LAMPIRAN

PERHITUNGAN

Keterangan

$\bar{x}$ = Nilai rata-rata (ml/jam)

D = Simpangan (ml/jam)

% simpangan = Persentase simpangan (%)

SD = Standar Deviasi (ml/jam)

Ua = Ketidakpastian (ml/jam)

1. Perhitungan Hasil Percobaan *flow rate* 100 ml/jam dengan *spuit* 10 ml

   a. Nilai rata-rata

   $$\bar{x} = \frac{\sum x_i}{n} = \frac{500,51}{5} = 100,05 \text{ ml/jam}$$

   b. Simpangan

   D $= x_s - \bar{x}$

   $= 100 - 100,05$

   $= -0,05$ ml/jam

   c. Persentase Simpangan

   % simpangan $= \frac{D}{X_s} \times 100\%$

   $= \frac{0,05}{100} \times 100\% = 0,05\ \%$

   d. Standar Deviasi

   $$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

   $$= \sqrt{\frac{(100-9,89)^2 + (100-100,24)^2 + (100-99,98)^2 + (100-100,16)^2 + (100-100,24)^2}{5-1}}$$

   $$= \sqrt{\frac{0,153}{4}} = 0,196 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}196}{\sqrt{5}} = 0{,}09 \text{ ml/jam}$$

2. Perhitungan Hasil Percobaan flow rate 75 ml/jam dengan spuit 10 ml

a. Nilai rata-rata

$$\bar{x} = \frac{\sum x_i}{n} = \frac{375{,}52}{5} = 75{,}1 \text{ ml/jam}$$

b. Simpangan

D $= x_s - \bar{x}$

$= 75 - 75{,}1$

$= -0{,}1$ ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0{,}1}{75}$ x 100% = 0,14 %

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(75-75{,}21)^2 + (75-75{,}24)^2 + (75-74{,}88)^2 + (75-75{,}18)^2 + (75-75{,}01)^2}{5-1}}$$

$$= \sqrt{\frac{0{,}149}{4}} = 0{,}193 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}193}{\sqrt{5}} = 0{,}09 \text{ ml/jam}$$

3. Perhitungan Hasil Percobaan flow rate 50 ml/jam dengan spuit 10 ml

   a. Nilai rata-rata

   $\bar{x} = \frac{\sum x_i}{n} = \frac{250,29}{5}$ = 50,1 ml/jam

   b. Simpangan

   D = x_s - $\bar{x}$

   = 50 – 50,1

   = -0,1 ml/jam

   c. Persentase Simpangan

   % simpangan = $\frac{D}{X_s}$ x 100%

   = $\frac{0,1}{50}$ x 100% = 0,2 %

   d. Standar Deviasi

   $SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

   $= \sqrt{\frac{(50-50,12)^2 + (50-50,22)^2 + (50-49,97)^2 + (50-50,18)^2 + (50-49,8)^2}{5-1}}$

   $= \sqrt{\frac{0,136}{4}}$ = 0,184 ml/jam

   e. Ketidakpastian (U_a)

   $U_a = \frac{SD}{\sqrt{n}} = \frac{0,184}{\sqrt{5}}$ = 0,08 ml/jam

4. Perhitungan Hasil Percobaan flow rate 25 ml/jam dengan spuit 10 ml

   a. Nilai rata-rata

   $\bar{x} = \frac{\sum x_i}{n} = \frac{125,55}{5}$ = 25,11 ml/jam

   b. Simpangan

   D = x_s - $\bar{x}$

   = 25 – 25,11

= -0,11 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,11}{25}$ x 100% = 0,46 %

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(25-25,23)^2+(25-24,92)^2+(25-25,25)^2+(25-25,17)^2+(25-24,98)^2}{5-1}}$

$= \sqrt{\frac{0,151}{4}}$ = 0,194 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,194}{\sqrt{5}}$ = 0,09 ml/jam

5. Perhitungan Hasil Percobaan flow rate 10 ml/jam dengan spuit 10 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{50,76}{5}$ = 10,1 ml/jam

b. Simpangan

D $= x_s - \bar{x}$

= 10 – 10,1

= 0,1 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,1}{10}$ x 100% = 1,04 %

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(10-10,12)^2 + (10-10,19)^2 + (10-10,16)^2 + (10-10,05)^2 + (10-10,24)^2}{5-1}}$$

$$= \sqrt{\frac{0,136}{4}} = 0,185 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0,185}{\sqrt{5}} = 0,08 \text{ ml/jam}$$

6. Perhitungan Hasil Percobaan *flow rate* 100 ml/jam dengan *spuit* 20 ml

a. Nilai rata-rata

$$\bar{x} = \frac{\sum x_i}{n} = \frac{500,93}{5} = 100,19 \text{ ml/jam}$$

b. Simpangan

$$D = x_s - \bar{x}$$

$$= 100 - 100,19$$

$$= -0,19 \text{ ml/jam}$$

c. Persentase Simpangan

$$\% \text{ simpangan} = \frac{D}{X_s} \times 100\%$$

$$= \frac{0,19}{100} \times 100\% = 0,19\ \%$$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(100-100,25)^2 + (100-100,04)^2 + (100-100,23)^2 + (100-100,14)^2 + (100-100,27)^2}{5-1}}$$

$= \sqrt{\frac{0,21}{4}}$ = 0,23 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,23}{\sqrt{5}}$ = 0,1 ml/jam

7. Perhitungan Hasil Percobaan *flow rate* 75 ml/jam dengan *spuit* 20 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{375,76}{5}$ = 75,15 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 75 – 75,15

= -0,15 ml/jam

c. Persentase Simpangan

% simpangan = $\frac{D}{X_s}$ x 100%

= $\frac{0,15}{75}$ x 100% = 0,2 %

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(75-75,29)^2+(75-75,56)^2+(75-74,89)^2+(75-74,78)^2+(75-75,24)^2}{5-1}}$

$= \sqrt{\frac{0,516}{4}}$ = 0,36 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,36}{\sqrt{5}}$ = 0,16 ml/jam

8. Perhitungan Hasil Percobaan *flow rate* 50 ml/jam dengan *spuit* 20 ml

   a. Nilai rata-rata

   $\bar{x} = \frac{\sum x_i}{n} = \frac{250,99}{5}$ = 50,2 ml/jam

   b. Simpangan

   D = x_s - $\bar{x}$

   = 50 – 50,2

   = -0,2 ml/jam

   c. Persentase Simpangan

   % simpangan = $\frac{D}{X_s}$ x 100%

   = $\frac{0,2}{50}$ x 100% = 0,4 %

   d. Standar Deviasi

   $SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

   $= \sqrt{\frac{(50-50,1)^2 + (50-49,98)^2 + (50-50,4)^2 + (50-50,25)^2 + (50-50,26)^2}{5-1}}$

   $= \sqrt{\frac{0,3}{4}}$ = 0,27 ml/jam

   e. Ketidakpastian (U_a)

   $U_a = \frac{SD}{\sqrt{n}} = \frac{0,27}{\sqrt{5}}$ = 0,12 ml/jam

9. Perhitungan Hasil Percobaan *flow rate* 25 ml/jam dengan *spuit* 20 ml

   a. Nilai rata-rata

   $\bar{x} = \frac{\sum x_i}{n} = \frac{125,75}{5}$ = 25,15 ml/jam

   b. Simpangan

   D = x_s - $\bar{x}$

   = 25 – 25,15

   = -0,15 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,15}{25}$ x 100% = 0,6 %

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(25-25,23)^2 + (25-25.24)^2 + (25-25,16)^2 + (25-24,94)^2 + (25-25,18)^2}{5-1}}$

$= \sqrt{\frac{0,172}{4}}$ = 0,21 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,21}{\sqrt{5}}$ = 0,09 ml/jam

10. Perhitungan Hasil Percobaan *flow rate* 10 ml/jam dengan *spuit* 20 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{50,94}{5}$ = 10,19 ml/jam

b. Simpangan

D $= x_s - \bar{x}$

$= 10 - 10,19$

= -0,19 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,19}{10}$ x 100% = 1,88 %

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$$= \sqrt{\frac{(10-10{,}26)^2+(10-10{,}34)^2+(10-9{,}92)^2+(10-9{,}85)^2+(10-10{,}57)^2}{5-1}}$$

$$= \sqrt{\frac{0{,}537}{4}} = 0{,}37 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}37}{\sqrt{5}} = 0{,}16 \text{ ml/jam}$$

11. Perhitungan Hasil Percobaan *flow rate* 100 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$$\bar{x} = \frac{\sum x_i}{n} = \frac{500{,}84}{5} = 100{,}17 \text{ ml/jam}$$

b. Simpangan

D $= x_s - \bar{x}$

$= 100 - 100{,}17$

$= -0{,}17$ ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s} \times 100\%$

$= \frac{0{,}17}{100} \times 100\% = 0{,}17\%$

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(100-99{,}69)^2+(100-100{,}07)^2+(100-100{,}57)^2+(100-100{,}17)^2+(100-100{,}34)^2}{5-1}}$$

$$= \sqrt{\frac{0{,}57}{4}} = 0{,}38 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}38}{\sqrt{5}} = 0{,}17 \text{ ml/jam}$$

12. Perhitungan Hasil Percobaan *flow rate* 75 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{376,27}{5}$ = 75,254 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 75 – 75,254

= -0,254 ml/jam

c. Persentase Simpangan

% simpangan = $\frac{D}{X_s}$ x 100%

= $\frac{0,254}{75}$ x 100% = 0,339%

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(75-75,59)^2 + (75-75,29)^2 + (75-74,92)^2 + (75-75,12)^2 + (75-75,35)^2}{5-1}}$

$= \sqrt{\frac{0,576}{4}}$ = 0,38 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,379}{\sqrt{5}}$ = 0,17 ml/jam

13. Perhitungan Hasil Percobaan *flow rate* 50 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{250,84}{5}$ = 50,17 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 50 – 50,17

= -0,17 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,17}{50}$ x 100% = 0,34%

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(50-50,28)^2 + (50-50,04)^2 + (50-50,42)^2 + (50-50,23)^2 + (50-49,87)^2}{5-1}}$$

$$= \sqrt{\frac{0,326}{4}} = 0,29 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,29}{\sqrt{5}} = 0,13$ ml/jam

14. Perhitungan Hasil Percobaan *flow rate* 25 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{125,68}{5} = 25,136$ ml/jam

b. Simpangan

D $= x_s - \bar{x}$

$= 25 - 25,136$

$= -0,136$ ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,136}{25}$ x 100% = 0,54%

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(25-25{,}56)^2+(25-25{,}21)^2+(25-25{,}01)^2+(25-24{,}88)^2+(25-25{,}02)^2}{5-1}}$$

$$= \sqrt{\frac{0{,}373}{4}} = 0{,}31 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}305}{\sqrt{5}} = 0{,}14 \text{ ml/jam}$$

15. Perhitungan Hasil Percobaan *flow rate* 10 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$$\bar{x} = \frac{\sum x_i}{n} = \frac{50{,}53}{5} = 10{,}11 \text{ ml/jam}$$

b. Simpangan

D $= x_s - \bar{x}$

$= 10 - 10{,}11$

$= -0{,}11$ ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0{,}11}{10}$ x 100% = 1,06%

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(10-10{,}04)^2+(10-10{,}17)^2+(10-10{,}21)^2+(10-9{,}87)^2+(10-10{,}24)^2}{5-1}}$$

$$= \sqrt{\frac{0{,}149}{4}} = 0{,}19 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}193}{\sqrt{5}} = 0{,}09 \text{ ml/jam}$$

16. Perhitungan Hasil Percobaan *flow rate bolus* 100 ml/jam dengan *spuit* 10 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{300,62}{3}$ = 100,21 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 100 – 100,21

= -0,21 ml/jam

c. Persentase Simpangan

% simpangan = $\frac{D}{X_s}$ x 100%

= $\frac{0,21}{100}$ x 100% = 0,21%

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(100-100,26)^2 + (100-100,16)^2 + (100-100,2)^2}{3-1}}$

$= \sqrt{\frac{0,133}{2}}$ = 0,26 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,266}{\sqrt{3}}$ = 0,15 ml/jam

17. Perhitungan Hasil Percobaan *flow rate bolus* 50 ml/jam dengan *spuit* 10 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{150,6}{3}$ = 50,2 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 50 – 50,2

= -0,2 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,2}{50}$ x 100% = 0,4%

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(50-50.21)^2 + (50-50,26)^2 + (50-50,2)^2}{3-1}}$

$= \sqrt{\frac{0,129}{2}}$ = 0,25 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,25}{\sqrt{3}}$ = 0,15 ml/jam

18. Perhitungan Hasil Percobaan *flow rate bolus* 100 ml/jam dengan *spuit* 20 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{300,46}{3}$ = 100,15 ml/jam

b. Simpangan

D $= x_s - \bar{x}$

= 100 – 100,15

= -0,15 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,15}{100}$ x 100% = 0,15%

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$$= \sqrt{\frac{(100-100{,}28)^2+(100-100{,}11)^2+(100-100{,}07)^2}{3-1}}$$

$$= \sqrt{\frac{0{,}095}{2}} = 0{,}22 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}22}{\sqrt{3}} = 0{,}13 \text{ ml/jam}$$

19. Perhitungan Hasil Percobaan *flow rate bolus* 50 ml/jam dengan *spuit* 20 ml

a. Nilai rata-rata

$$\bar{x} = \frac{\sum x_i}{n} = \frac{150{,}61}{3} = 50{,}2 \text{ ml/jam}$$

b. Simpangan

D $= x_s - \bar{x}$

$= 50 - 50{,}2$

$= 0{,}2$ ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0{,}2}{50}$ x 100% = 0,41%

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(50-50{,}2)^2+(50-50{,}2)^2+(50-50{,}21)^2}{3-1}}$$

$$= \sqrt{\frac{0{,}124}{2}} = 0{,}25 \text{ ml/jam}$$

e. Ketidakpastian (U_a)

$$U_a = \frac{SD}{\sqrt{n}} = \frac{0{,}25}{\sqrt{3}} = 0{,}14 \text{ ml/jam}$$

20. Perhitungan Hasil Percobaan *flow rate bolus* 100 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{300,21}{3}$ = 100,07 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 100 – 100,07

= -0,07 ml/jam

c. Persentase Simpangan

% simpangan = $\frac{D}{X_s}$ x 100%

= $\frac{0,07}{100}$ x 100% = 0,07%

d. Standar Deviasi

$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$

$= \sqrt{\frac{(100-100,22)^2 + (100-99,87)^2 + (100-100,12)^2}{3-1}}$

$= \sqrt{\frac{0,080}{2}}$ = 0,2 ml/jam

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,2}{\sqrt{3}}$ = 0,12 ml/jam

21. Perhitungan Hasil Percobaan *flow rate bolus* 50 ml/jam dengan *spuit* 50 ml

a. Nilai rata-rata

$\bar{x} = \frac{\sum x_i}{n} = \frac{150,54}{3}$ = 50,18 ml/jam

b. Simpangan

D = x_s - $\bar{x}$

= 50 – 50,18

= -0,18 ml/jam

c. Persentase Simpangan

% simpangan $= \frac{D}{X_s}$ x 100%

$= \frac{0,18}{50}$ x 100% = 0,36%

d. Standar Deviasi

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(50-50,24)^2 + (50-50,12)^2 + (50-50,18)^2}{3-1}}$$

$$= \sqrt{\frac{0,104}{2}} = 0,23 \text{ml/jam}$$

e. Ketidakpastian (U_a)

$U_a = \frac{SD}{\sqrt{n}} = \frac{0,23}{\sqrt{3}} = 0,13$ ml/jam

Code Program Syringe Pump

```
Chip type               : ATmega16
Program type            : Application
AVR Core Clock frequency: 12.000000 MHz
Memory model            : Small
External RAM size       : 0
Data Stack size         : 256
*****************************************************/

#include <mega16.h>
#include <delay.h>
#include <alcd.h>
#include <stdlib.h>
#include <stdio.h>
#define start PINB.1
#define up    PINB.0
#define down  PINB.3
#define stop  PINB.4
#define bolus PINB.2
#define buzzer PORTD.0
#define irun PORTD.3
#define istop PORTD.1

int data1,data2,data3=1,data4=0,data5=0, data6;
float a,b,c,d,e,f,g,h,i;
unsigned char temp[16];
unsigned char buf[16];
unsigned char uy[16];
unsigned char huy[16];
int frekuensi=0;
int hasil_volume;
float tetes;
float t,ts,t_tunda,tb,tsb,t_bolus;
float nilai;
int data;
unsigned int count,satuan=0;
// Timer 0 overflow interrupt service routine
interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
// Reinitialize Timer 0 value
TCNT0=0x8B;
count++;
if (count>=100)
{
    satuan++;
    count=0;
}
}
#define ADC_VREF_TYPE 0x40

// Read the AD conversion result
unsigned int read_adc(unsigned char adc_input)
{
ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
// Delay needed for the stabilization of the ADC input voltage
delay_us(10);
// Start the AD conversion
```

```
ADCSRA|=0x40;
// Wait for the AD conversion to complete
while ((ADCSRA & 0x10)==0);
ADCSRA|=0x10;
return ADCW;
}
void adc()
{
  data1=read_adc(1);
  data2=read_adc(2);
  if (data1>=200 && data1<=300) {PORTD.6=1; a=2.9; c=537;
  d=101; e=50; f=700; g=680; h=2; i=1.5;}
  else {PORTD.6=0;}
   if (data1>=450 && data1<=600) {PORTD.5=1; a=1.33;  c=404;
  d=101; e=20; f=515; g=422; h=1.5; i=1;}
  else {PORTD.5=0;}
  if (data1>=620 && data1<=700) {PORTD.4=1; a=0.8468;  c=379;
  d=101; e=10; f=480; g=396; h=1; i=0.5;}
  else {PORTD.4=0;}
  if (data1>700) {PORTD.7=1;}
  else {PORTD.7=0;}
}
void soklusi()
{
  data=read_adc(3);
}
void tampil_lcd()
{
    nilai=(float)satuan*(data3/3600.0);
    ftoa(nilai,2,temp);
    lcd_gotoxy(4,1);
    lcd_puts(temp);
    lcd_gotoxy(10,1);
    lcd_putsf("ml");
    lcd_gotoxy(0,0);
    lcd_putsf("-CAIRAN KELUAR-");
}
void tampil_lcdbolus()
{
    nilai=(float)satuan*(data6/3600.0);
    ftoa(nilai,2,temp);
    lcd_gotoxy(4,1);
    lcd_puts(temp);
    lcd_gotoxy(10,1);
    lcd_putsf("ml");
    lcd_gotoxy(0,0);
    lcd_putsf("-CAIRAN KELUAR-");
}
void kecepatan()
{
      hasil_volume=data4*212;
      t=(3600000*data4/data3*a);
      ts=t/hasil_volume;
      t_tunda=ts/16;
}
void boluss()
{
      hasil_volume=data4*a;
      tb=(3600000*data4/data6);
```

```
      tsb=tb/hasil_volume;
      t_bolus=tsb/16;
}
void stopped()
{
    PORTA=0b00000000;
    TIMSK=0x00;
    istop=1;
    irun=0;
    if(!start)
    {
    while(1)
    {
      istop=0;
      irun=1;
      tampil_lcd();
      adc();
      soklusi();
      kecepatan();
      TIMSK=0X01;
      PORTA=0b00010000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b00100000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b01000000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b10000000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 && P
      ORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      if(data2<=f && data2>=g || data4-tetes<=h && data4-
      tetes>=i){buzzer=1;} else {buzzer=0;}
      if(tetes>data4 || data2<=c)
      {while(1){PORTA=0x00;buzzer=1; irun=0;
      istop=1;}}
     }
    }
    if(!bolus)
    {
      TIMSK=0x01;
      istop=0;
      irun=1;
      tampil_lcdbolus();
      boluss();
      adc();
      soklusi();
```

```
      PORTA=0b00010000;
      delay_ms(t_bolus);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b00100000;
      delay_ms(t_bolus);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b01000000;
      delay_ms(t_bolus);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b10000000;
      delay_ms(t_bolus);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      if(data2<=f && data2>=g || data4-tetes<=h && data4-
      tetes>=i){buzzer=1;} else {buzzer=0;}
      if(tetes>data4 || data2<=c)
      {while(1){PORTA=0x00;buzzer=1; irun=0; istop=1;}}
      return;
    }
}
void putar()
{
      PORTA=0b00010000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b00100000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b01000000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
      PORTA=0b10000000;
      delay_ms(t_tunda);
      if(!stop || PORTD.4==0 && PORTD.5==0 &&
      PORTD.6==0){while(1){stopped();}}
      if(data>=b){while(1){stopped(); buzzer=1;}}
}
void menu1()
{
 if(!up)  {data3=data3+1; delay_ms(200);}
 if(!down){data3=data3-1; delay_ms(200);}
 lcd_gotoxy(2,0);
 lcd_putsf("-FLOW RATE-");
 lcd_gotoxy(3,1);
```

```
 sprintf(uy,"%d mL/h   ", data3);
 lcd_puts(uy);
 if(data3==d){data3=1;}
 if(data3==0){data3=d-1;}
}
void menu2()
{
 if(!up)  {data6=data6+1; delay_ms(200);}
 if(!down){data6=data6-1; delay_ms(200);}
 //tombol setting menu2
 lcd_gotoxy(2,0);
 lcd_putsf("-BOLUS MODE-");
 lcd_gotoxy(3,1);
 sprintf(huy,"%d mL/h   ", data6);
 lcd_puts(huy);
 if(data6==0){data6=data3+1;}
 if(data6==101){data6=data3+1;}
 if(data6==data3){data6=101-1;}
}
void menu3()
{
 if(!up)  {data4=data4+1; delay_ms(200);}
 if(!down){data4=data4-1; delay_ms(200);}
 //tombol setting menu2
 lcd_gotoxy(2,0);
 lcd_putsf("-MAX VOLUME-");
 lcd_gotoxy(4,1);
 sprintf(buf," %d ml  ", data4);
 lcd_puts(buf);
 if(data4==0){data4=e;}
 if(data4==e+1){ data4=1;}
}
void low()
{
  lcd_gotoxy(3,1);
  lcd_putsf("LEVEL  I");
  istop=1;
  adc();
  b=820.0;
  if(!bolus)
  {
    irun=1;
    istop=0;
    PORTA=0b00010000;
    delay_ms(7);
    PORTA=0b00100000;
    delay_ms(7);
    PORTA=0b01000000;
    delay_ms(7);
    PORTA=0b10000000;
    delay_ms(7);
  }
  else {irun=0; istop=1; PORTA=0;}
  if(PORTD.4==1 || PORTD.5==1 || PORTD.6==1)
  {
  if(!start)
  {
    lcd_clear();delay_ms(200);
```

```
    while(1)
    {
      menu1();if(!start)
      {
        lcd_clear();delay_ms(200);
        while(1)
        {
          menu2();if(!start)
          {
            lcd_clear();delay_ms(200);
            while(1)
            {
              menu3();if(!start)
              {
                lcd_clear();delay_ms(200);
                while(1)
                {
                  TIMSK=0x01;
                  irun=1;
                  istop=0;
                  adc();
                  soklusi();
                  kecepatan();
                  putar();
                  tampil_lcd();
                  if(data2<=f && data2>=g || data4-nilai<=h &&
                  data4-nilai>=i){buzzer=1;} else {buzzer=0;}
                  if(nilai>=data4||data2<=c)
                  {while(1){PORTA=0x00; buzzer=1; irun=0;
                  istop=1;}}
                 }
               }
            }
          }
      }
   }
}
}
}
}
void medium()
{
  lcd_gotoxy(3,1);
  lcd_putsf("LEVEL II");
  istop=1;
  adc();
  b=748.0;
  if(!bolus)
  {
    irun=1;
    istop=0;
    PORTA=0b00010000;
    delay_ms(7);
    PORTA=0b00100000;
    delay_ms(7);
    PORTA=0b01000000;
    delay_ms(7);
```

```
    PORTA=0b10000000;
    delay_ms(7);
  }
  else {irun=0; istop=1; PORTA=0;}
  if(PORTD.4==1 || PORTD.5==1 || PORTD.6==1)
  {
  if(!start)
  {
    lcd_clear();delay_ms(200);
    while(1)
    {
      menu1();if(!start)
      {
        lcd_clear();delay_ms(200);
        while(1)
        {
          menu2();if(!start)
          {
            lcd_clear();delay_ms(200);
            while(1)
            {
              menu3();if(!start)
              {
                lcd_clear();delay_ms(200);
                while(1)
                {
                  TIMSK=0x01;
                  irun=1;
                  istop=0;
                  adc();
                  soklusi();
                  kecepatan();
                  putar();
                  tampil_lcd();
                  if(data2<=f && data2>=g || data4-nilai<=h &&
                  data4-nilai>=i){buzzer=1;} else {buzzer=0;}
                  if(nilai>=data4||data2<=c)
                  {while(1){PORTA=0x00; buzzer=1; irun=0;
                  istop=1; }}
                }
              }
            }
          }
        }
      }
    }
}
}
}
}
void high()
{
  lcd_gotoxy(3,1);
  lcd_putsf("LEVEL III");
  istop=1;
  adc();
  b=820.0;
  if(!bolus)
  {
```

```
    irun=1;
    istop=0;
    PORTA=0b00010000;
    delay_ms(7);
    PORTA=0b00100000;
    delay_ms(7);
    PORTA=0b01000000;
    delay_ms(7);
    PORTA=0b10000000;
    delay_ms(7);
  }
  else {irun=0; istop=1; PORTA=0;}
  if(PORTD.4==1 || PORTD.5==1 || PORTD.6==1)
  {
  if(!start)
  {
    lcd_clear();delay_ms(200);
    while(1)
    {
      menu1();if(!start)
      {
        lcd_clear();delay_ms(200);
        while(1)
        {
          menu2();if(!start)
          {
            lcd_clear();delay_ms(200);
            while(1)
            {
              menu3();if(!start)
              {
                lcd_clear();delay_ms(200);
                while(1)
                {
                  TIMSK=0x01;
                  irun=1;
                  istop=0;
                  adc();
                  soklusi();
                  kecepatan();
                  putar();
                  tampil_lcd();
                  if(data2<=f && data2>=g || data4-nilai<=h &&
                  data4-nilai>=i){buzzer=1;} else {buzzer=0;}
                  if(nilai>=data4||data2<=c)
                  {while(1){PORTA=0x00; buzzer=1; irun=0;
                  istop=1; }}
                }
              }
            }
          }
        }
      }
    }
}
}
}
}
```

```
void oklusi()
 {
 if(!up)  {data5=data5+1; delay_ms(500); lcd_clear();}
 if(!down){data5=data5-1; delay_ms(500); lcd_clear();}
 if(data5==3){data5=0;}
 if(data5==-1){data5=2;}
 switch(data5)
 {
   case 0 :low();break;
   case 1 :medium();break;
   case 2 :high();break;
 } //setting menu tampilan awal
 }
void main(void)
{
PORTA=0x00;
DDRA=0b11110000;
PORTB=0xFF;
DDRB=0x00;

PORTC=0x00;
DDRC=0x00;

PORTD=0x00;
DDRD=0b111111011;

// Timer/Counter 0 initialization
// Clock source: System Clock
// Clock value: 11.719 kHz
// Mode: Normal top=0xFF
// OC0 output: Disconnected
TCCR0=0x05;
TCNT0=0x8B;
OCR0=0x00;

// Timer/Counter 1 initialization
// Clock source: System Clock
// Clock value: Timer1 Stopped
// Mode: Normal top=0xFFFF
// OC1A output: Discon.
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
// Timer1 Overflow Interrupt: Off
// Input Capture Interrupt: Off
// Compare A Match Interrupt: Off
// Compare B Match Interrupt: Off
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
ICR1H=0x00;
ICR1L=0x00;
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;
GICR|=0x40;
MCUCR=0x02;
MCUCSR=0x00;
```

```
GIFR=0x40;
// USART initialization
// USART disabled
UCSRB=0x00;

// Analog Comparator initialization
// Analog Comparator: Off
// Analog Comparator Input Capture by Timer/Counter 1: Off
ACSR=0x80;
SFIOR=0x00;

// ADC initialization
// ADC Clock frequency: 750.000 kHz
// ADC Voltage Reference: AVCC pin
// ADC Auto Trigger Source: ADC Stopped
ADMUX=ADC_VREF_TYPE & 0xff;
ADCSRA=0x84;
// SPI initialization
// SPI disabled
SPCR=0x00;

// TWI initialization
// TWI disabled
TWCR=0x00;
// Alphanumeric LCD initialization
// Connections specified in the
// Project|Configure|C Compiler|Libraries|Alphanumeric LCD
menu:
// RS - PORTC Bit 0
// RD - PORTC Bit 1
// EN - PORTC Bit 2
// D4 - PORTC Bit 4
// D5 - PORTC Bit 5
// D6 - PORTC Bit 6
// D7 - PORTC Bit 7
// Characters/line: 16
lcd_init(16);
// Global enable interrupts
#asm("sei")
 lcd_gotoxy(2,0);
 lcd_putsf("SYRINGE PUMP");
 lcd_gotoxy(4,1);
 lcd_putsf("TEM UMY");
 delay_ms(2000);
 lcd_clear();
 lcd_gotoxy(3,0);
 lcd_putsf("M.A In'am");
 lcd_gotoxy(2,1);
 lcd_putsf("20163010075");
 delay_ms(2000);
 lcd_clear();
 while (1)
 {
    adc();
    lcd_gotoxy(1,0);
    lcd_putsf("__OCCLUSION__");
    oklusi();
 }
}
```

Hasil Perancangan Alat

Pengambilan data (Pengukuran *Flow Rate*)

Pengambilan data (Pengukuran Target Volume dengan *Flow rate* 1 ml/jam)