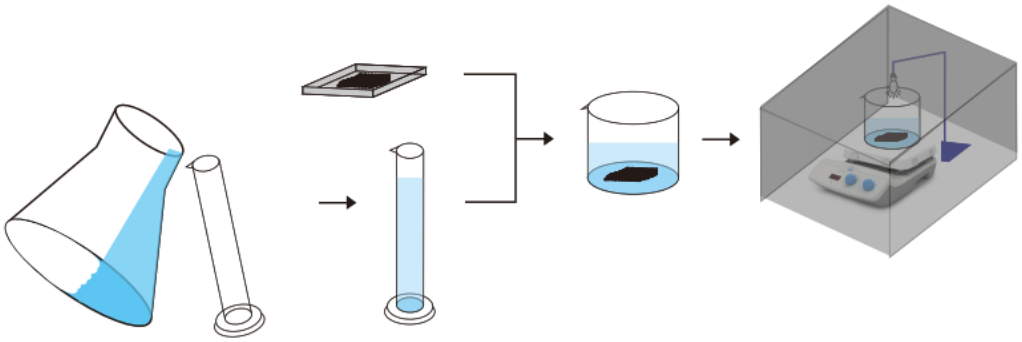
Lampiran 6 Skema Penelitian

Preparasi Komposit GeO_2/Karbon Aktif



Gambar 1 Skema preparasi komposit GeO_2/Karbon Aktif

Uji Fotokatalis



Gambar 2 Skema uji fotokatalis dengan polutan MB