



# ADVANCED CONTROLS, SIMULATION AND EMISSIONS

## CLEAN ENERGY TECHNOLOGIES

# UPPER FURNACE HEAT EXCHANGER MODEL

Scientists at CETC-Ottawa have developed a robust upper furnace model that can predict with a high degree of accuracy the steam and flue gas performance in the superheater, reheater, economizer, and cavity sections of boilers. The model can be used independently or as a unit operation within CETC-Ottawa's macro-boiler model.

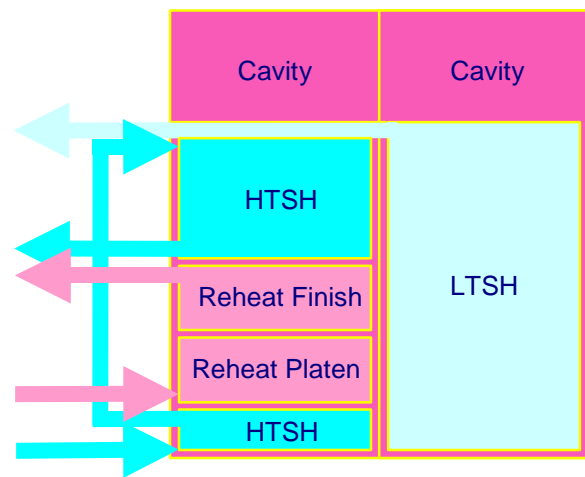
### Capabilities

The upper furnace model can replicate various aspects of the boiler including:

- Flue gas streams
- Steam properties
- Section geometries
- Section configurations
- Air/oxy-fuel modes of operation

### Technical Information

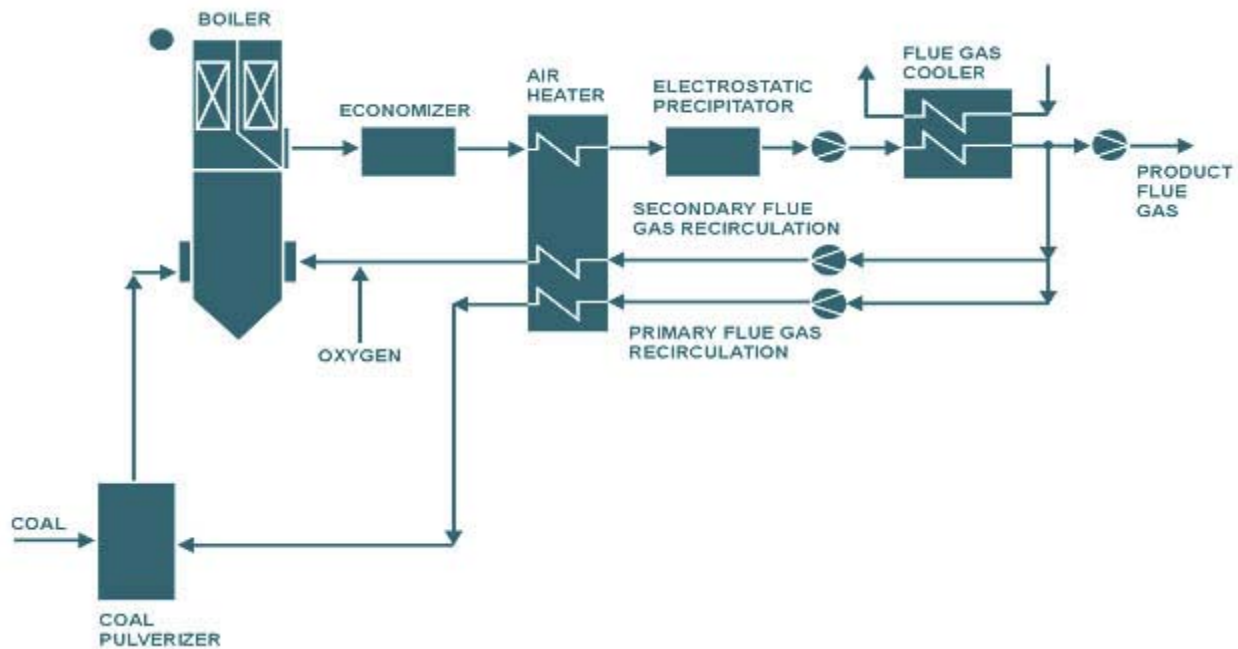
The upper furnace model simulates the convection sections of the superheater, reheater, cavities and economizer. In these areas the modes of heat transfer are both convection and radiation. The model developed is based on countercurrent or parallel flow heat exchangers that can be positioned and configured by the user to match the configuration of the specific unit being modeled. The heat transfer relationships in the model can handle both air and oxy-fuel modes of operation.



Generic Upper Furnace Model - model used to predict temperatures to optimize performance

### Accomplishments

The upper furnace model has been vigorously tested against industrial scale reference data with various furnace layouts and has proven to be highly robust and accurate. It has also been successfully applied in a Canadian Clean Power Coalition (CCPC) study to retrofit a 400 MW<sub>e</sub> air-based boiler for O<sub>2</sub>/CO<sub>2</sub> operation.



Macro-Boiler Model Schematic (Advanced Oxy-Fuel Cycle)

## Possible Applications

The model is a powerful tool that can be used in a variety of applications such as:

- New boiler design
- Existing boiler retrofit
- Flue gas suitability evaluation
- Production rate optimization
- Quality control
- Thermal efficiency optimization

### Your Invitation to Work with Us

We are interested in collaborating with you. Please contact the Business Office to discuss your particular needs.

☎ (613) 996-8693

✉ [cetc-bdo@nrcan.gc.ca](mailto:cetc-bdo@nrcan.gc.ca)

### For Further Information Please Contact:

Bruce Clements  
 Research Scientist  
 ☎ (613) 943-8881  
 ✉ [clements@nrcan.gc.ca](mailto:clements@nrcan.gc.ca)

CANMET Energy Technology Centre – Ottawa  
 Natural Resources Canada  
 1 Haanel Drive  
 Nepean, Ontario, K1A 1M1  
 Canada

[cetc.nrcan.gc.ca](http://cetc.nrcan.gc.ca)