# ANALYSIS AND COMPARISON OF DIFFERENT MODELING APPROACHES FOR THE SIMULATION OF A MICRO-SCALE ORGANIC RANKINE CYCLE POWER PLANT

## APPENDIX

Rémi Dickes*, Olivier Dumont, Arnaud Legros, Sylvain Quoilin, Vincent Lemort

Energy System Research Unit
Aerospace and Mechanical Engineering Department
Faculty of Applied Sciences
University of Liège
Belgium

* Corresponding Author (rdickes@ulg.ac.be)

## MODEL PARAMETERS

- **Parameters of model $PP_A$**
  - $\bar{\eta}_{vol,pp} = 84.162\ [\%]$
  - $\bar{\eta}_{is,pp} = 21.052\ [\%]$
  - $V_{dis,pp} = 3.931\ [cm^3]$

- **Parameters of model $PP_B$**
  - $A_{leak} = 3.038 \cdot 10^{-7}\ [m^2]$
  - $K_0 = 2.553\ [-]$
  - $\dot{W}_0 = 71.64\ [W]$
  - $V_{dis,pp} = 3.931\ [cm^3]$

- **Parameters of model $PP_C$**
  - $a_{00} = -0.1177$
  - $a_{10} = 0.04549$
  - $a_{01} = 0.4028$
  - $a_{20} = -0.005304$
  - $a_{11} = 0.02547$
  - $a_{02} = -0.2046$
  - $b_{00} = 0.9729$
  - $b_{10} = -0.1903$
  - $b_{01} = 0.7815$
  - $b_{20} = 0.00551$
  - $b_{11} = 0.1077$
  - $b_{02} = -0.59$

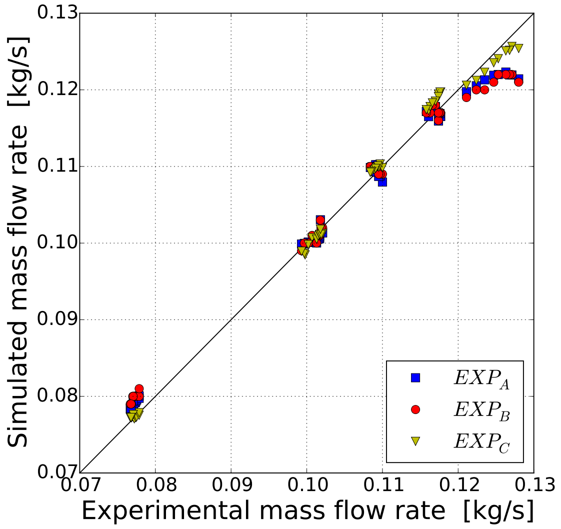
- **Parameters of model $EXP_A$**
  - $\bar{\phi}_{vol,exp} = 106.5\ [\%]$
  - $\bar{\eta}_{is,exp} = 66.7\ [\%]$
  - $V_{dis,pp} = 20.2\ [cm^3]$
  - $AU_{loss} = 6.7234\ [W/K]$

- **Parameters of model $EXP_B$**
  - $AU_{amb} = 5.7\ [W/K]$
  - $AU_{ex,n} = 23.8\ [W/K]$
  - $AU_{su,n} = 35.1\ [W/K]$
  - $\dot{m}_n = 0.1062\ [kg/s]$
  - $V_{dis,pp} = 20.2\ [cm^3]$
  - $r_{v,in} = 2.2\ [-]$
  - $A_{leak} = 1.02 \cdot 10^{-6} + 0.0128 \cdot 10^{-6} P_{su}\ [m^2]$
  - $\tau_{loss} = 0.88\ [N/m]$

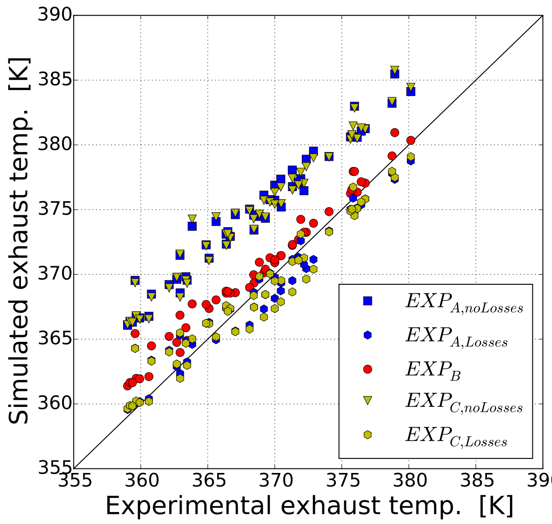
- **Parameters of model $EXP_C$**
  - $a_{00} = 0.2753$
  - $a_{10} = 1.326$
  - $a_{01} = -0.003807$
  - $a_{20} = -0.7742$
  - $a_{11} = 0.001246$
  - $a_{02} = 1.155 \cdot 10^{-5}$
  - $b_{00} = 1.415$
  - $b_{10} = -0.5236$
  - $b_{01} = -0.004392$
  - $b_{20} = 0.189$
  - $b_{11} = 0.002444$
  - $b_{02} = 1.839 \cdot 10^{-5}$
  - $AU_{loss} = 6.7234\ [W/K]$

- **Parameters of model $CD_A$**
  - $\bar{\theta}_{cd} = 8.5391 \ [K]$
- **Parameters of model $CD_B$**
  - $\alpha_{wf,liq} = 3270.5 \ [W/K.m^2]$
  - $\alpha_{wf,tp} = 5286.5 \ [W/K.m^2]$
  - $\alpha_{wf,vap} = 3188.9 \ [W/K.m^2]$
  - $\alpha_{htf} = 3763.4 \ [W/K.m^2]$
- **Parameters of model $CD_C$**
  - $\alpha_{wf,liq,nom} = 2159.2 \ [W/K.m^2]$
  - $\alpha_{wf,tp,nom} = 7222.7 \ [W/K.m^2]$
  - $\alpha_{wf,vap,nom} = 1291.9 \ [W/K.m^2]$
  - $\alpha_{htf,nom} = 7174.7 \ [W/K.m^2]$
  - $\dot{m}_{htf,nom} = 1.48 \ [kg/s]$
  - $\dot{m}_{wf,nom} = 0.149 \ [kg/s]$
- **Parameters of model $EV_A$**
  - $\bar{\theta}_{ev} = 5.2568 \ [K]$
- **Parameters of model $EV_B$**
  - $\alpha_{wf,liq} = 1965.1 \ [W/K.m^2]$
  - $\alpha_{wf,tp} = 4026.4 \ [W/K.m^2]$
  - $\alpha_{wf,vap} = 72.12 \ [W/K.m^2]$
  - $\alpha_{htf} = 145.22 \ [W/K.m^2]$
- **Parameters of model $EV_C$**
  - $\alpha_{wf,liq,nom} = 1964.8 \ [W/K.m^2]$
  - $\alpha_{wf,tp,nom} = 4026 \ [W/K.m^2]$
  - $\alpha_{wf,vap,nom} = 24.06 \ [W/K.m^2]$
  - $\alpha_{htf,nom} = 487.9 \ [W/K.m^2]$
  - $\dot{m}_{htf,nom} = 0.719 \ [kg/s]$
  - $\dot{m}_{wf,nom} = 0.1038 \ [kg/s]$

## ADDITIONAL FIGURES

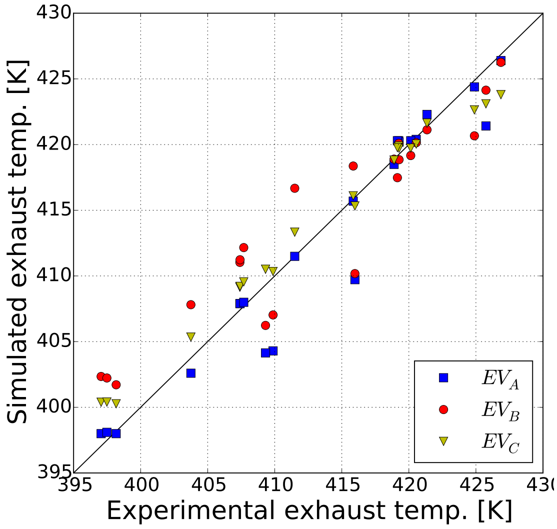



(a) Predicted mass flow rate vs. experimental data

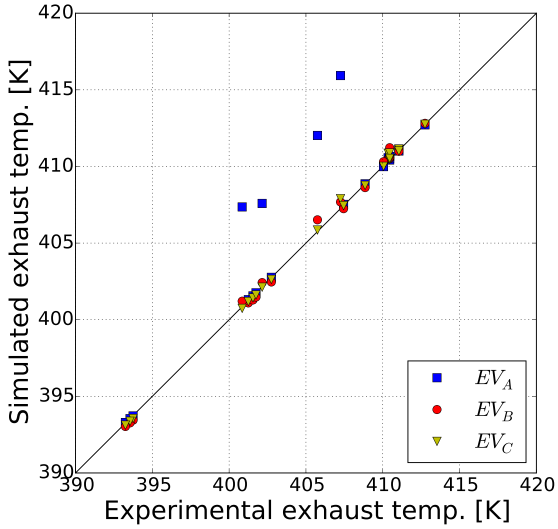



(b) Predicted exhaust temperature vs. experimental data (including results with and without heat losses taken into account)

**Figure 1: Goodness of fit of the expander models $EXP_A$, $EXP_B$ and $EXP_C$**

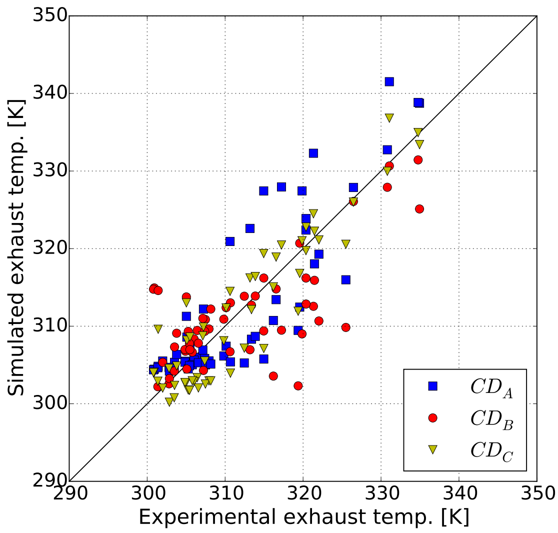



(a) Predicted exhaust temperature vs. experimental data (R245fa side)

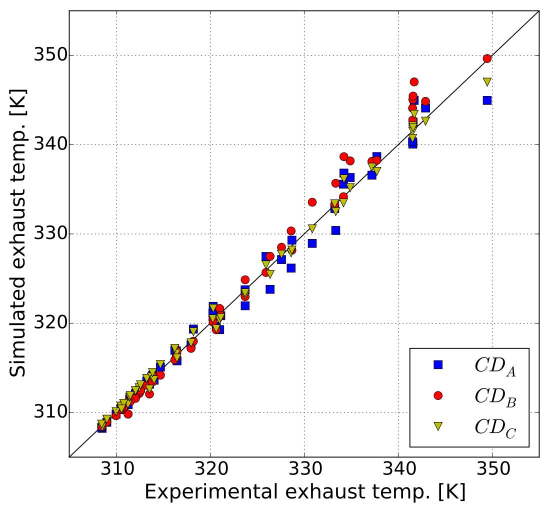



(b) Predicted exhaust temperature vs. experimental data (heat transfer fluid side)

**Figure 2: Goodness of fit of the expander models $EV_A$, $EV_B$ and $EV_C$**




(a) Predicted exhaust temperature vs. experimental data (R245fa side)




(b) Predicted exhaust temperature vs. experimental data (heat transfer fluid side)

**Figure 3: Goodness of fit of the expander models $CD_A$, $CD_B$ and $CD_C$**