CHAPTER IV
RESULTS AND DISCUSSION

Results in this study are separated into two parts. The first part is experimental results of the gasoline emission. Results from the study of the effects of temperature, vent height and initial gasoline volume are discussed in details. In the second part, the model developed in this work was tested against the experimental data. Predictions from the model are compared to those from the other models. The experimental data are presented in Appendix D.

4.1 Experimental Results of Gasoline Emission Rate

4.1.1 Effect of Temperature on Gasoline Emission Rate

Figures 4.1-4.2 show the gasoline emission in the studied system having 300 ml gasoline volume and 15 cm vent height at the temperatures of 30, 35 and 40°C. From these figures, the amount of the gasoline emitted increases with an increase in the system temperature. The increase is due to higher evaporation rate at higher temperature. Another factor which affects the emission is the expansion effect. The increase of the temperature contributes to the expansion of both liquid and vapor gasoline, which also enhances the amount of the gasoline emitted. Remarkably high amount of the emission was observed on the first day of every temperature. That is presumably due to some high vapor pressure components that have completely vaporized during the first day. It is very interesting to point out that as can be seen from Figure 4.2, an increase in temperature results in increasing the emission rate of gasoline almost linearly.

4.1.2 Effect of Release Vent Height on Gasoline Emission Rate

Figures 4.3-4.4 present the gasoline emission results in the system containing 300 ml gasoline volume, 30°C at vent heights of 15, 30 and 45 cm. From these figures, the lost is highest on the first day of the experiment. The emission in this experiment decreases as the vent height increases. This can be explained by the Fick's law,

$$L_D = M_V A J_{AZ} \tag{2.22}$$

$$J_{AZ} = \frac{D_G P_{VA}}{RT\Delta z} \tag{2.23}$$

From these equations, the amount of gasoline emission (L_D) decreases with the increase of vent height (Δz).

4.1.3 Effect of Initial Gasoline Volume on Gasoline Emission Rate

Figures 4.5-4.6 show the gasoline emission results in the system of 30 cm vent height, 40°C at gasoline volumes of 250, 300 and 350 ml. Again, the surge of the emission on the first day was observed here. It can be reduced from Figure 4.5 that the initial volume of gasoline has very little effect on the emission because vapor space volume of the storage is unsaturated with gasoline. Therefore, continuous evaporation of gasoline occurs until vapor space volume of storage is saturated with gasoline vapor. Then, the evaporation was stopped.

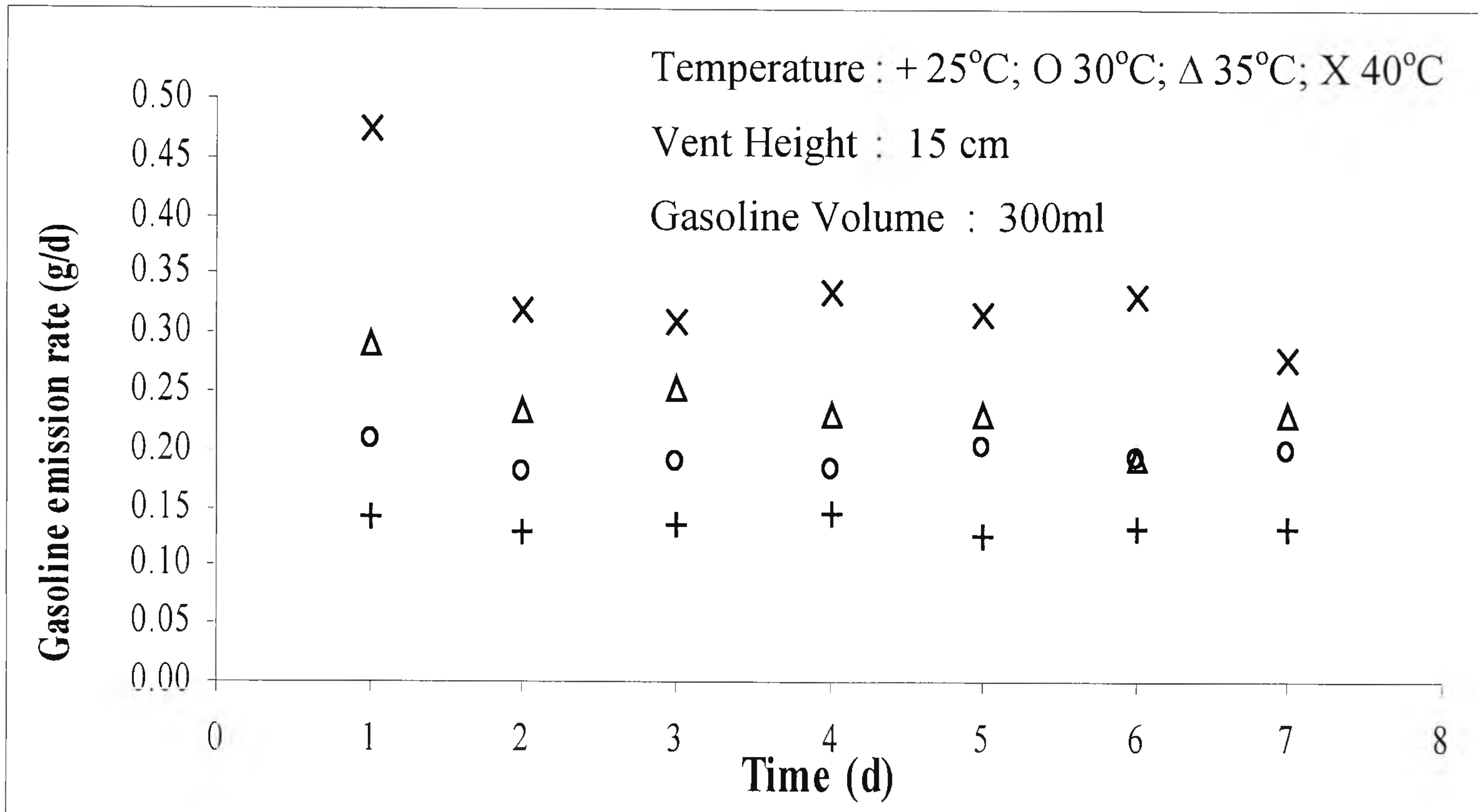

Figure 4.1 Daily gasoline emission rate at different temperatures

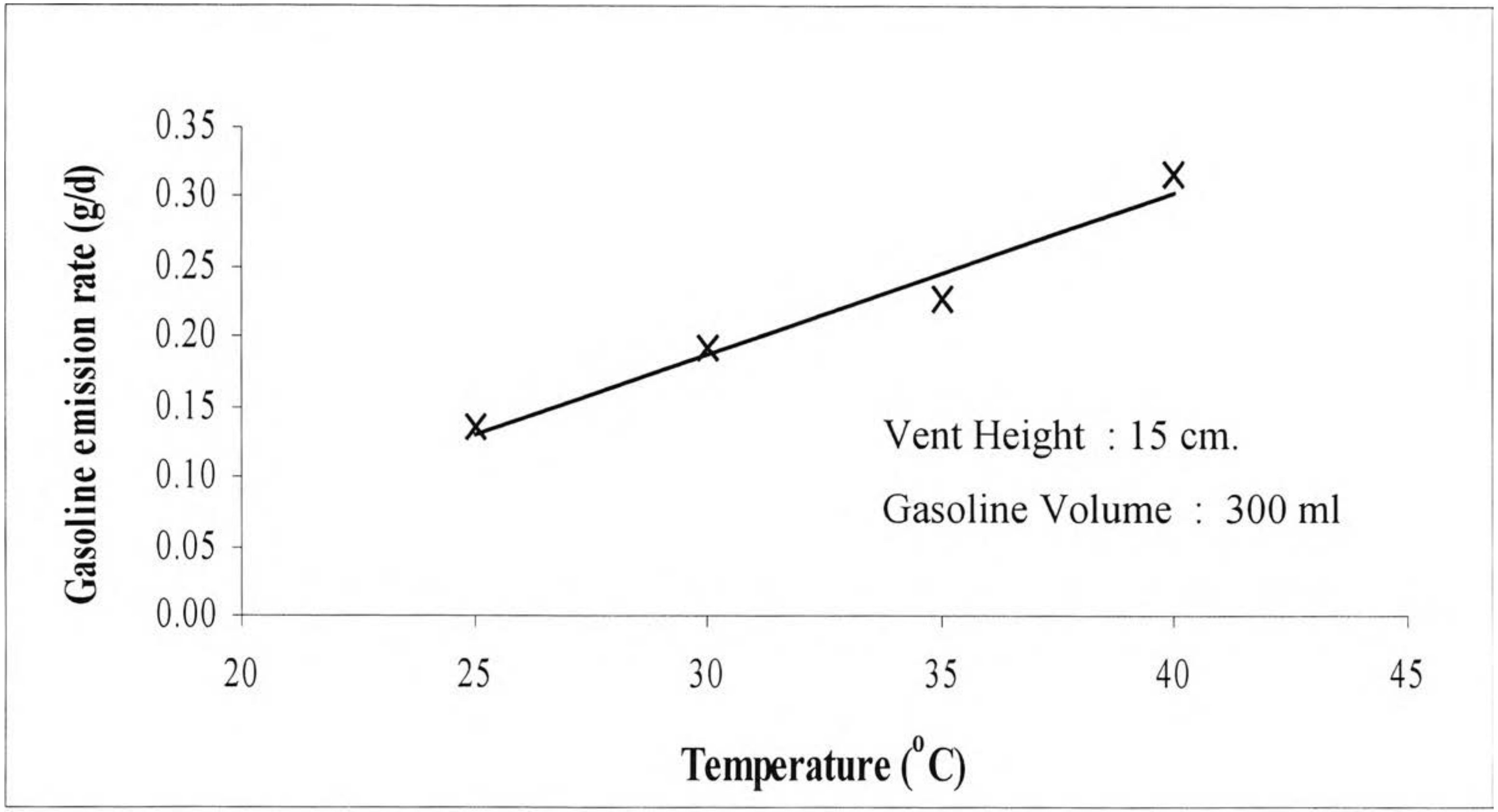

Figure 4.2 Average emission rate of gasoline at different temperatures

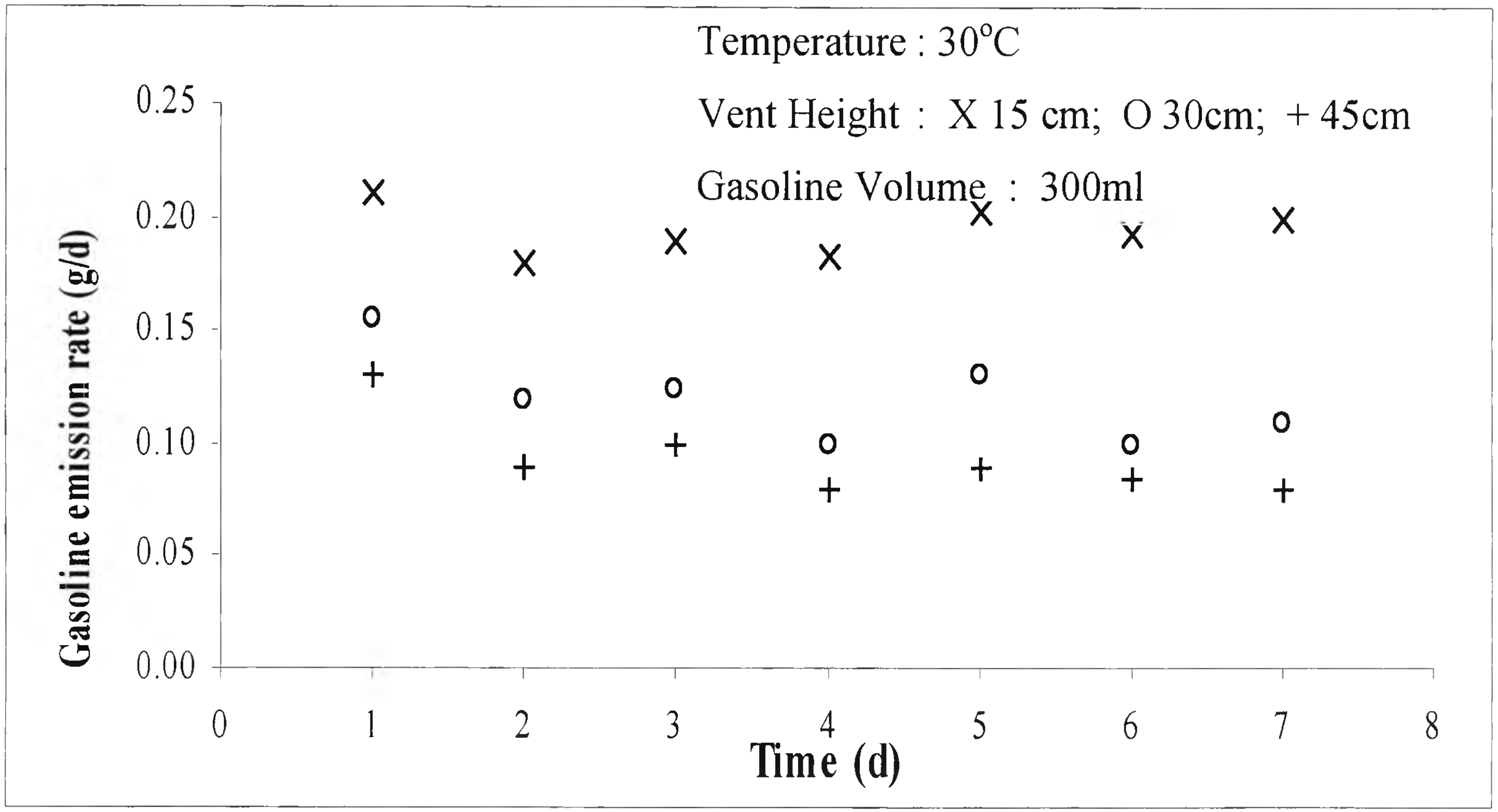

Figure 4.3 Daily gasoline emission rate at different vent heights

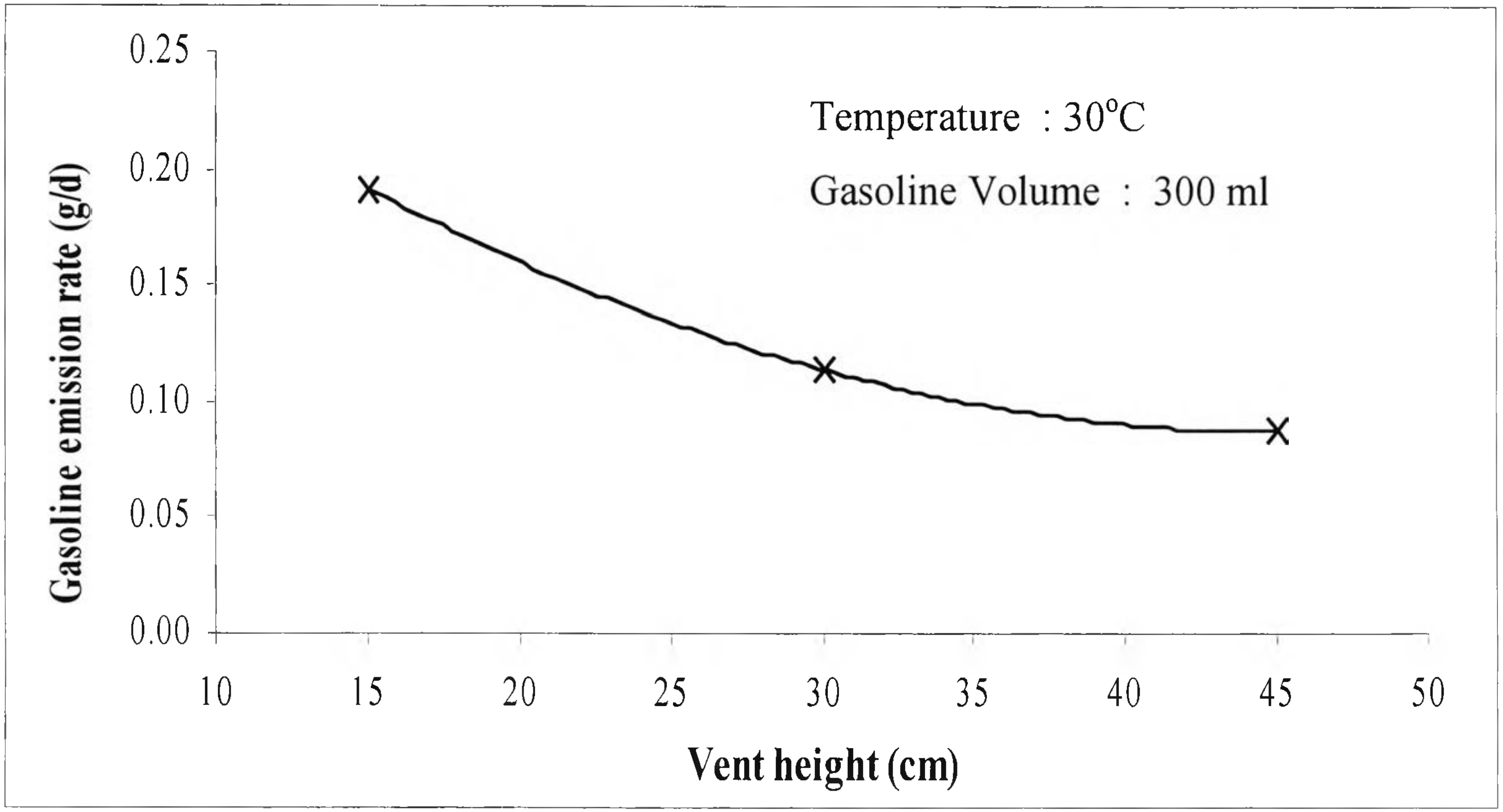

Figure 4.4 Average emission rate of gasoline at different vent heights

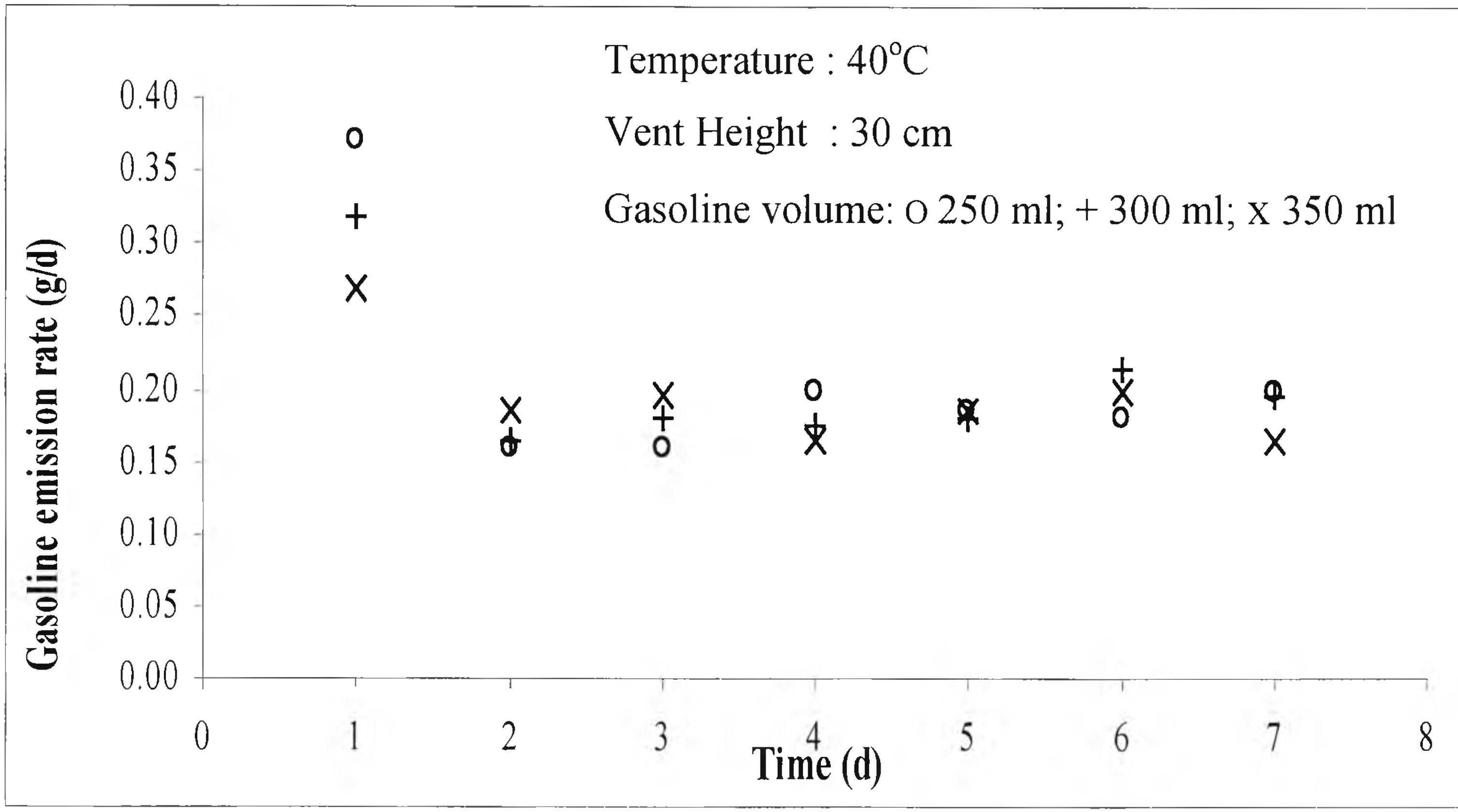

Figure 4.5 Daily gasoline emission rate at different gasoline volumes

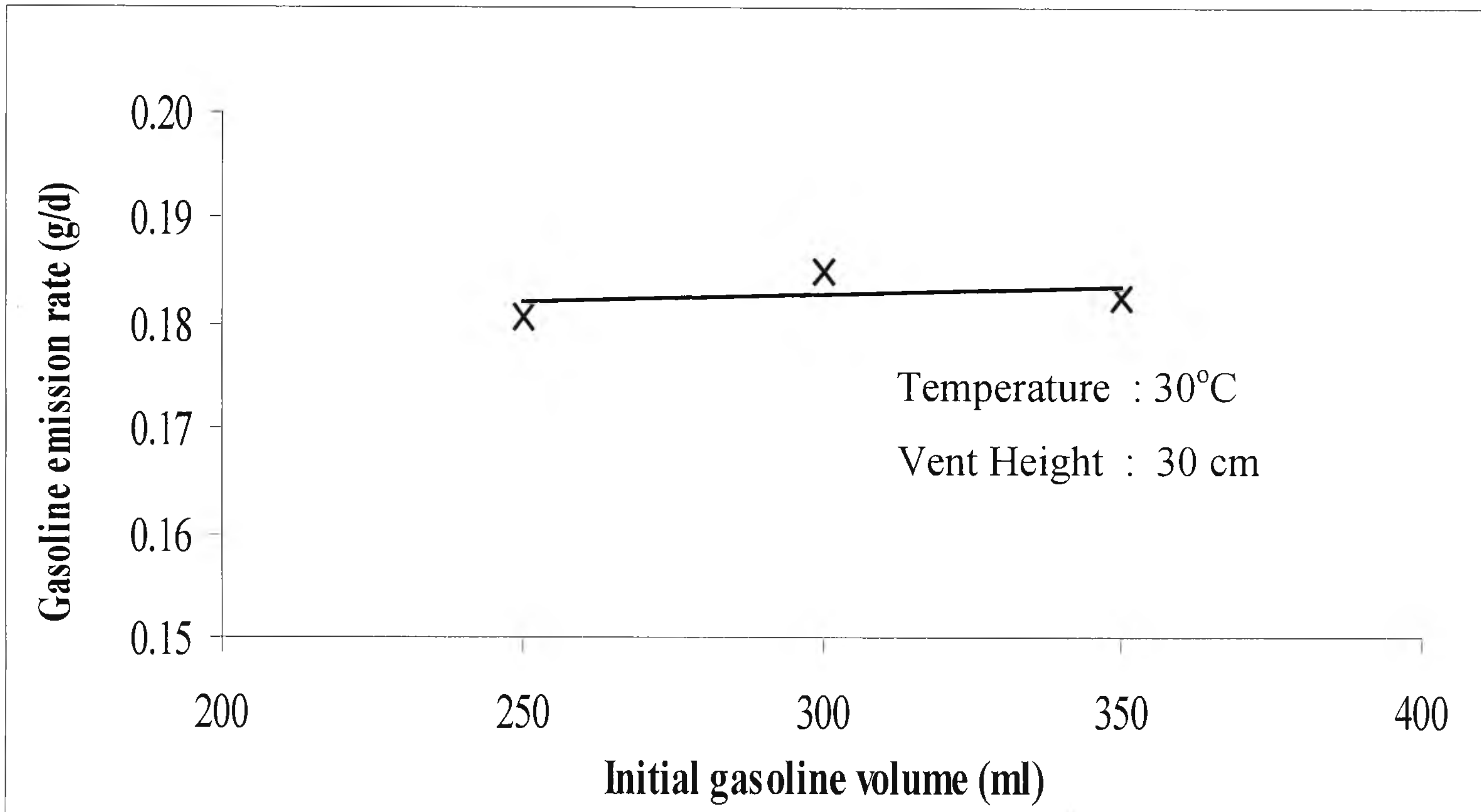

Figure 4.6 Average emission rate of gasoline at different initial gasoline volume

4.2 Modeling Results

Figures 4.7-4.9 show the comparisons of the experimental results with the predictions from the three models, i.e. this work model, U.S. EPA model and Nevers model, in the system of 300 ml initial gasoline volume, 15 cm vent height at 30, 35 and 40°C. From these figures, the proposed model gives consistently excellent agreement with the experimental data while the U.S. EPA model and Nevers model does not represent the data as expected.

Figures 4.10-4.12 give the comparisons between the experimental data and results from the model in the system of 300 ml initial gasoline volume with varying the vent height from 15 to 30 cm at three different temperatures, 30, 35 and 40°C. According to these figures, the proposed model still gives better representation to the experimental data with the average deviation of 8.41%.

To test each model on the effects of vent height, experiments were set up with 300 ml initial gasoline volume, varying the vent height from 30 to 45 cm at three different temperatures, 30, 35 and 40°C. The results are shown in Figures 4.13-4.15. Again, compared with the other models, the proposed model shows excellent agreement with the experimental data. The average deviation of this model was approximately 9.63%.

Figures 4.16-4.18 present the comparison between the experimental data and results from the models in the system of 30 cm vent height, 40°C and three gasoline volumes of 250, 300 and 350 ml. The best model that agrees with the experimental data is this work model with average deviation of 10.14%.

Finally, Figure 4.19 shows the comparison between the proposed model, U.S. EPA model and Nevers model in the system of 30°C, 300 ml gasoline volume and different cross-sectional area per vent height ratio. From this figure, this work model could be used with a wide range of this ratio while the others model could not be used to predict gasoline emission in this system.

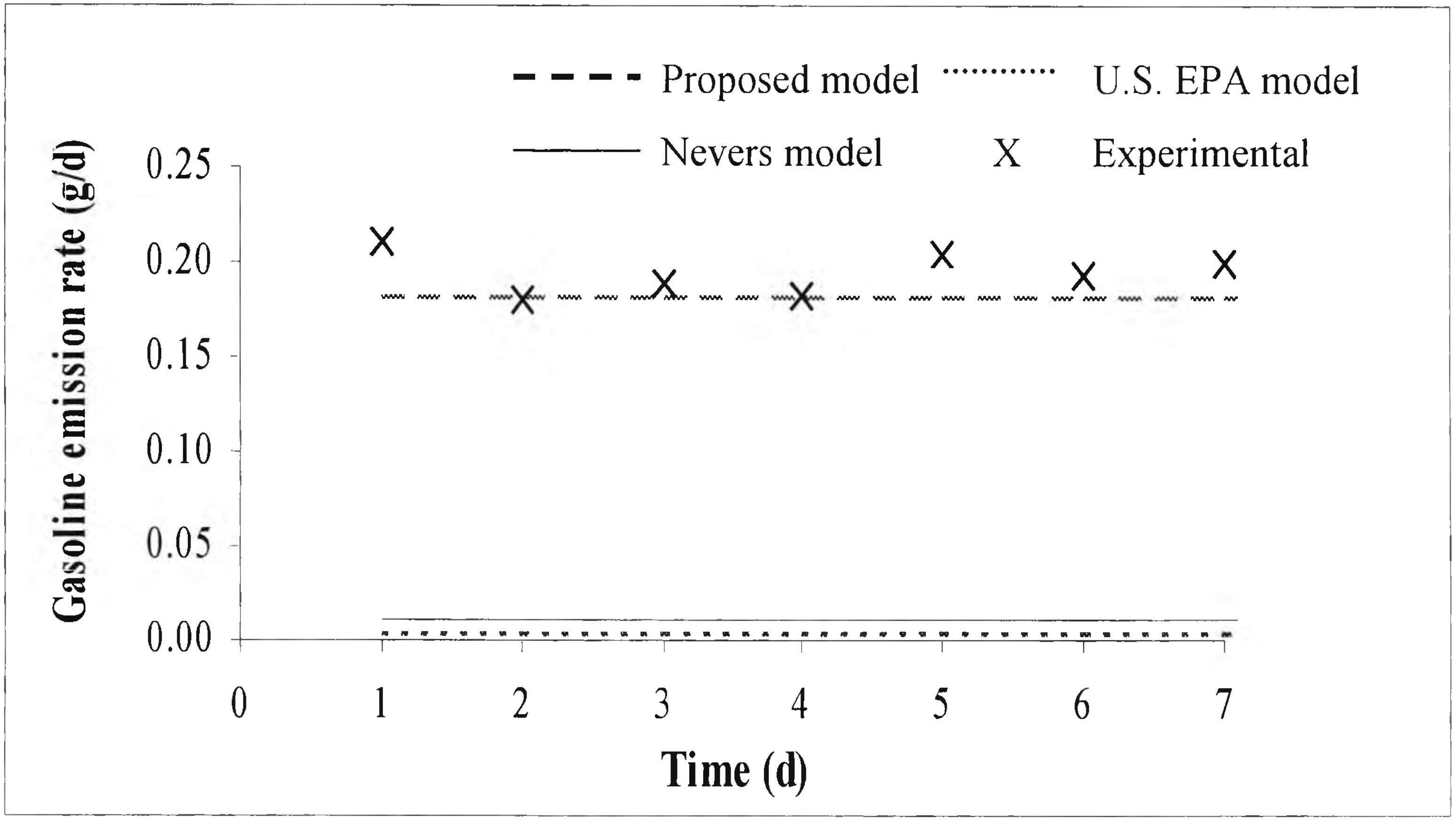

Figure 4.7 Comparison of prediction from the models to the experimental data at 30°C, 15 cm release vent height and 300ml gasoline volume

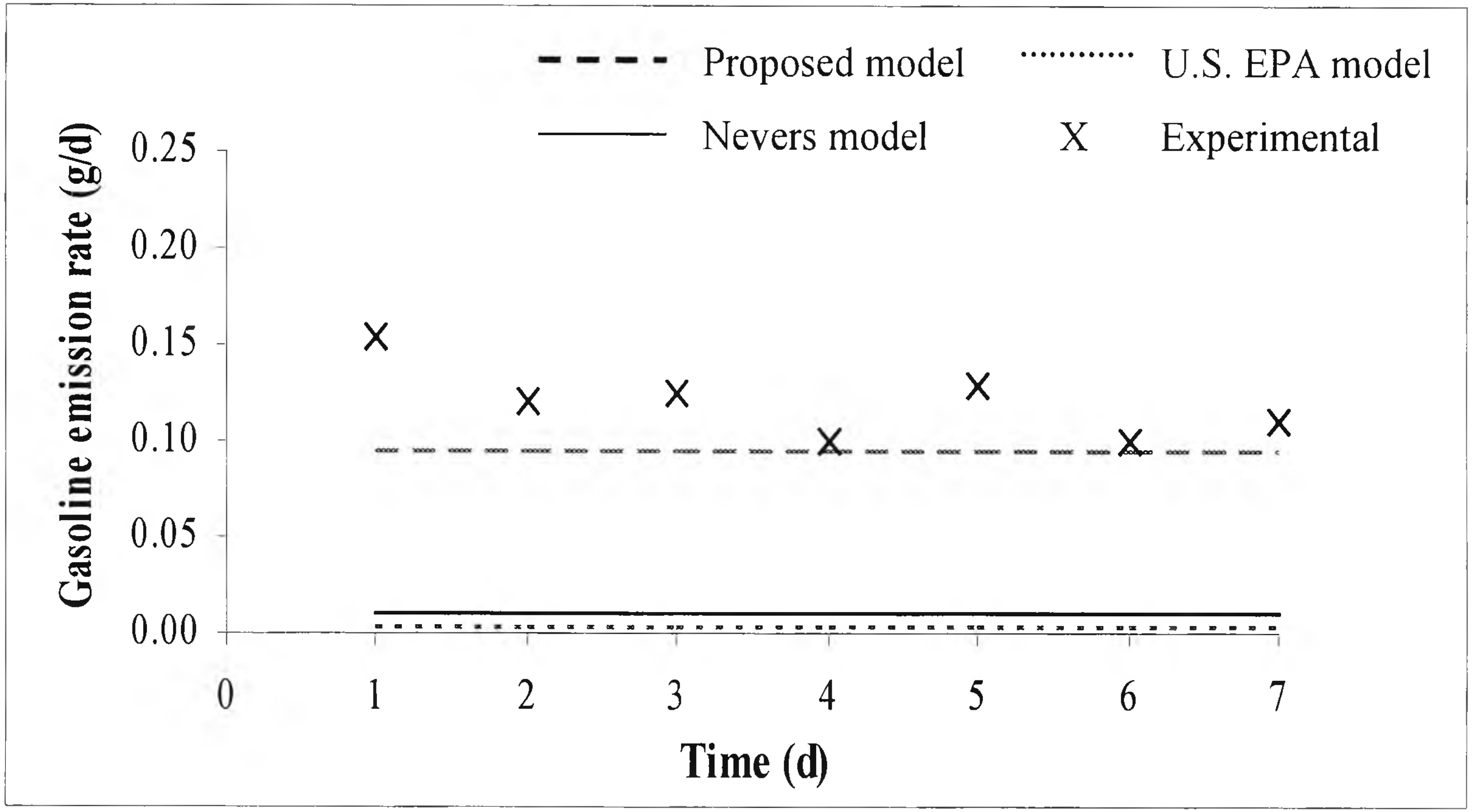

Figure 4.8 Comparison of prediction from the models to the experimental data at 30°C, 30 cm release vent height and 300ml gasoline volume

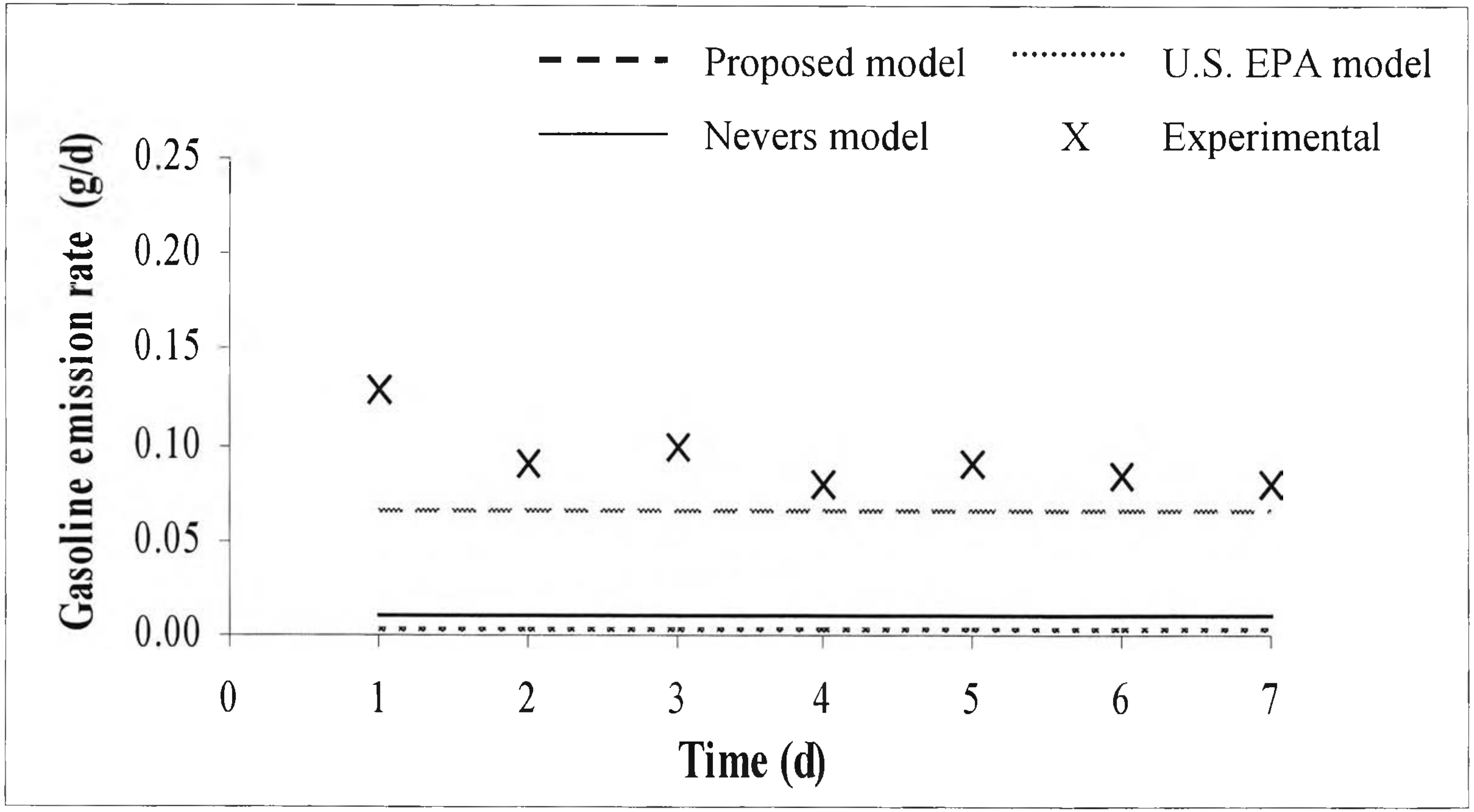

Figure 4.9 Comparison of prediction from the models to the experimental data at 30°C, 45 cm release vent height and 300ml gasoline volume

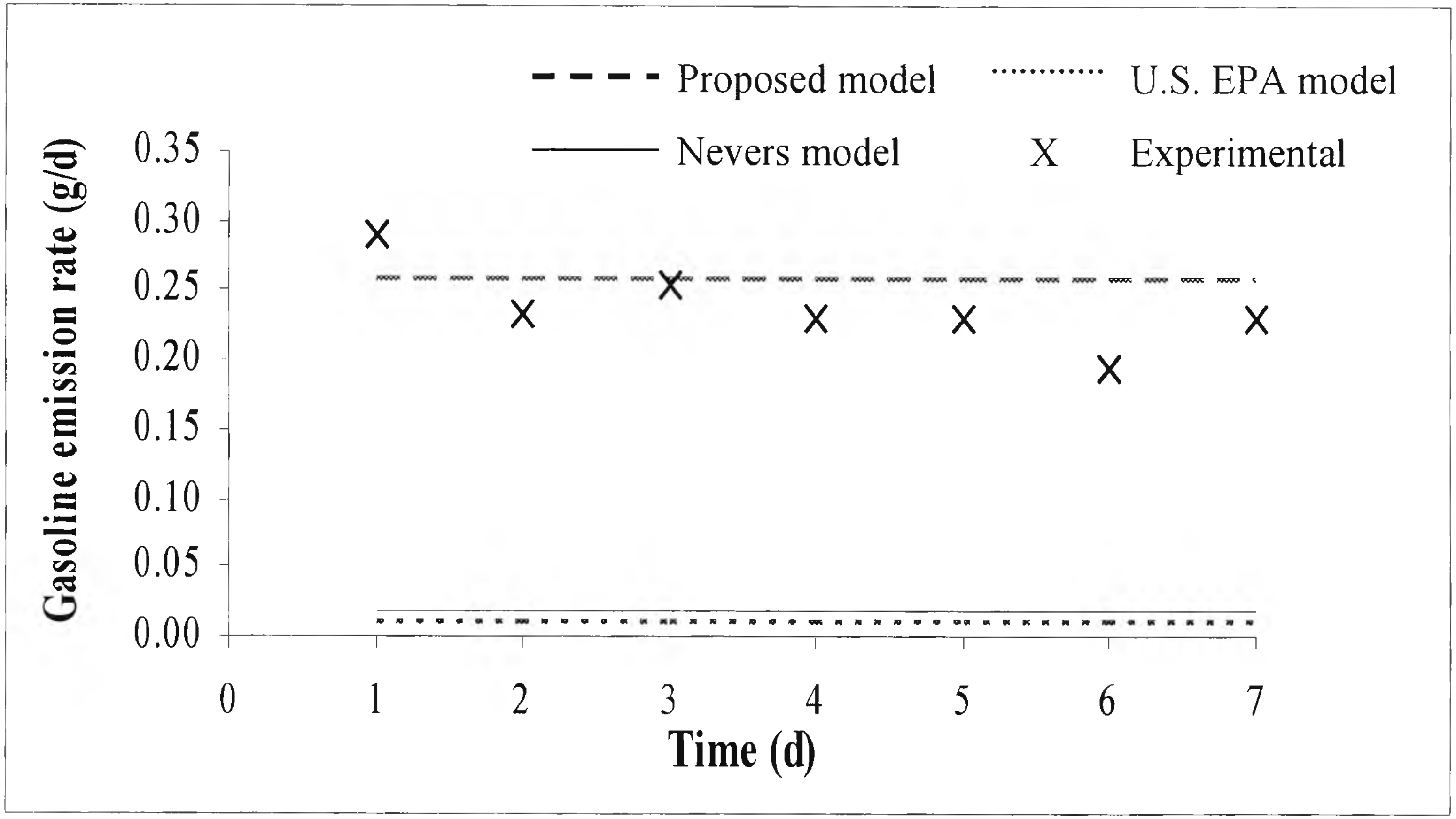

Figure 4.10 Comparison of prediction from the models to the experimental data at 35°C, 15 cm release vent height and 300 ml gasoline volume

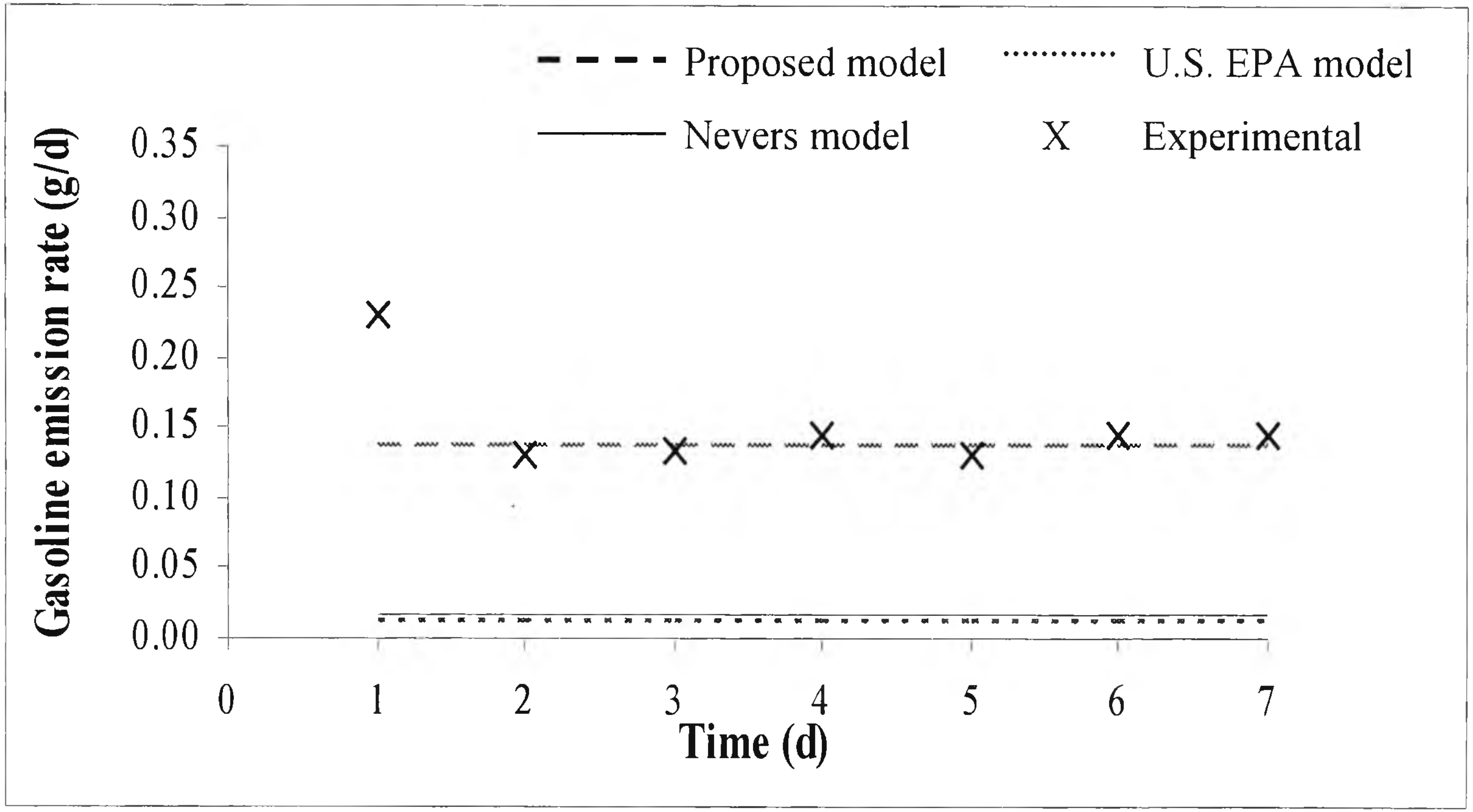

Figure 4.11 Comparison of prediction from the models to the experimental data at 35°C, 30 cm release vent height and 300 ml gasoline volume

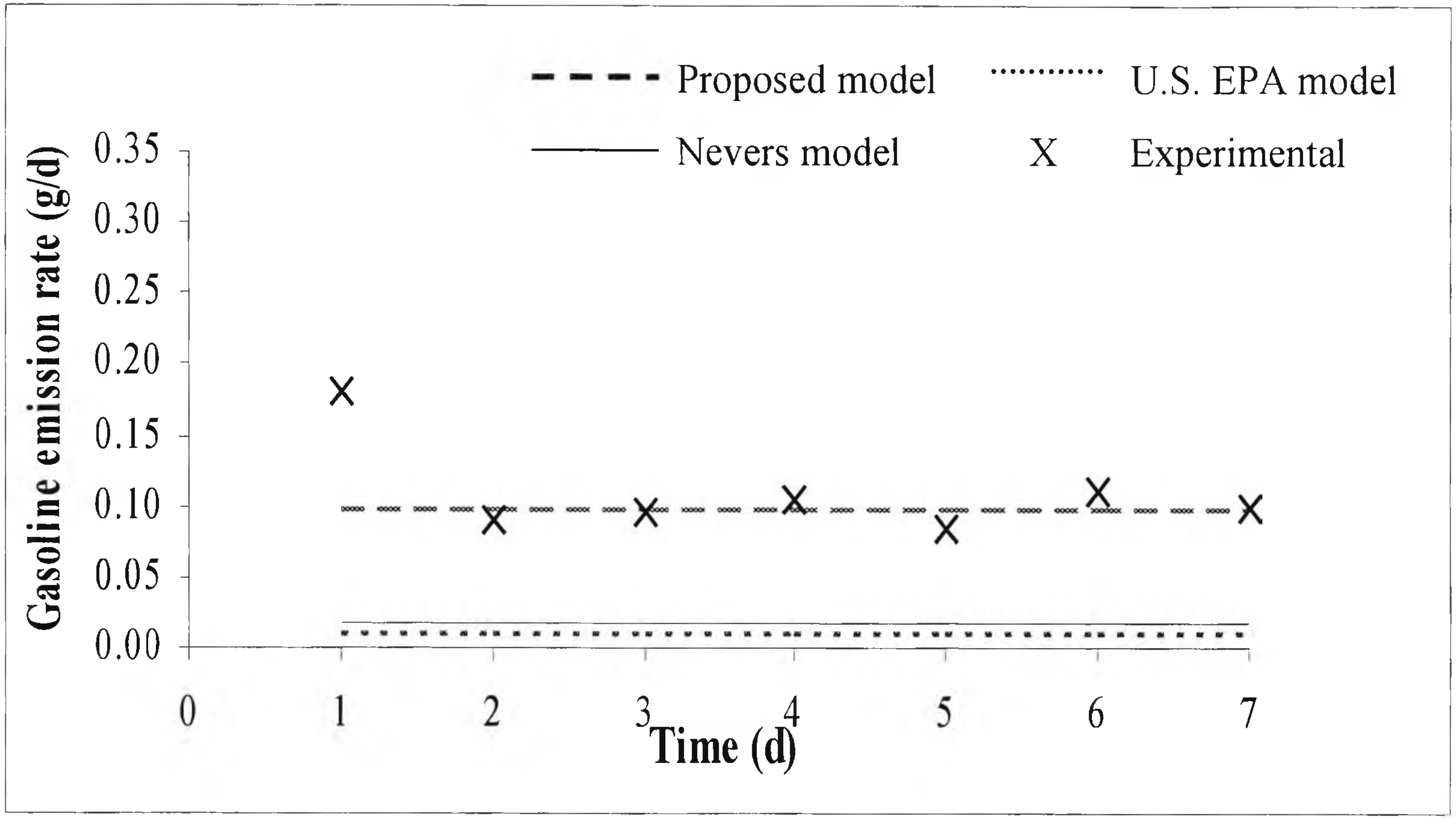

Figure 4.12 Comparison of prediction from the models to the experimental data at 35°C, 45 cm release vent height and 300 ml gasoline volume

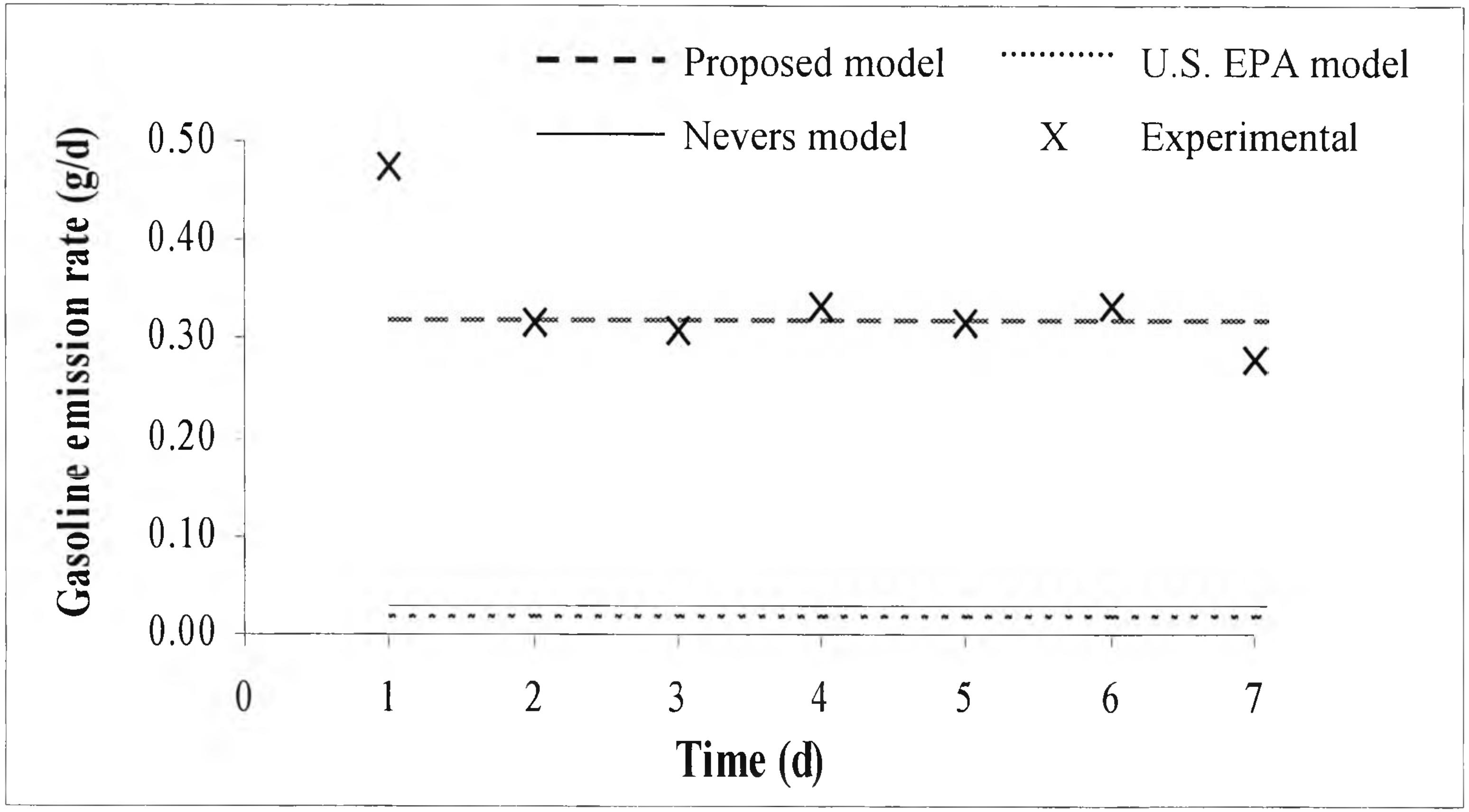

Figure 4.13 Comparison of prediction from the models to the experimental data at 40°C, 15 cm release vent height and 300 ml gasoline volume

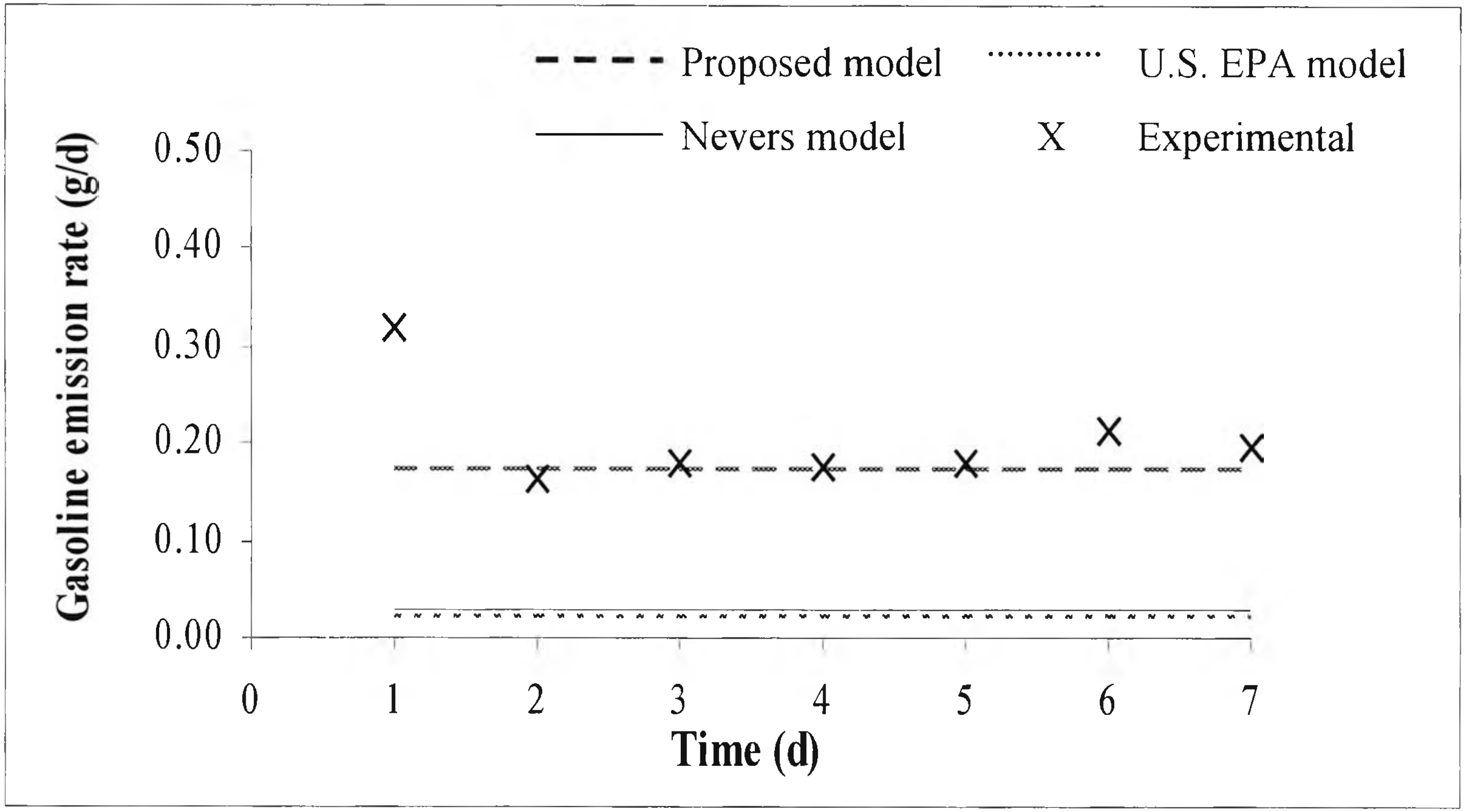

Figure 4.14 Comparison of prediction from the models to the experimental data at 40°C, 30 cm release vent height and 300 ml gasoline volume

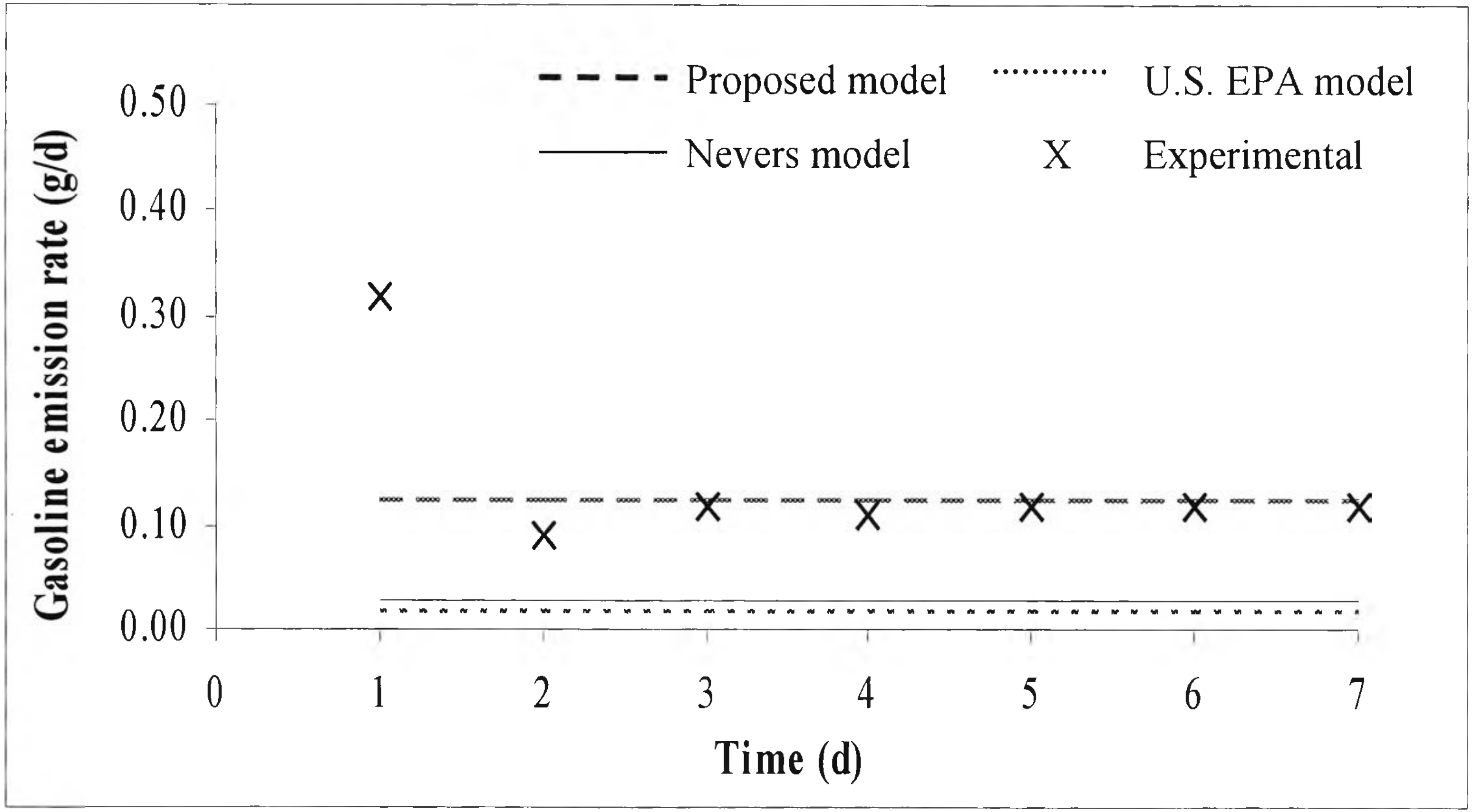

Figure 4.15 Comparison of prediction from the models to the experimental data at 40°C, 45 cm release vent height and 300 ml gasoline volume

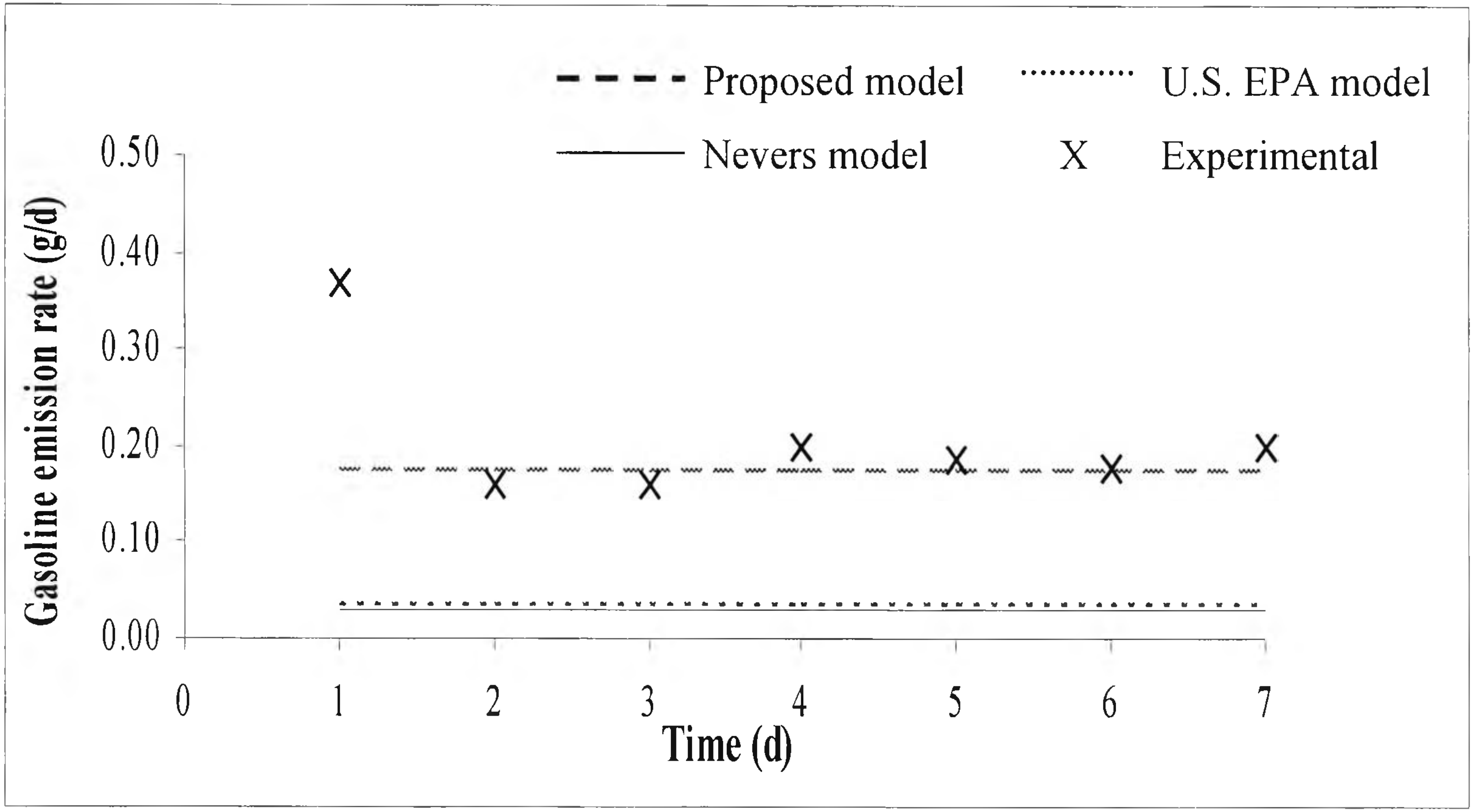

Figure 4.16 Comparison of prediction from the models to the experimental data at 40°C, 30 cm release vent height and 250 ml gasoline volume

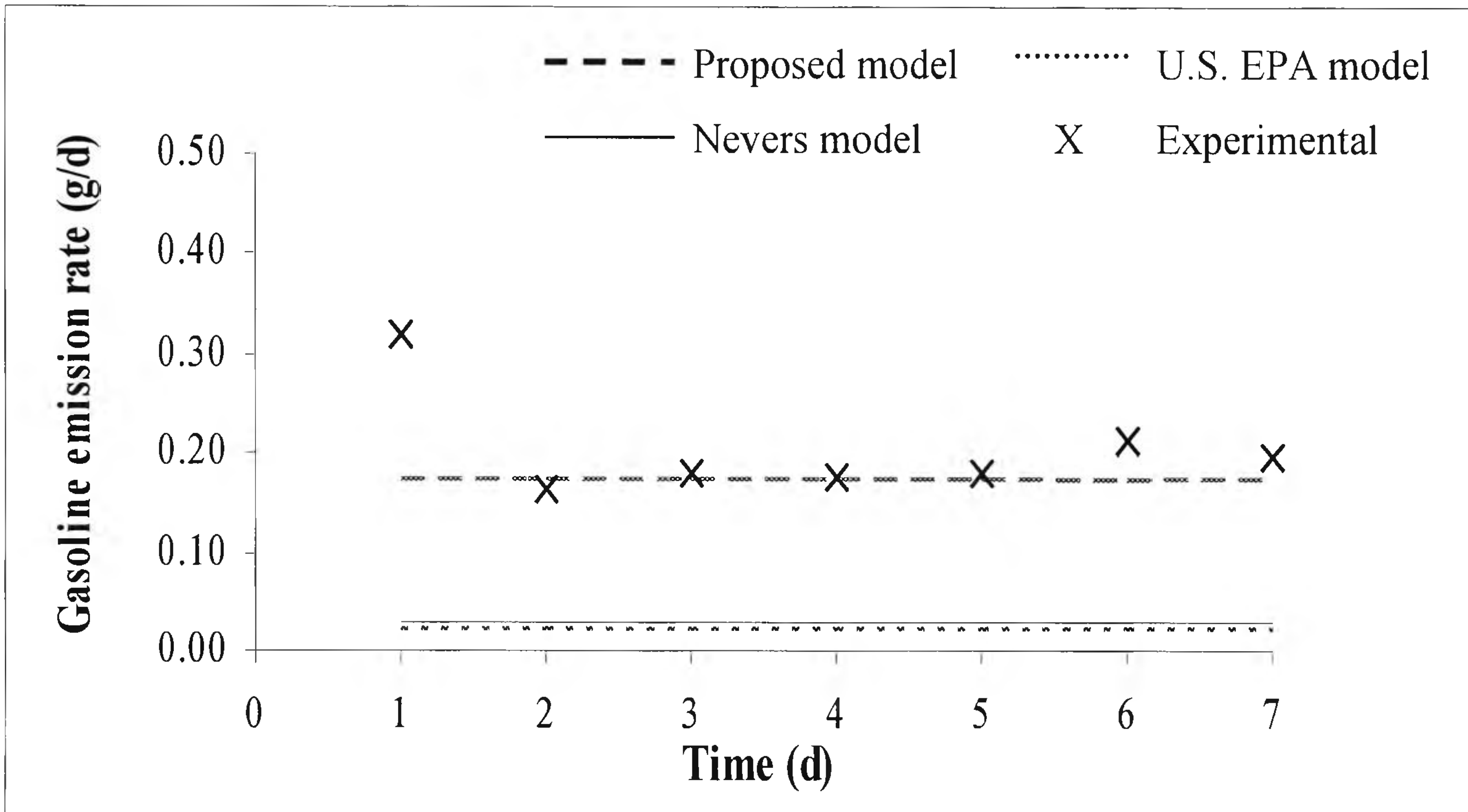

Figure 4.17 Comparison of prediction from the models to the experimental data at 40°C, 30 cm release vent height and 300 ml gasoline volume

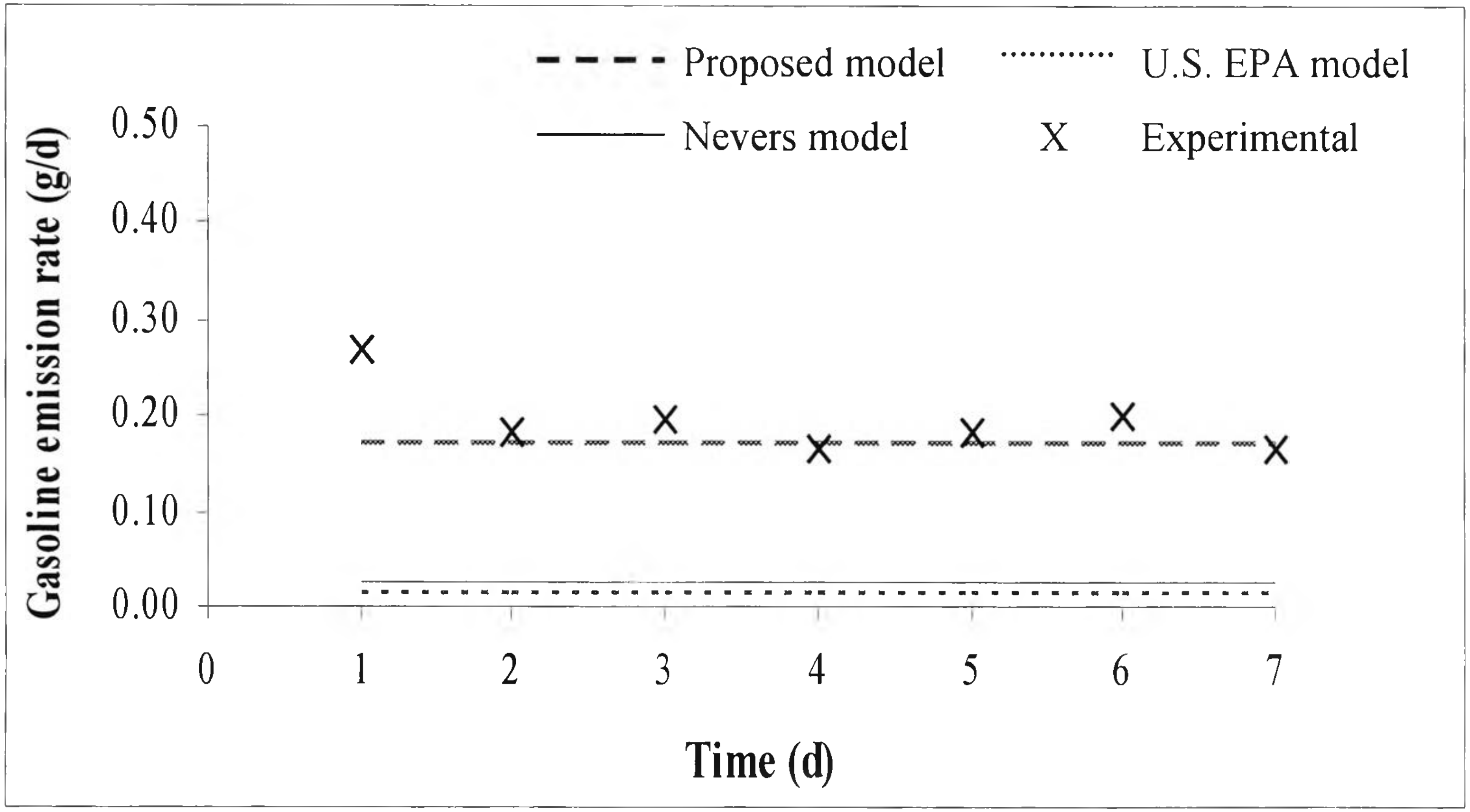

Figure 4.18 Comparison of prediction from the models to the experimental data at 40°C, 30 cm release vent height and 350 ml gasoline volume

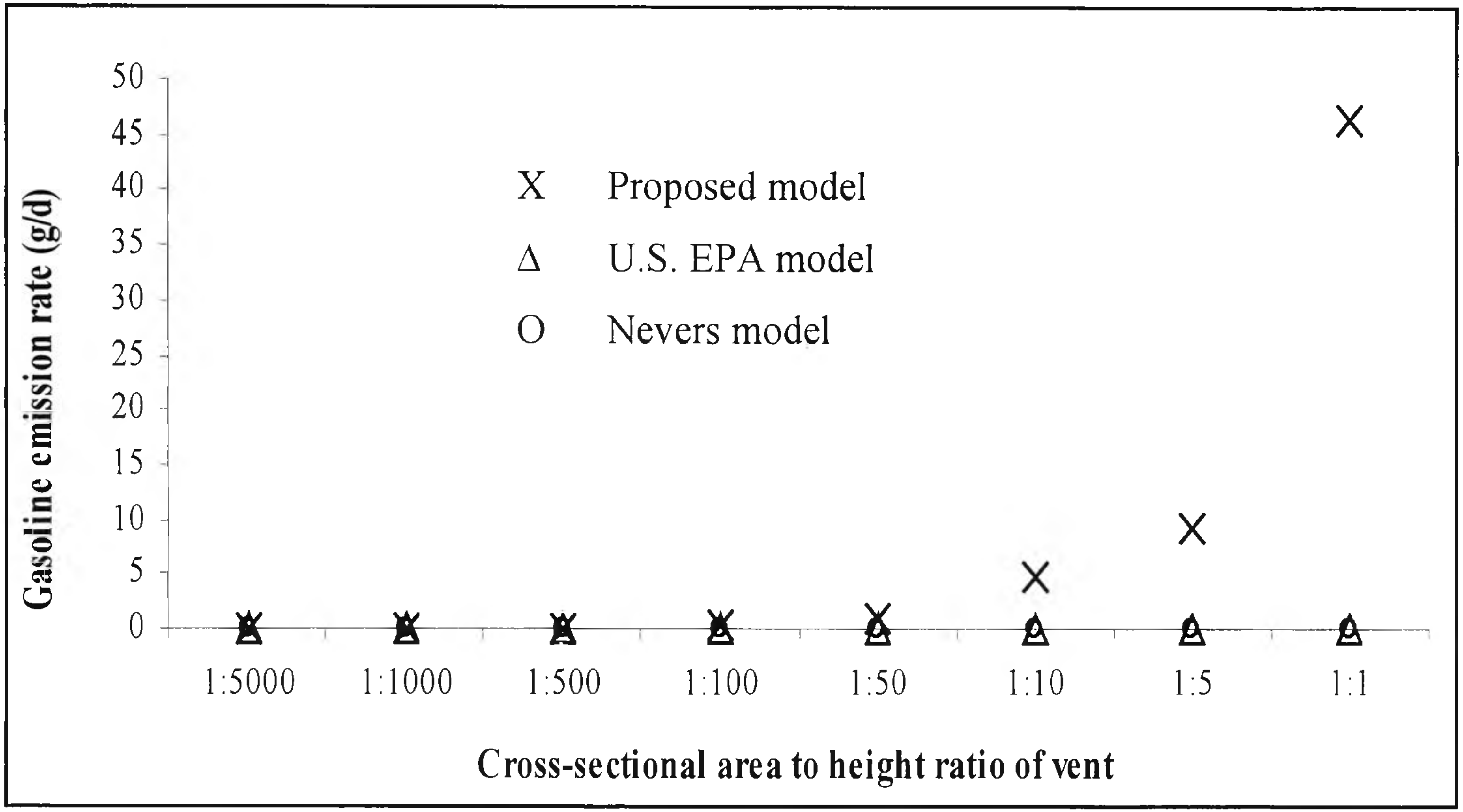

Figure 4.19 Comparison of prediction from the models at 30°C, 300 ml gasoline volume and vary cross-sectional area per vent height ratio.