Wet biofuels –
aspects on furnace design and boiler operation

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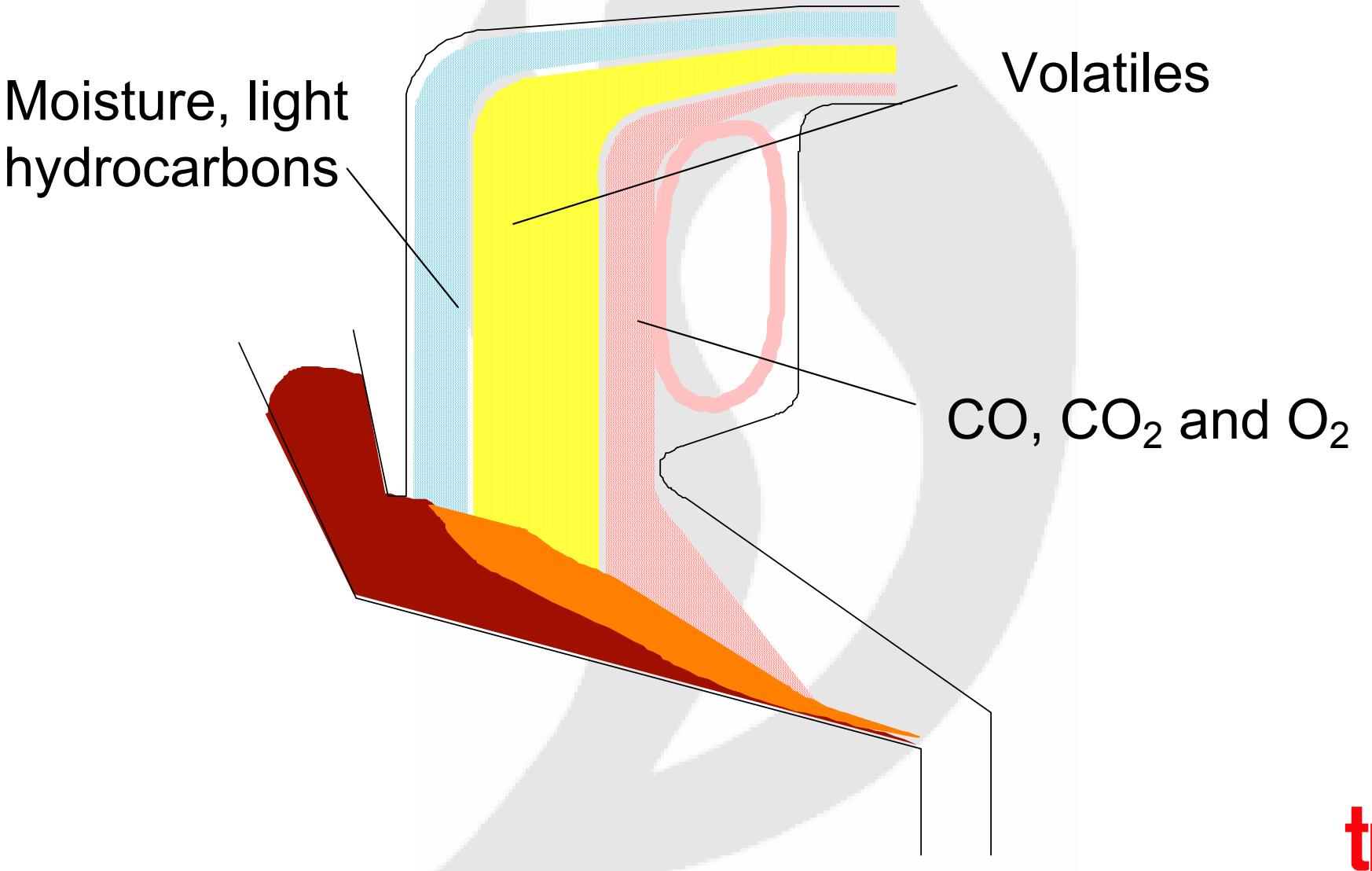
Fuel properties

Moisture content 30 – 60 %
Ash content (dry base) 0,3 – 6
Lower calorific value (a.r.) 6 – 14 MJ/kg
Adiabatic temperature 1050 – 1450ºC
Volatile content (dry base) 70 – 85 %

National and EU emissions restrictions

Fluid dynamics

Streams formed in a grate fired or FB boiler

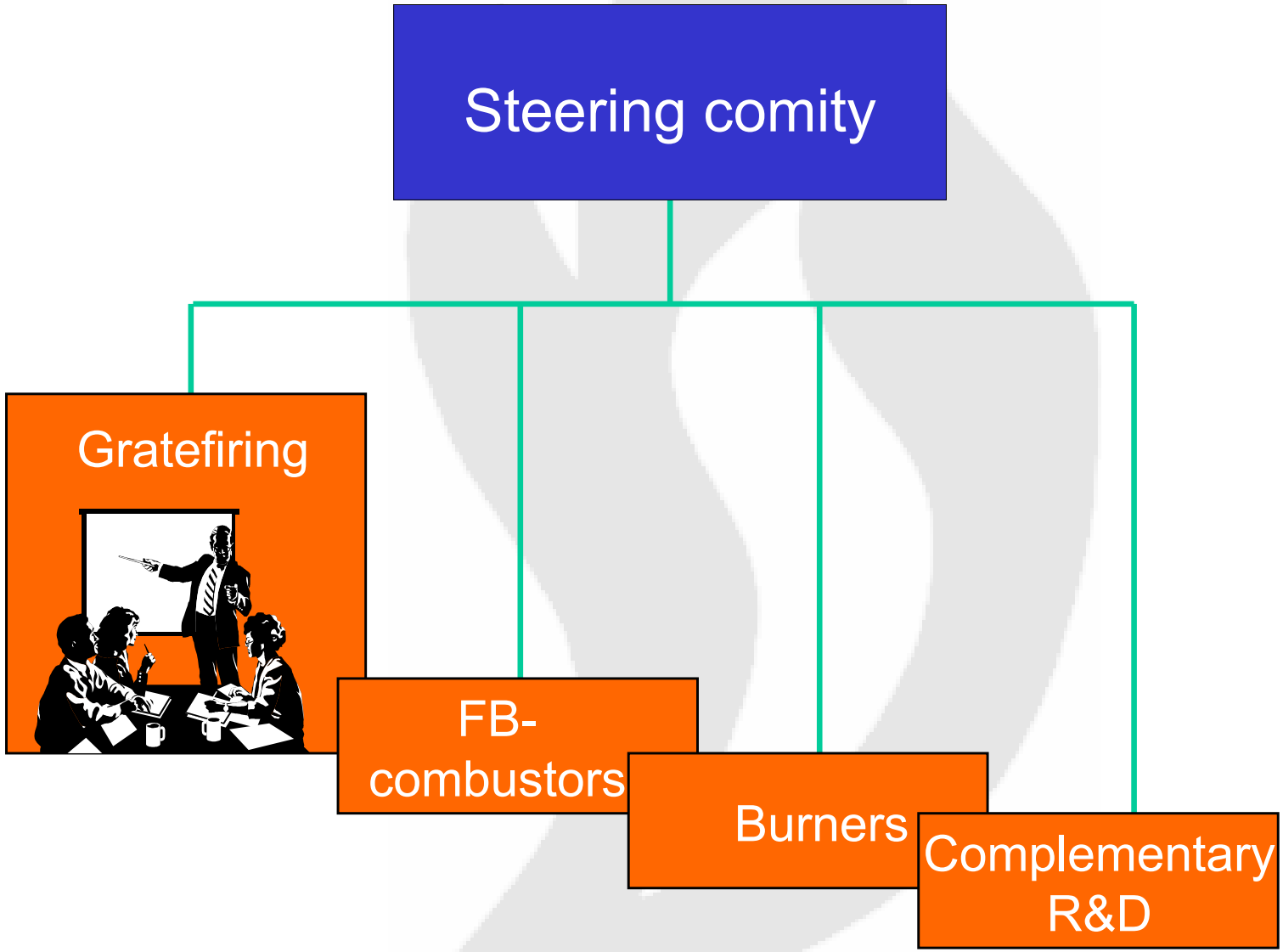


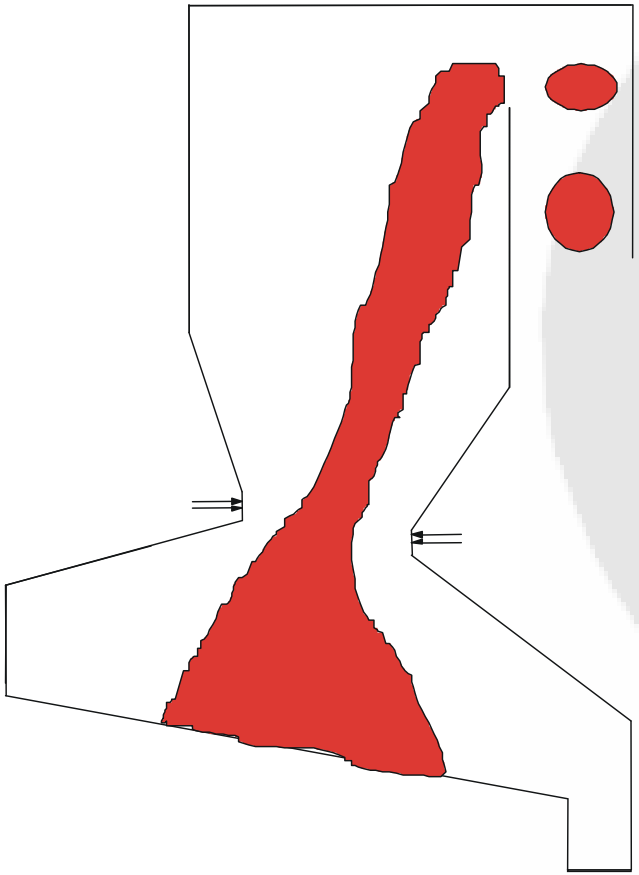
Actions

The topics has been under continues research and methods development in the “TPS Multi Client Research Programme for District Heating Utilities”

tps Branschforskning

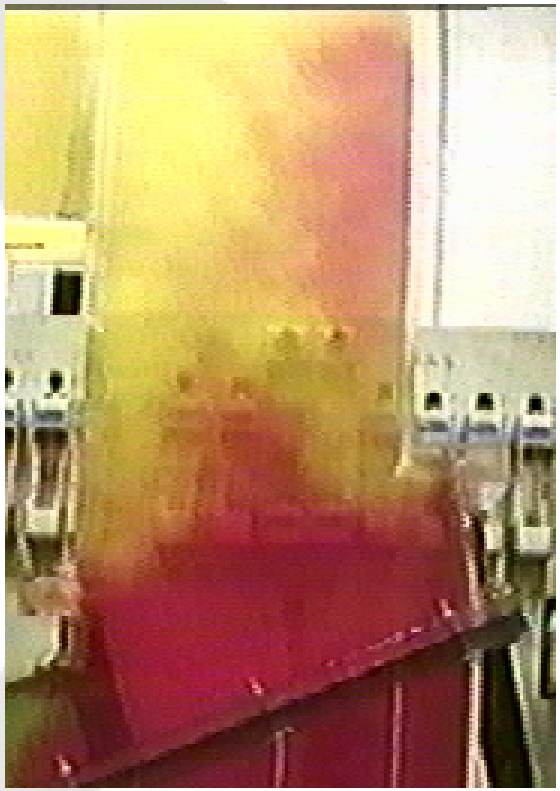
Research program organisation





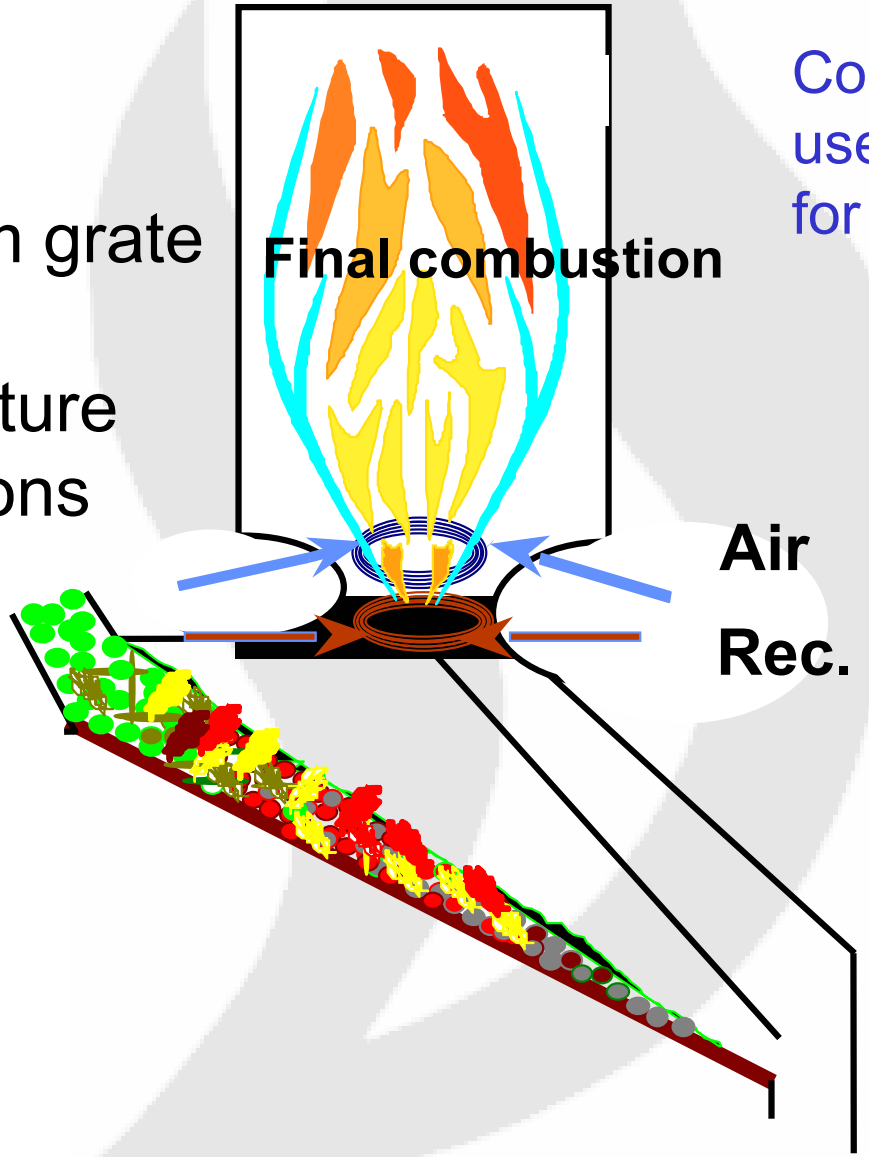
Bad penetration of secondary air

Uncontrolled recirculation zones



Freeboard of furnace

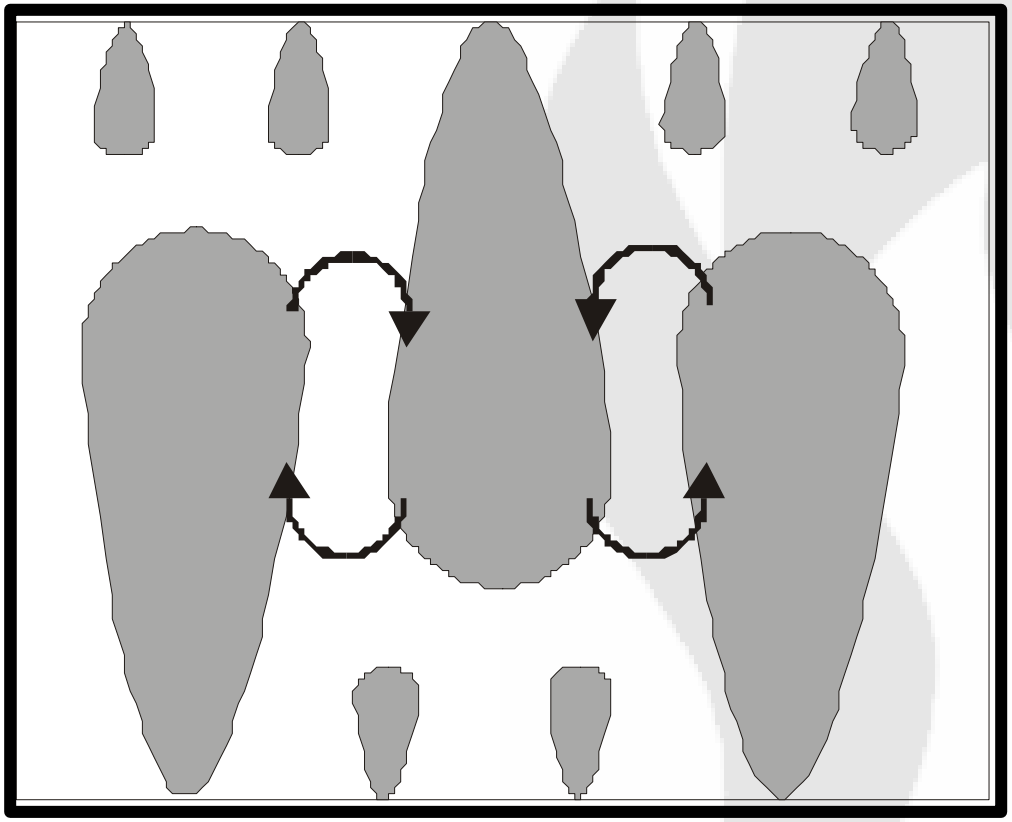
Mixing gases from grate
Even air supply
Maintain temperature
Control of emissions
Fuel flexibility
Low O_2

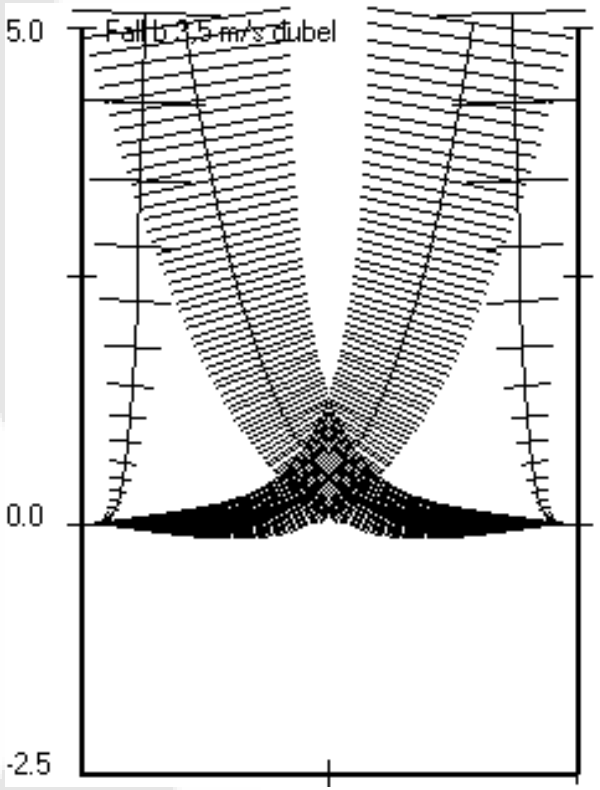


Contract the flow and use recycled flue gas for mixing

”Gas throat”

Freeboard of furnace



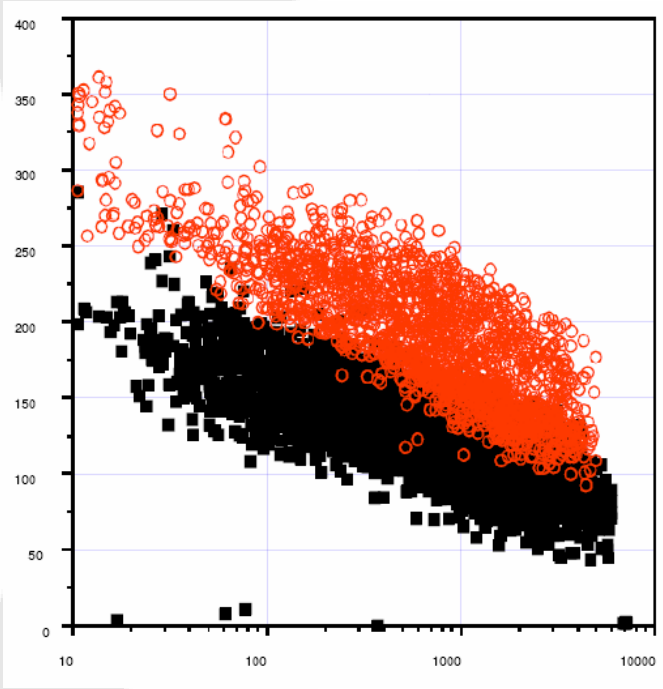


Staggered nozzles for secondary air and flue gas recirculation

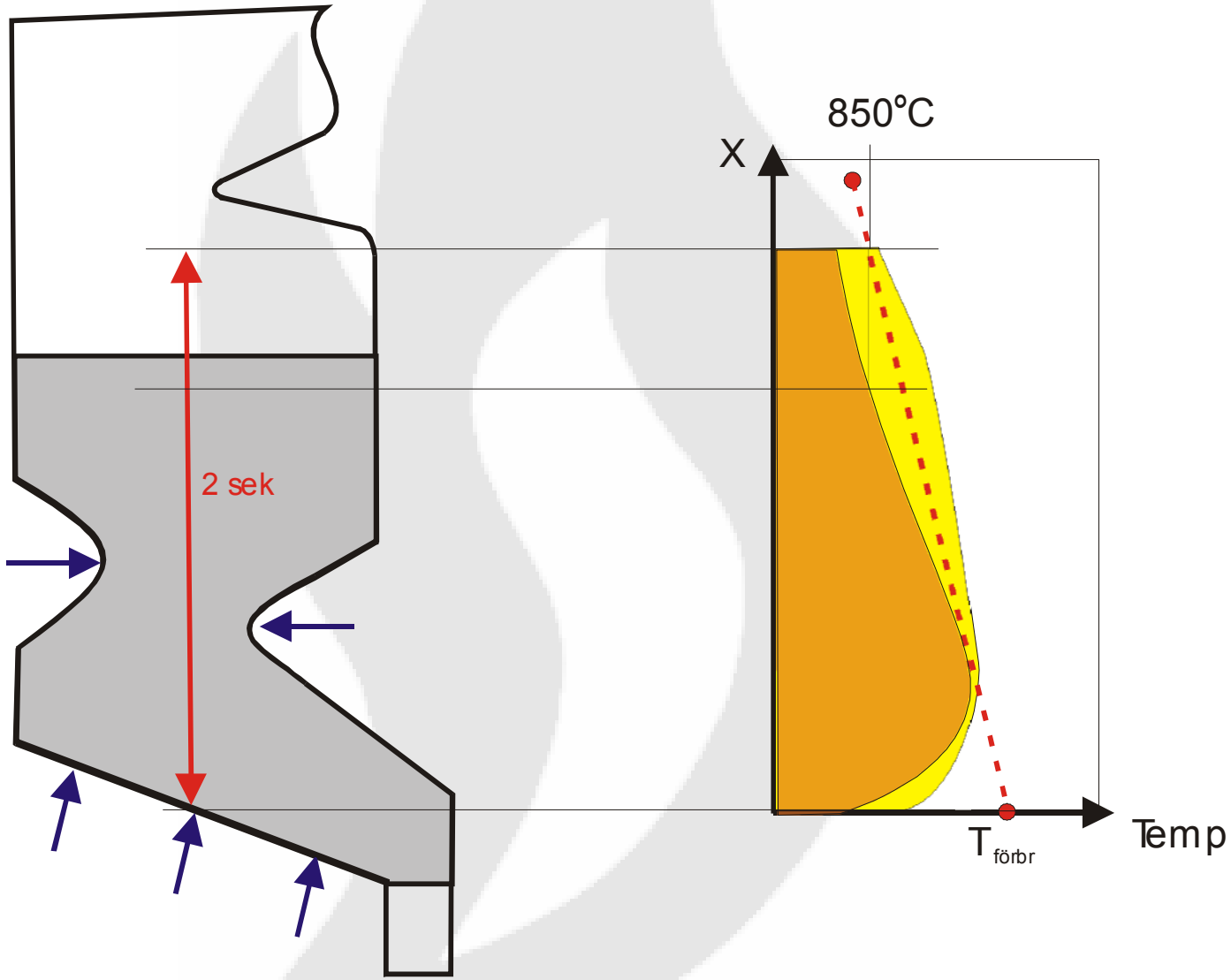
Staggered nozzles

Simple retrofit in existing boilers

Improved control of CO and NOx



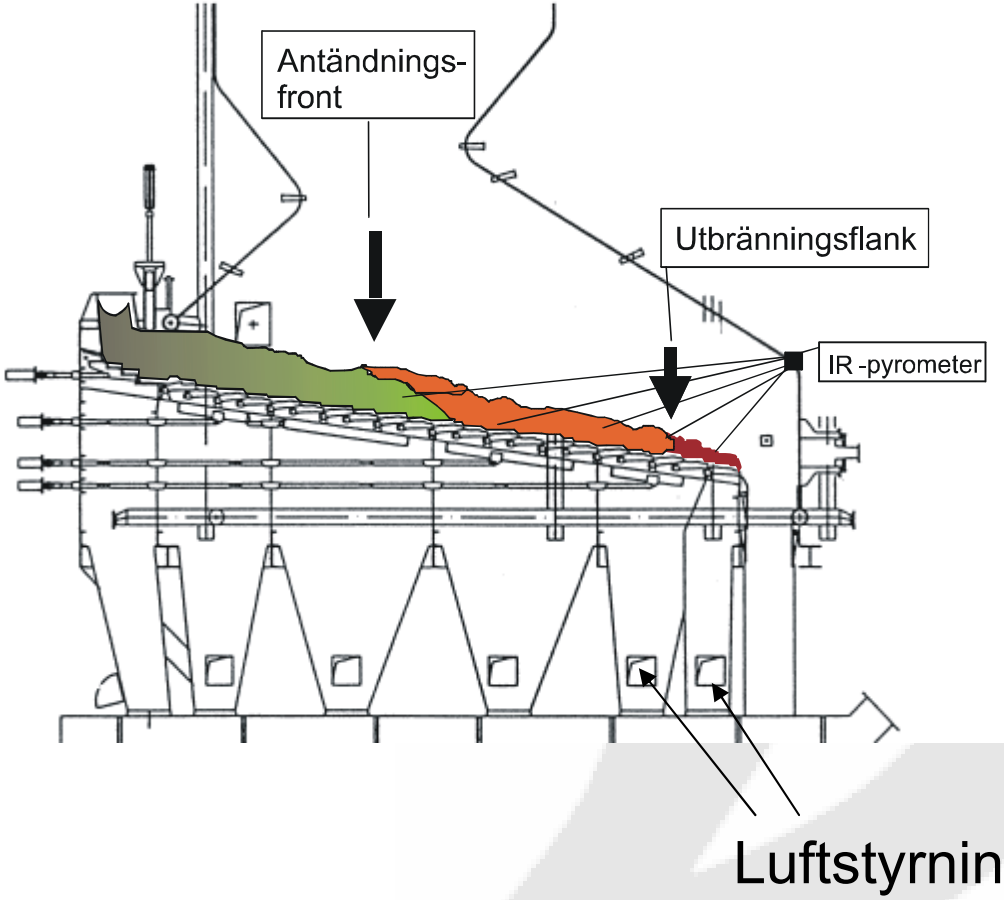
Reducing heat transfer to improve fuel flexibility



Control off the primary combustion on the grate

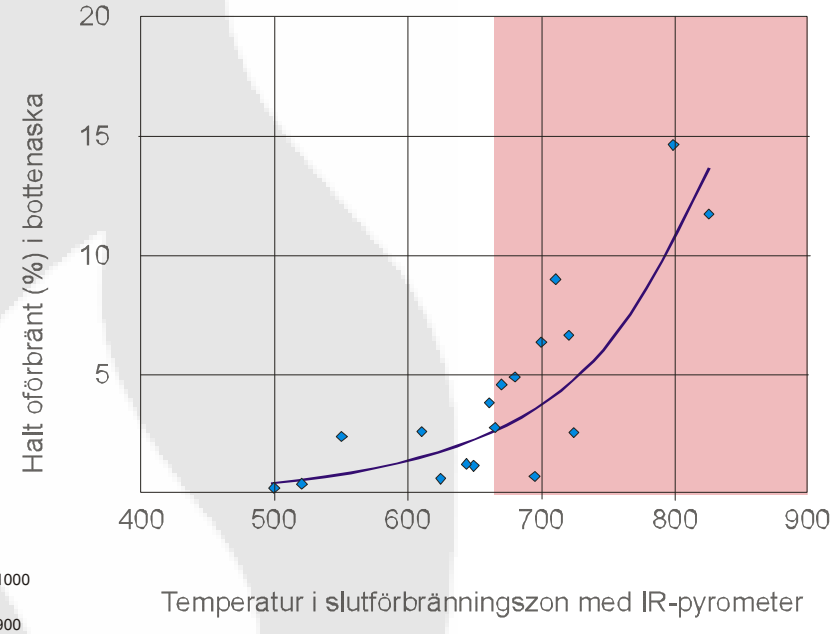
- Optimise the drying of the biofuel
- Fast and stable ignition control of the fuel bed
- Controlled burn out of the bottom ash

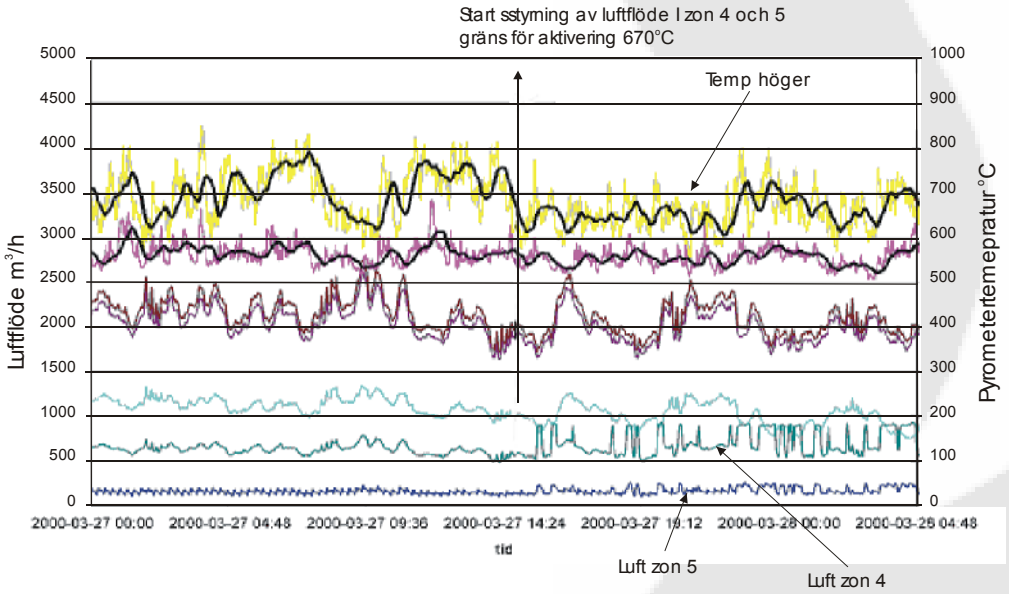
Control of burn-out with IR-detection



Control of burn-out with IR-detection

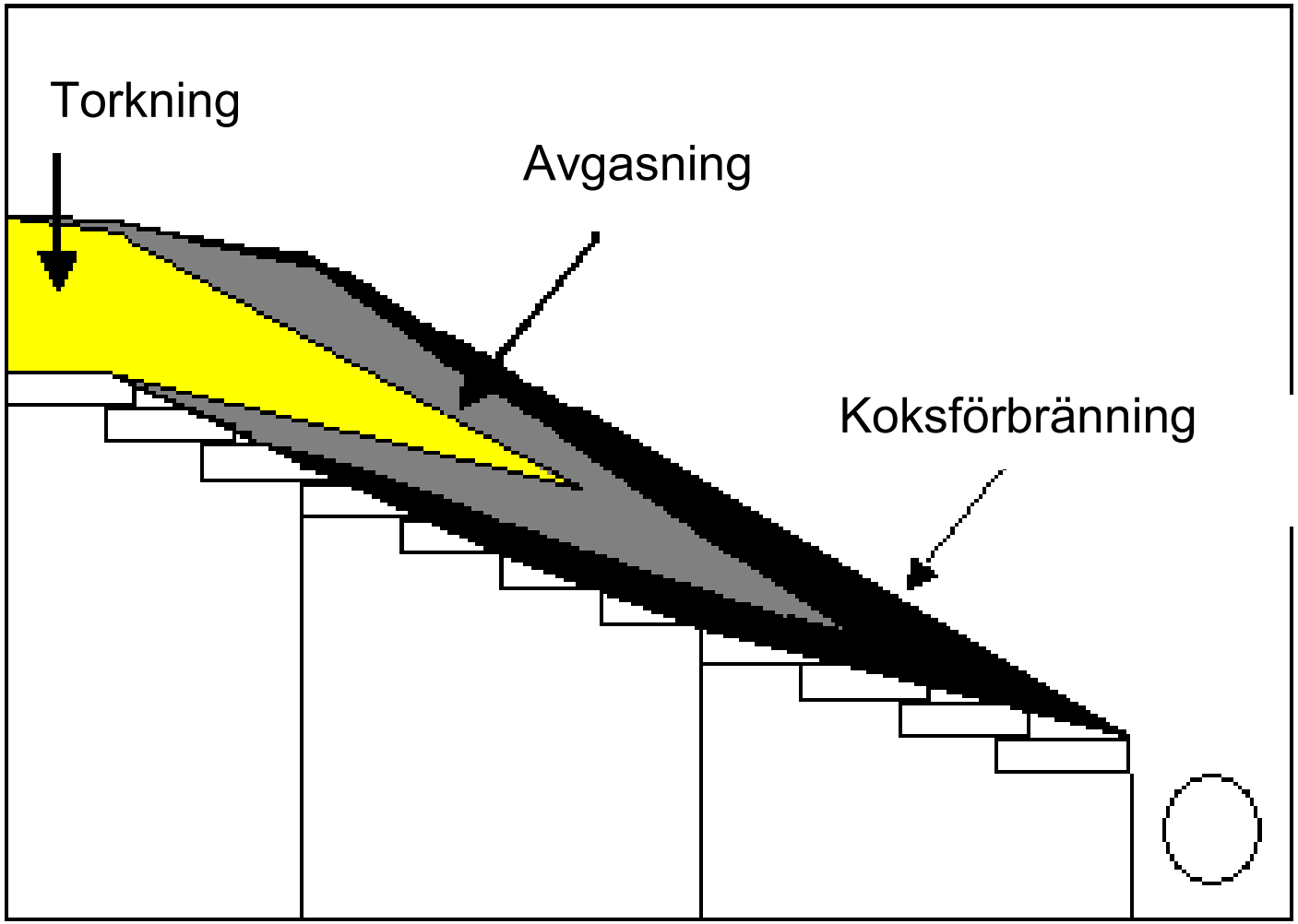
Content of unburnt in bottom ash vs. surface temperature





Burn-out controlled by primary air flow in late grate zone

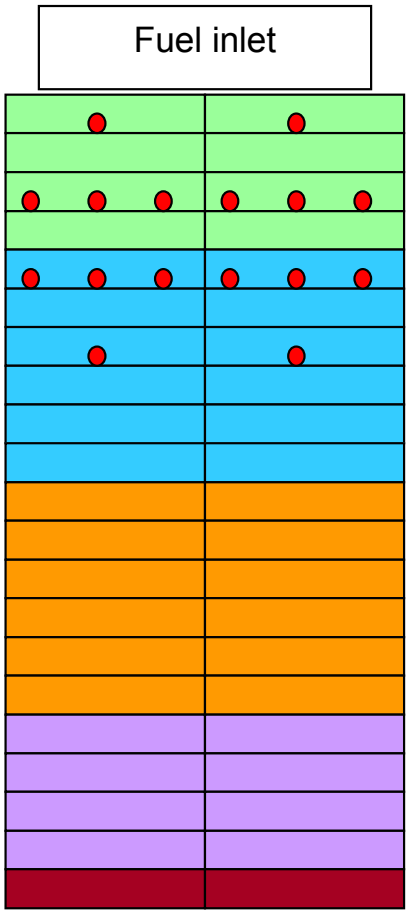
Two front combustion

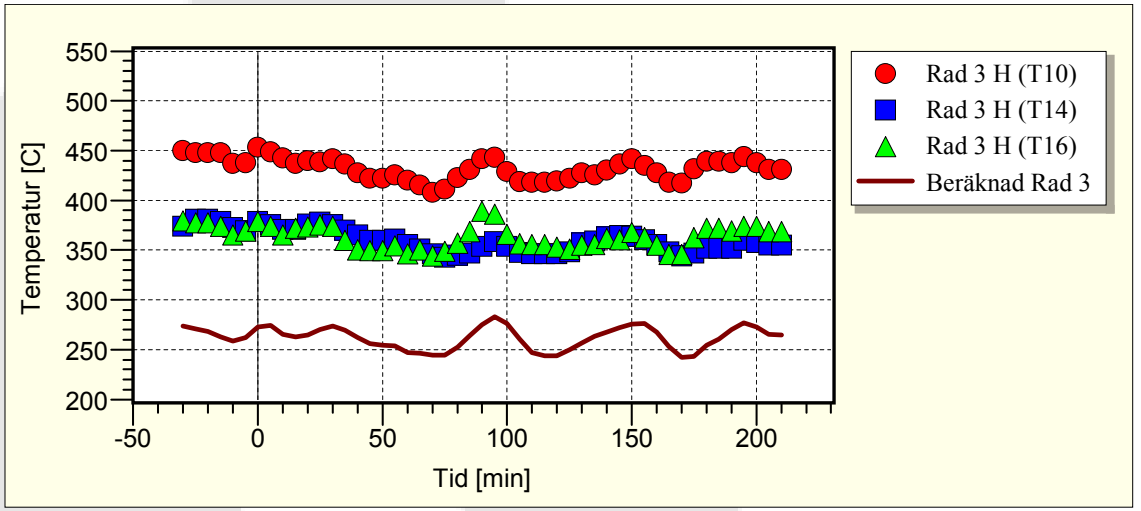


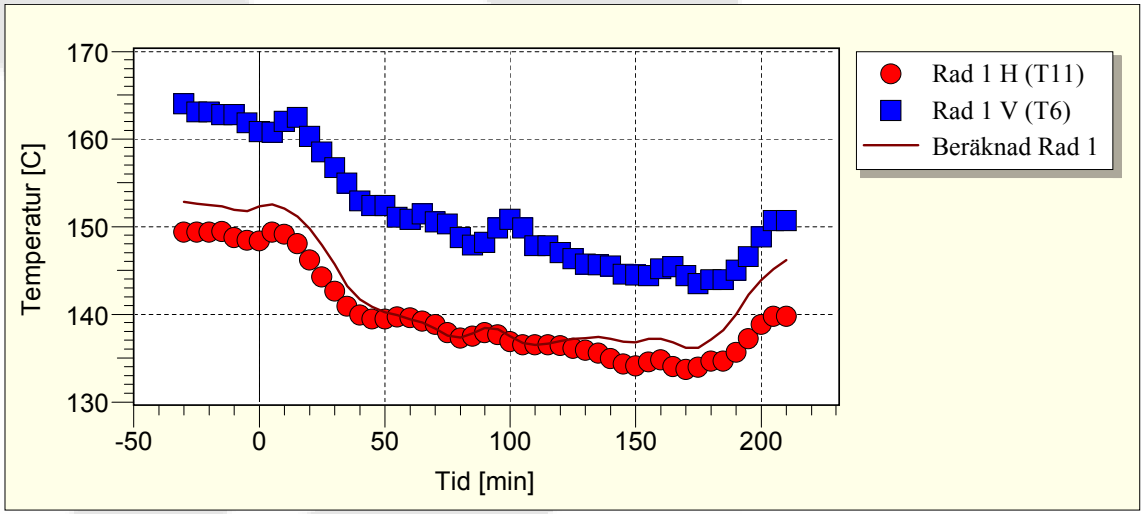
Measuring the grate rod temperature

Temperature measured with thermocouples close to the surface of the grate rod.

Measuring the grate rod temperature

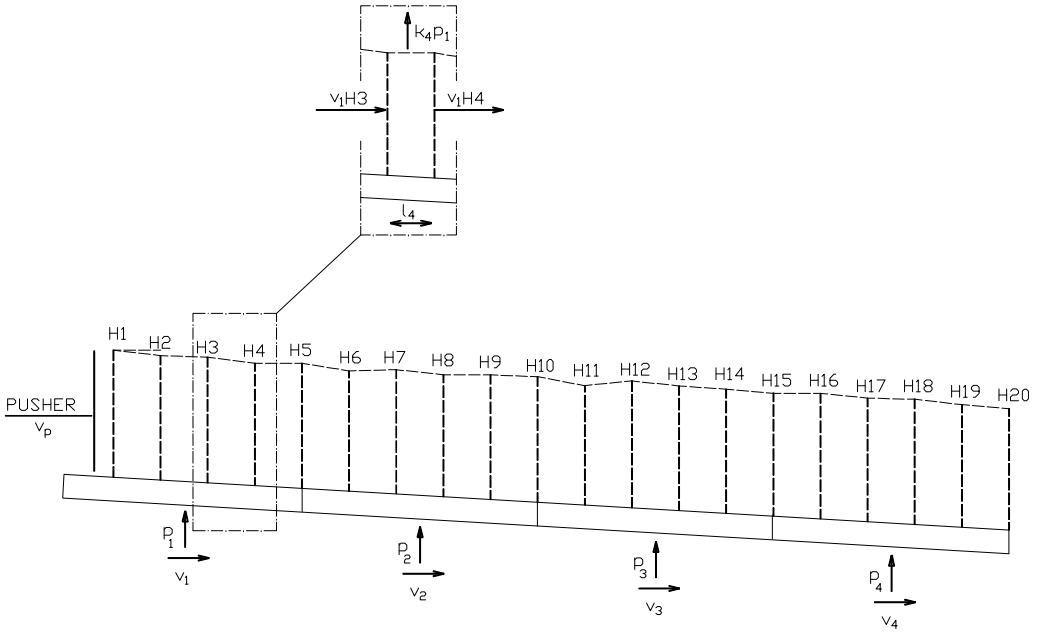






High temperatures already in the “drying zone”

TPS dynamic grate model



- The model predicts grate and bed temperature, height and oxygen concentration
- Heat transfer in the grate rods
- Dynamic of the bed at changes in the input conditions
- Simulates both top, bottom and mixed ignition of the bed

Conclusions bed model

- Combustion near the grate often starts already within 1 m from the fuel inlet
- Temperature indication and control can be used to control the distribution of primary air and early indication of changes in moisture content
- Grate rod temperature is affected by a complex relation of several parameters
- Model can be used to compute temperature variations

Conclusions

To achieve good fuel flexibility in a boiler it is necessary to have:

- Good measurements of temperature in both primary and secondary combustion zones
- Control of the aerodynamics of the freeboard combustion
- Good control of input parameters such as air and recycled flue gas distribution
- Heat transfer properties of boiler for worst possible case with recycled flue gas for controlling temperature
- Control of air supply to grate and temperature distribution
- Individual control of ash burn out
- Good understanding of effect of and interaction between control parameters