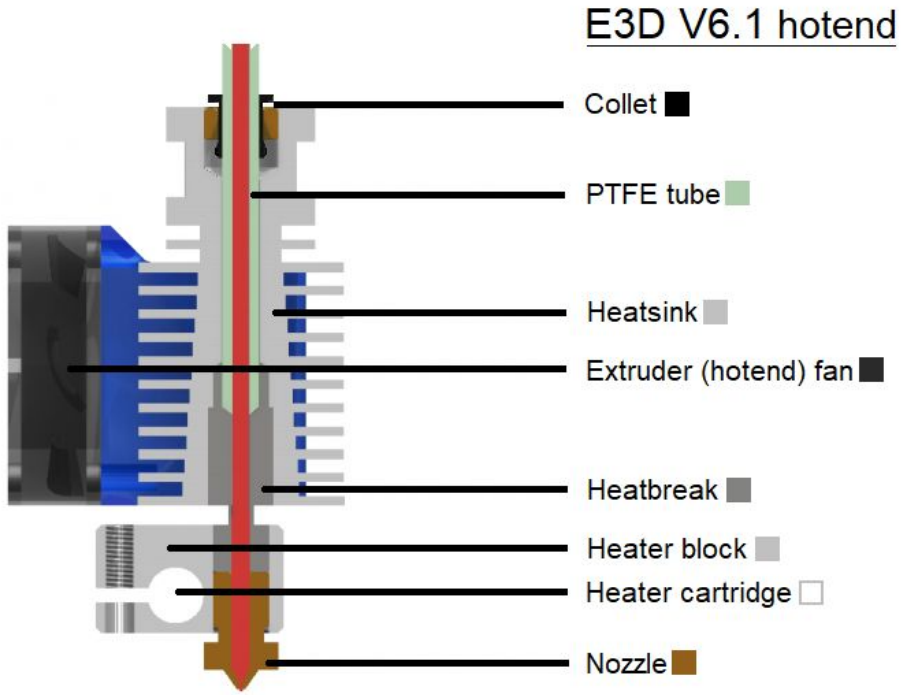
Hot End Thermal Modeling (lumped): Euler's method application

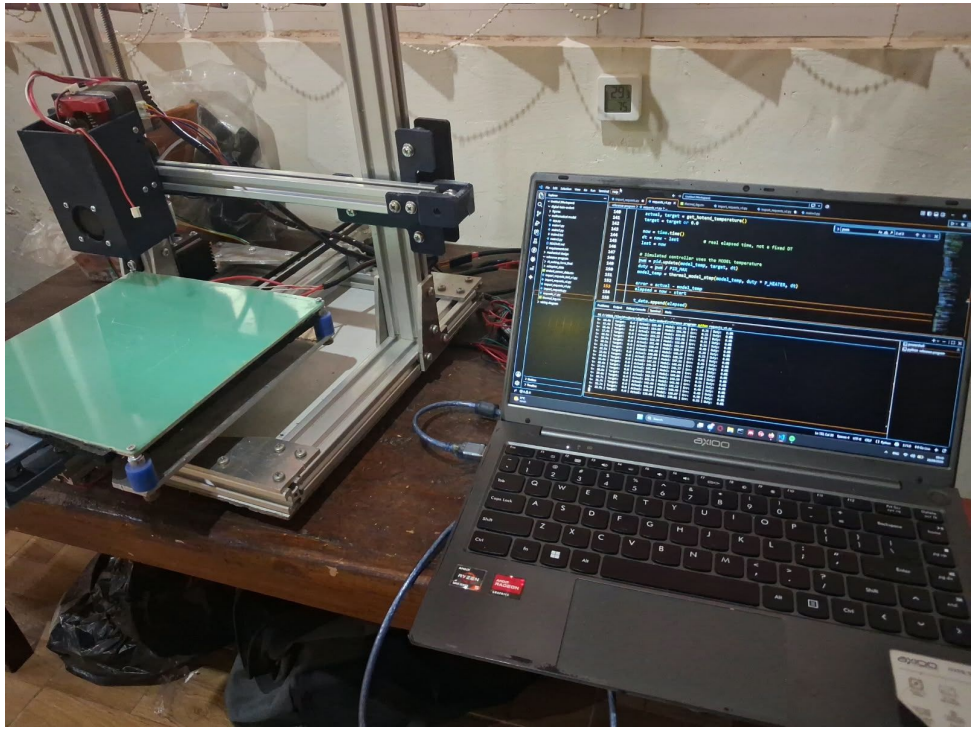
Nazhmi Fadhila
2606759986
Department of Mechanical Engineering
Universitas Indonesia

Struktur Hot End



Hot End Thermal Modeling (lumped) : Euler’s method application

Setup experimental



Hot End Thermal Modeling (lumped) : Euler’s method application

Thermal model + Euler’s method

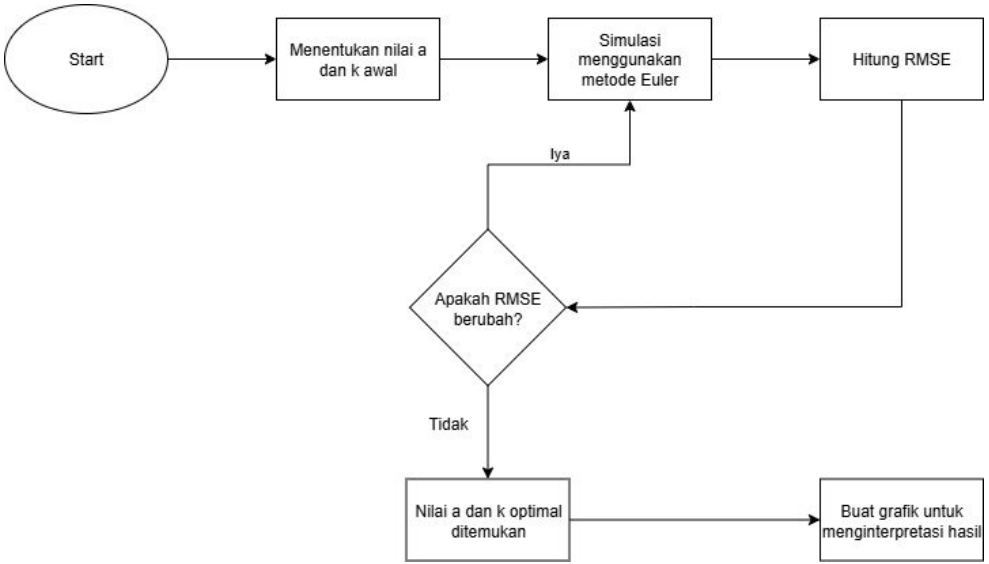
$$C\,\frac{dT}{dt} = P\,u(t) - K\left(T - T_{\text{amb}}\right) \tag{1}$$

$$\frac{dT}{dt} = a\,u(t) - k\left(T - T_{\text{amb}}\right), \qquad a = \frac{P}{C},\ k = \frac{K}{C} \tag{2}$$

$$T_{n+1} = T_n + h\left(a\,u_n - k\left(T_n - T_{\text{amb}}\right)\right) \tag{3}$$

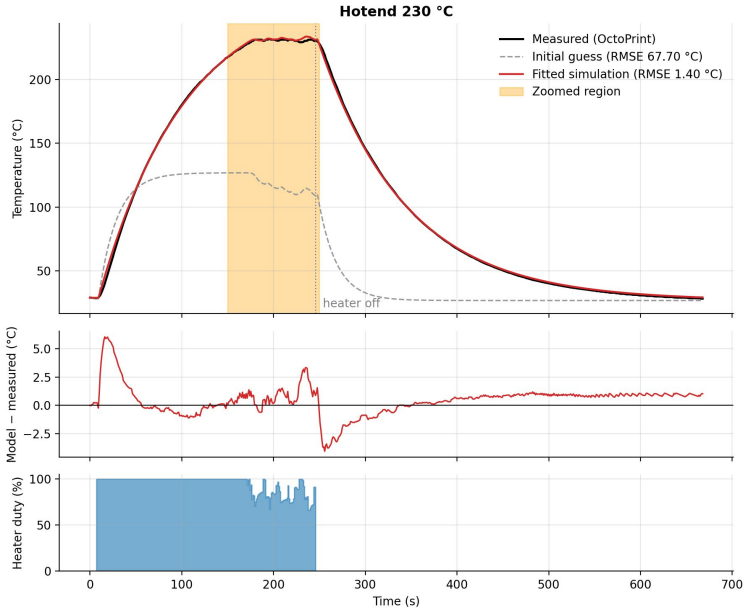
Hot End Thermal Modeling (lumped) : Euler's method application

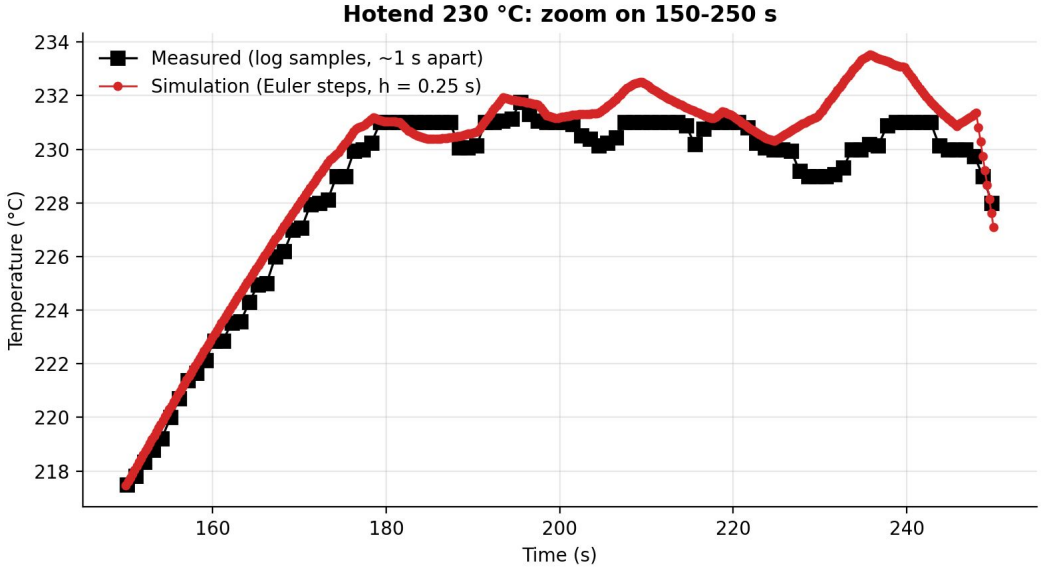
Alur Algoritma



Hot End Thermal Modeling (lumped) : Euler's method application

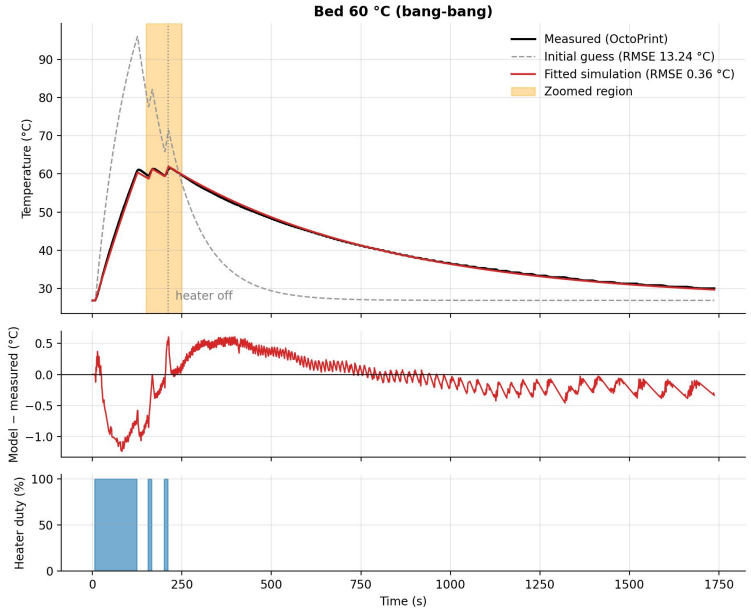
Hasil

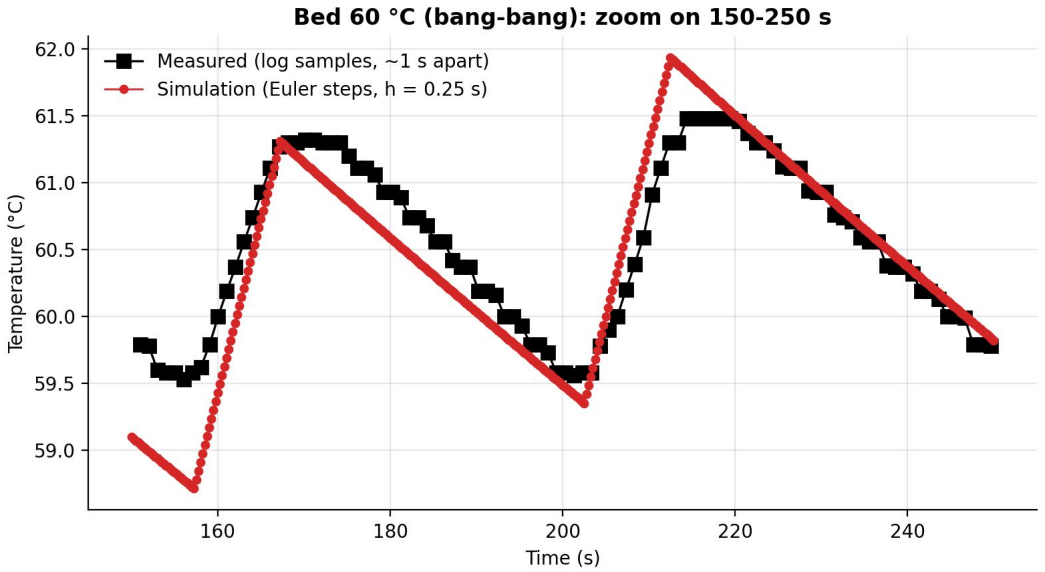




Hot End Thermal Modeling (lumped) : Euler's method application

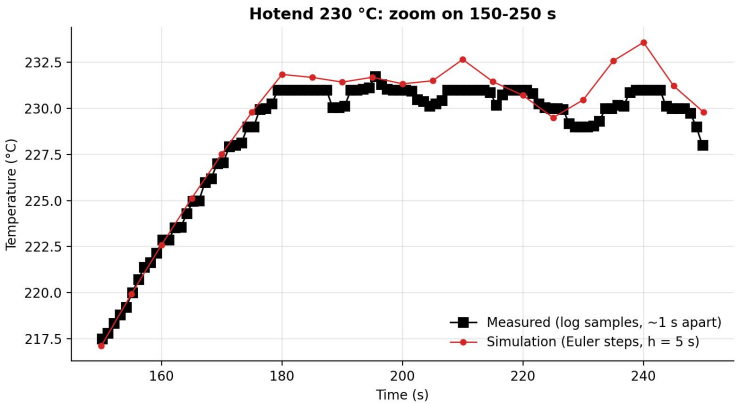
Hasil

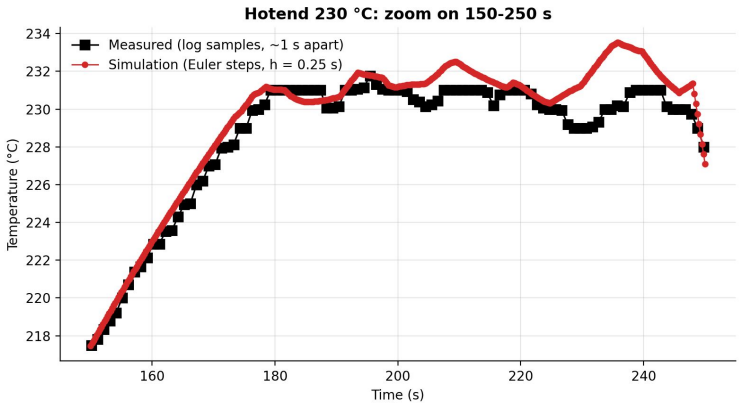


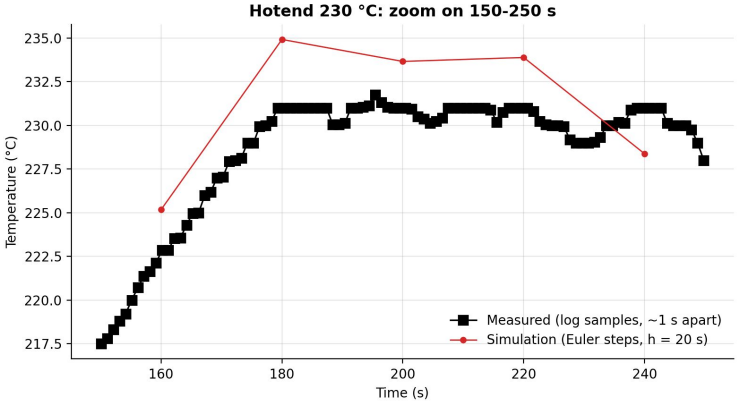


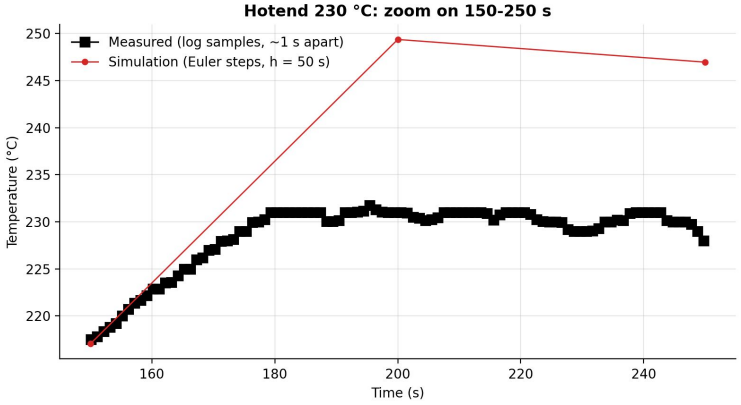
Hot End Thermal Modeling (lumped) : Euler's method application

Hasil (Perbedaan timestep)



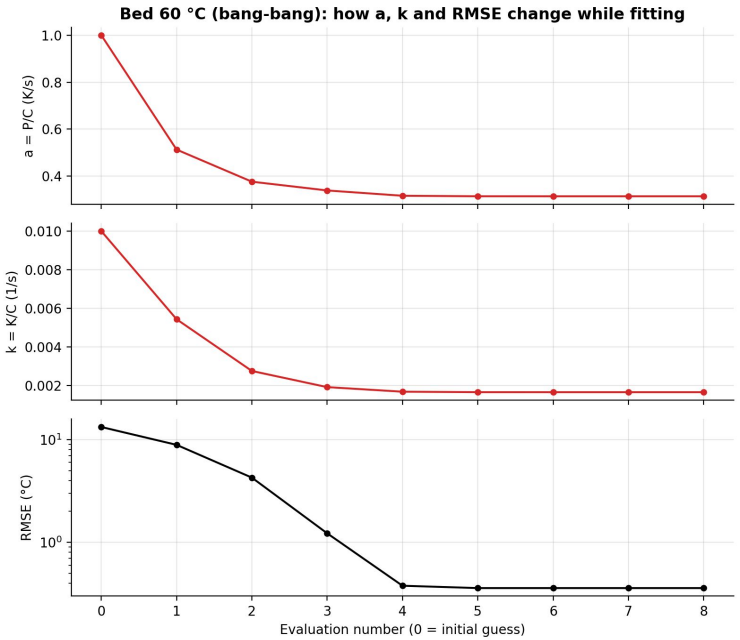


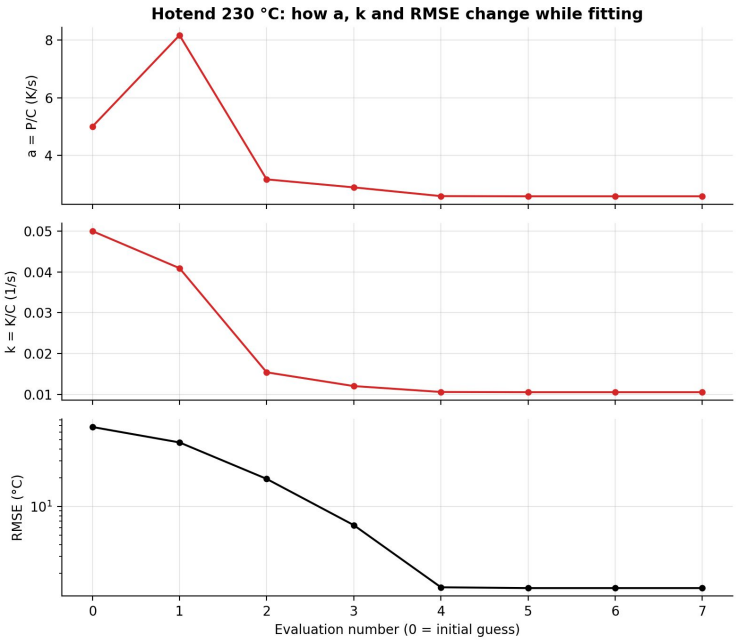




Hot End Thermal Modeling (lumped) : Euler's method application

Hasil





Hot End Thermal Modeling (lumped) : Euler's method application

Hasil

```
===== Hotend 230 °C =====  Tamb=26.85 C
initial guess: a=5.000  k=0.05000  RMSE=67.70 C
fitted       : a=2.589  k=0.01052  (tau=1/k=95 s)  RMSE=1.40 C  after 8 evaluations
 eval         a          k     RMSE
    0    5.0000   0.050000   67.704
    1    8.1627   0.040909   46.685
    2    3.1745   0.015391   19.421
    3    2.8966   0.012021    6.381
    4    2.5948   0.010576    1.431
    5    2.5886   0.010525    1.404
    6    2.5886   0.010525    1.404
    7    2.5886   0.010525    1.404

===== Bed 60 °C (bang-bang) =====  Tamb=26.85 C
initial guess: a=1.000  k=0.01000  RMSE=13.24 C
fitted       : a=0.314  k=0.00165  (tau=1/k=604 s)  RMSE=0.36 C  after 9 evaluations
 eval         a          k     RMSE
    0    1.0000   0.010000   13.241
    1    0.5127   0.005433    8.877
    2    0.3760   0.002753    4.261
    3    0.3387   0.001916    1.225
    4    0.3161   0.001680    0.379
    5    0.3139   0.001655    0.360
    6    0.3138   0.001654    0.360
    7    0.3138   0.001654    0.360
    8    0.3138   0.001654    0.360

If heater power at 100% duty is P (W): C = P/2.59, K = C*0.01052  (hotend)
```

The End

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