Investigating of waste plastic co-pyrolysis with char by ANFIS coupled with ant colony algorithm

Ruming PAN

24/06/2021

Investigating of waste plastic co- pyrolysis with coal by ANFIS coupled with ant colony algorithm

I. Introduction

Figure 1. Illustrations of municipal solid waste (MSW) and waste plastic (WP).

- It is estimated that within 34 years (from 2016 to 2050), MSW will increase from 2.01 billion tons to 3.40 billion tons.
- Plastic waste accounts for a large part of Municipal Solid Waste (MSW) due to its wide range of uses.

I. Introduction

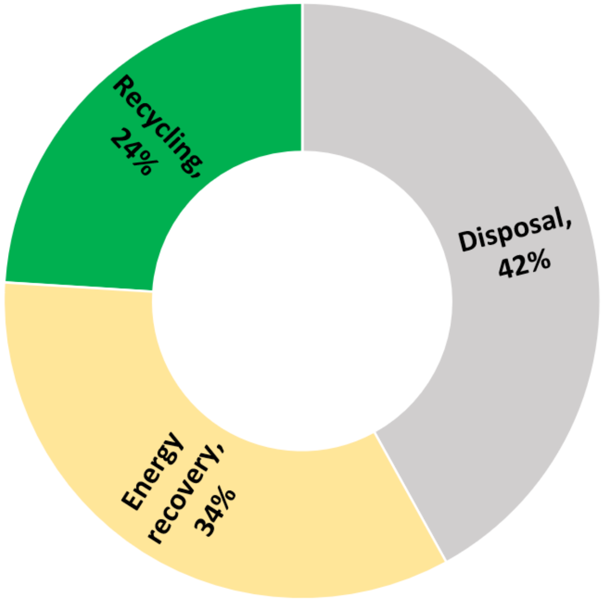

Figure 2. Waste plastic treatment methods.

- Disposal (direct landfill) of waste plastic is not the desired method due to the environmental unsustainability.
- As the main way of energy recovery, incineration of waste plastic leads to toxic pollutants emission.
- The mechanical recycling is not a good choice because of the inhomogeneity of municipal waste plastic.

I. Introduction

Figure 3. Municipal waste plastic and coal.

- The most suitable approach in dealing with the waste plastic is the **chemical recycling** such as the **pyrolysis**, which converts the plastic wastes into valuable hydrocarbon products.
- Due to the disadvantages such as low efficiency and high CO_2 emissions during direct combustion of low rank coal, **pyrolysis** has been considered as the main method for effectively **converting low rank coal** into tar and gas.

II. Hybrid model of ANFIS-ant colony algorithm

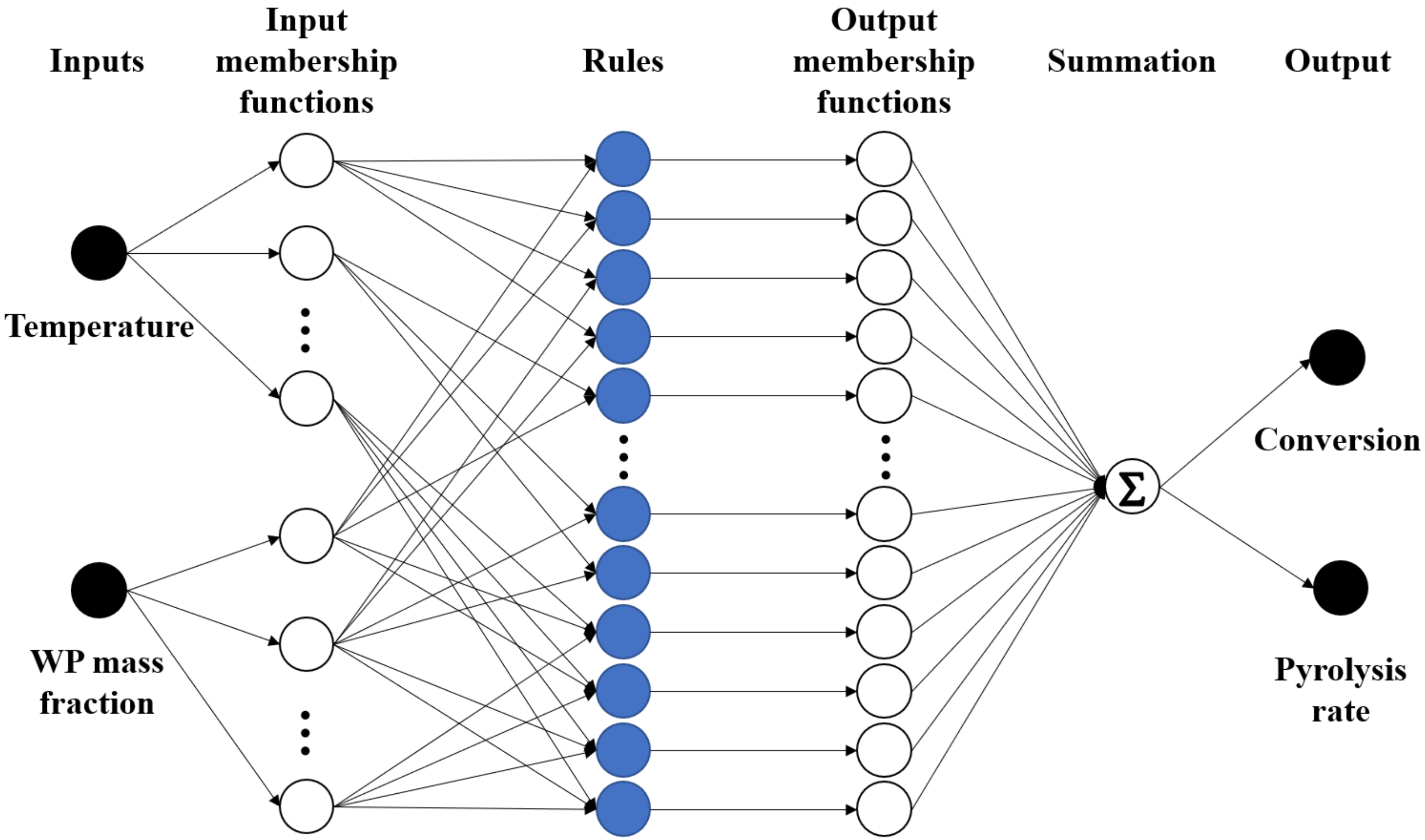

Figure 4. The network structure of the adaptive neural fuzzy inference system (ANFIS)

II. Hybrid model of ANFIS-ant colony algorithm

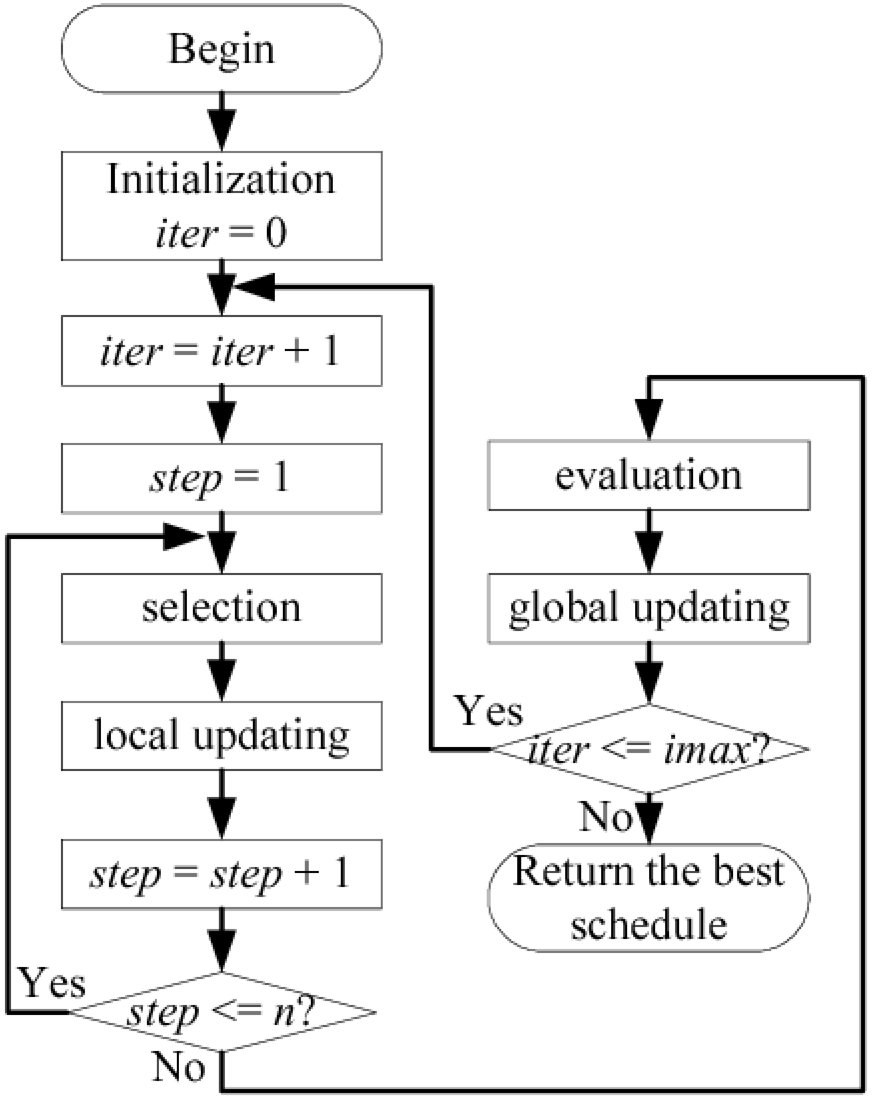

Figure 5. Ant colony algorithm (ACA) schematic diagram.

III. Results and discussion

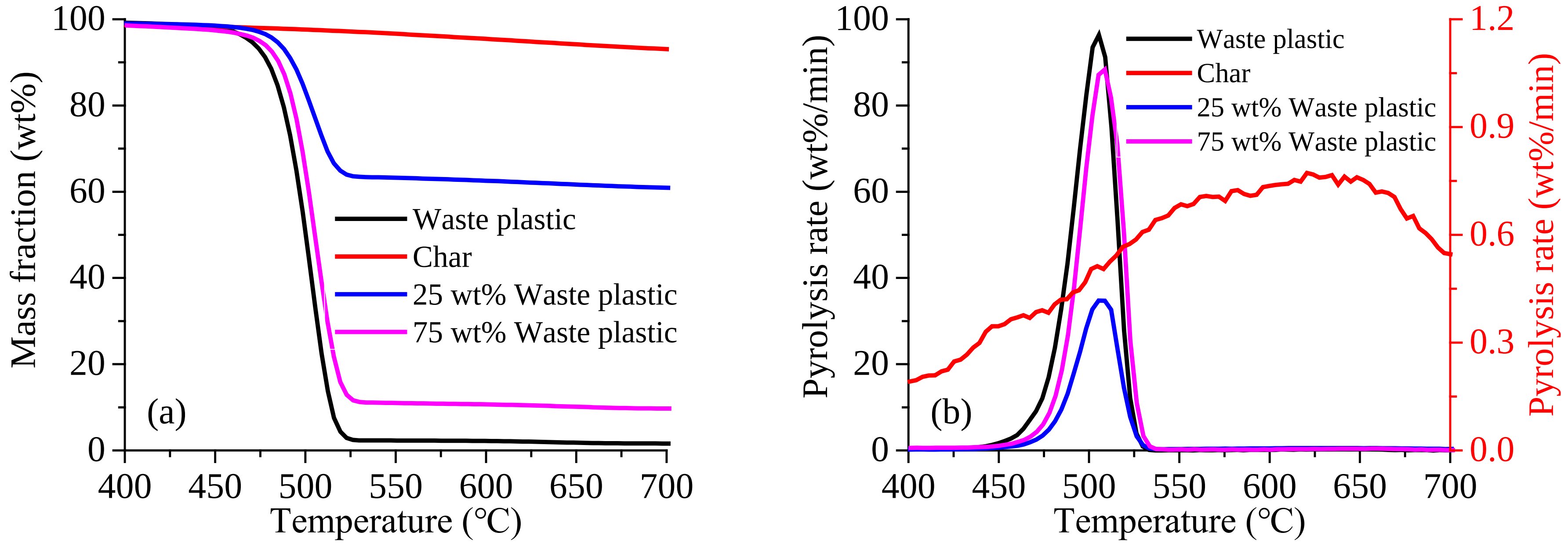

Figure 6. Experimental mass fractions and pyrolysis rates of the WP, char and WP/char mixture materials.

- Slow char decomposition process compared to the WP and the WP/char mixture materials.
- Pyrolysis processes of the WP and the WP/char mixture materials conducted in the temperature range of about 400-550 °C.
- Maximum pyrolysis rate decreased when WP mass fraction decreased.

III. Results and discussion

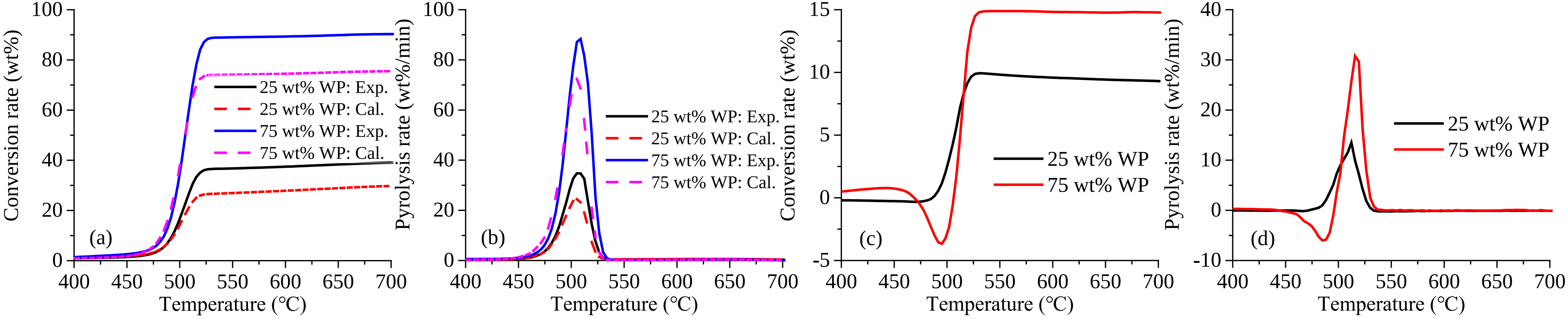

Figure 7. The WP co-pyrolysis effects with char.

- Experimental conversions higher than the linear calculated results at the end of the pyrolytic processes.
- Maximum experimental pyrolysis rates higher than the linear calculated ones.
- The char could both enhance and inhibit the WP pyrolysis conversion and pyrolysis rate in different temperature ranges.

III. Results and discussion

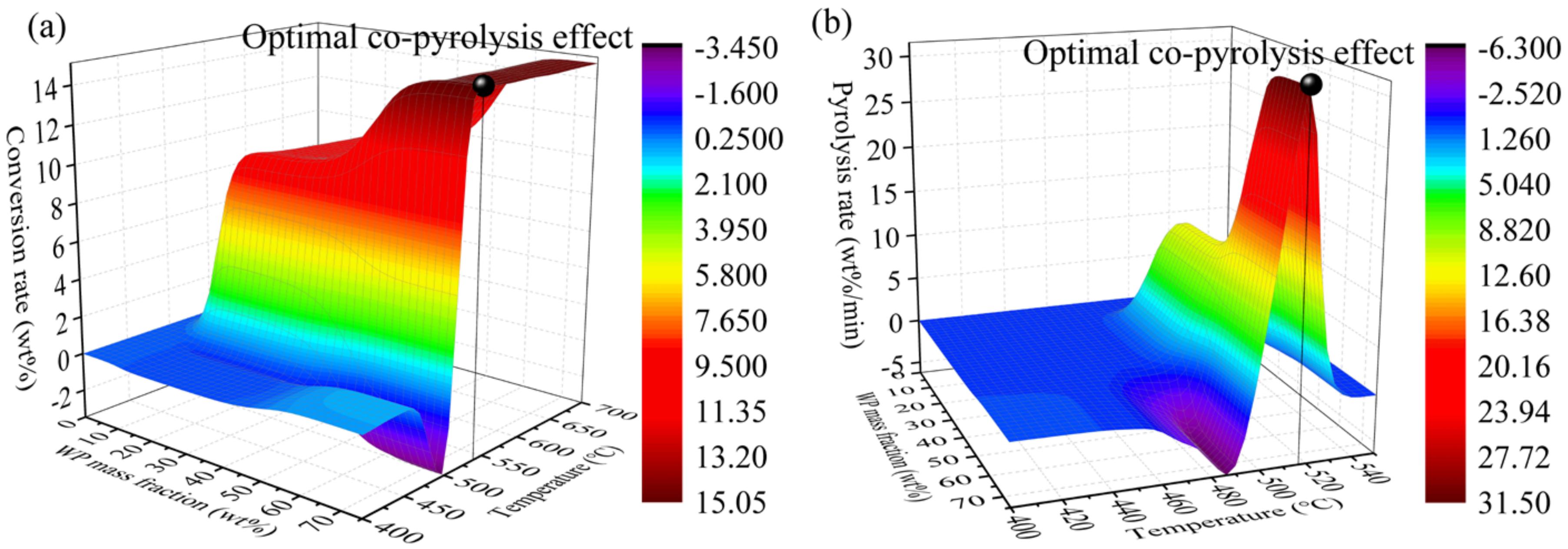

Figure 8. The optimal co-pyrolysis conversion rate and pyrolysis rate predicted by ANFIS coupled with ACA.

- ANFIS predicted co-pyrolysis conversion and pyrolysis rate → same trends compared to experimental ones.
- ACA determined optimal co-pyrolysis effect of the conversion : **15.02 wt%** at 538.61 °C with WP mass fraction of 75.00 wt%.
- Optimal co-pyrolysis effect of the pyrolysis rate determined by the ACA : **31.66 wt%/min** at 516.89 °C with WP mass fraction of 75.00 wt%.

IV. Conclusion

- TG experiments of WP, char and WP/char mixture materials with 25 wt% and 75 wt% WP mass fractions were conducted at 30 ℃/min.

  -Differences exist between the linear calculated and the experimental results of the WP/char mixture materials pyrolysis.

  -Conversion and pyrolysis rate are enhanced in specific temperature ranges with different WP mass fractions.

- ANFIS coupled with ACA used to determine the optimal operating conditions for obtaining the optimal enhancements of the conversion and the pyrolysis rate.

  -Optimal enhancement of the conversion : 15.02 wt% at 538.61 ℃ with the WP mass fraction of 75.00 wt%.

  -Optimal pyrolysis rate enhancement : 31.66 wt%/min at 516.89 ℃ with WP mass fraction of 75.00 wt%.