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Radiative energy flux characteristics and model analysis for one-dimensional fixed-bed oxy-coal combustion

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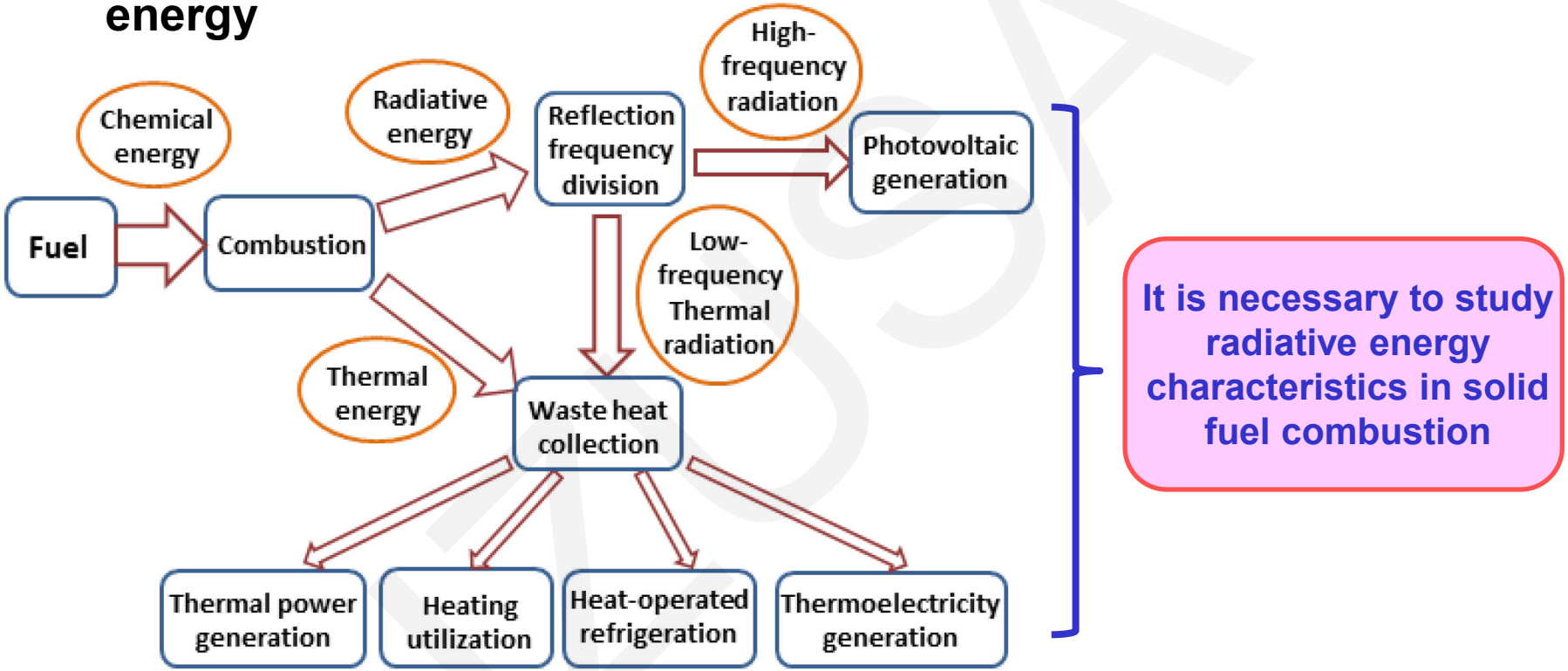
Background

- **A novel concept of quality-splitting conversion of combustion energy**



- Radiation energy is separated from the thermal energy in fuel combustion
- Radiation energy is utilized based on different frequencies
- High-frequency radiation is used for photovoltaic power generation
- Low-frequency radiation and the waste heat can be recycled

Methods

Experiment → **Semi-empirical model** → **ANN model**

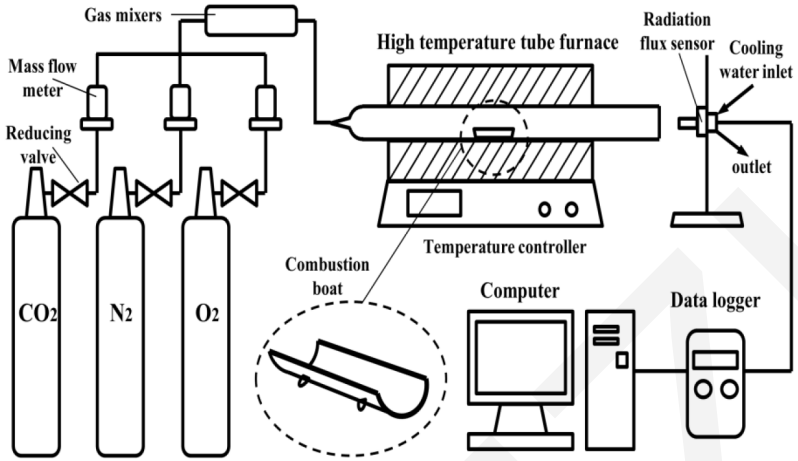


Fig. 1. Schematic diagram of the experimental system.

Use WSGG model to construct semi-empirical model *[1,2]

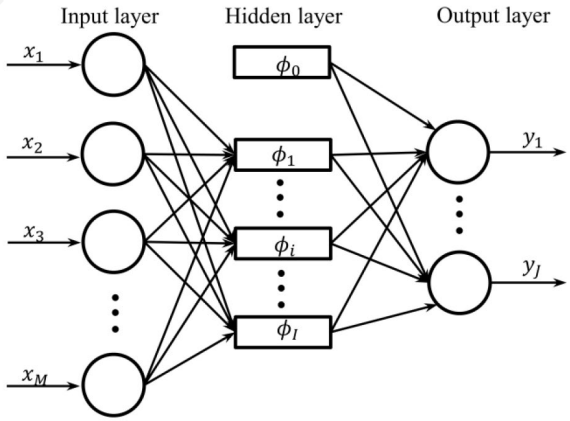


Fig.2. RBF network structure diagram

1 *Shan* et al; IJHMT, 2018, https://doi.org/10.1016/j.ijheatmasstransfer.2018.01.079
2 *Shan* et al; IJER,2017, https://doi.org/10.1002/er.3838

Results and discussions

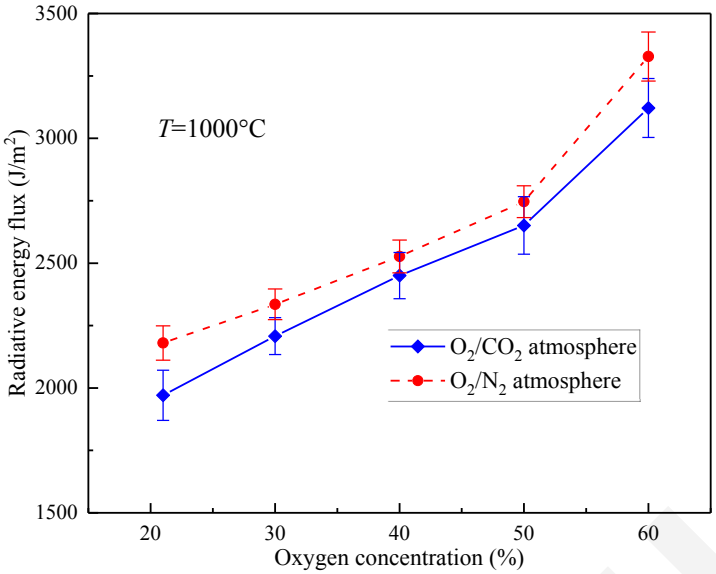


Fig.3 Radiative energy flux for different oxygen ratios in two atmospheres

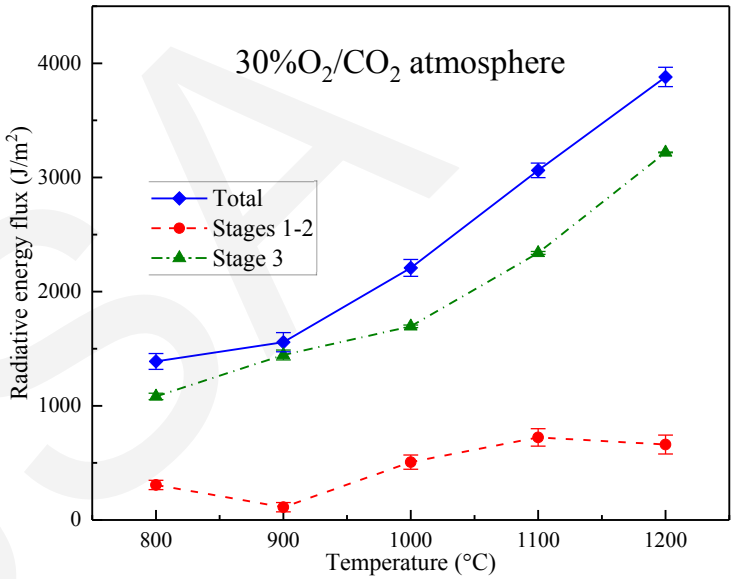


Fig. 4 Effect of temperature on the radiative energy flux

Influence factors:
Temperature
Oxygen ratio
Atmosphere

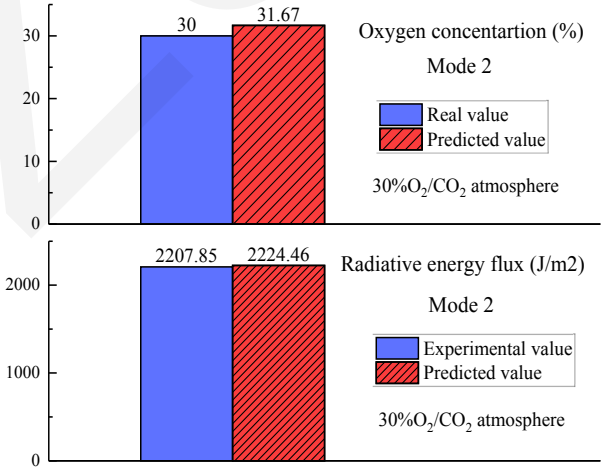


Fig. 5 RBF network prediction results

Main conclusions

- Elevating the temperature and the oxygen ratio in oxy-fuel combustion could enhance the proportion of radiative energy.
- The volatile matter and soot released during the initial stage of solid fuel combustion was the main cause of a reduction of the radiative energy flux.
- The radiative energy flux of semi-coke was higher than that of coal. An efficient coal grading conversion scheme could be created by combining coal pyrolysis poly-generation with quality-splitting conversion of semi-coke combustion energy.
- The radiative energy in a specific combustion mode could be described both by a semi-empirical model and an ANN. The ANN also had a good ability to predict experimental results.