



# 1 MW<sub>th</sub> Oxyfuel Combustion Test Facility

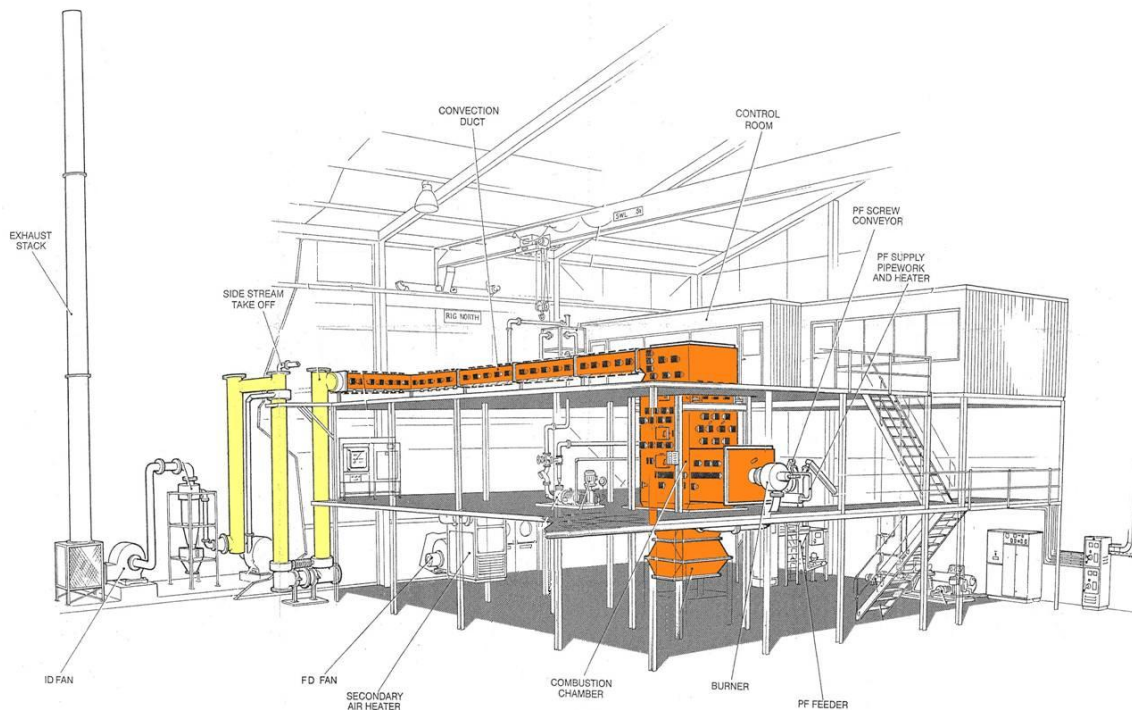
Ben Goh, Power Technology

“Recent Developments in CCS”

Coal Research Forum – Combustion Division meeting

17<sup>th</sup> April 2007, Imperial College London

# E.ON UK's 1 MW<sub>th</sub> Combustion Test Facility (CTF)



**Commissioned 1993**  
**Located at Power Technology**  
**Time-temperature scaled**  
**Fuel flexible**

Coal, biomass, oil,  
Orimulsion, gas, others

**Full combustion staging**

Overfire air

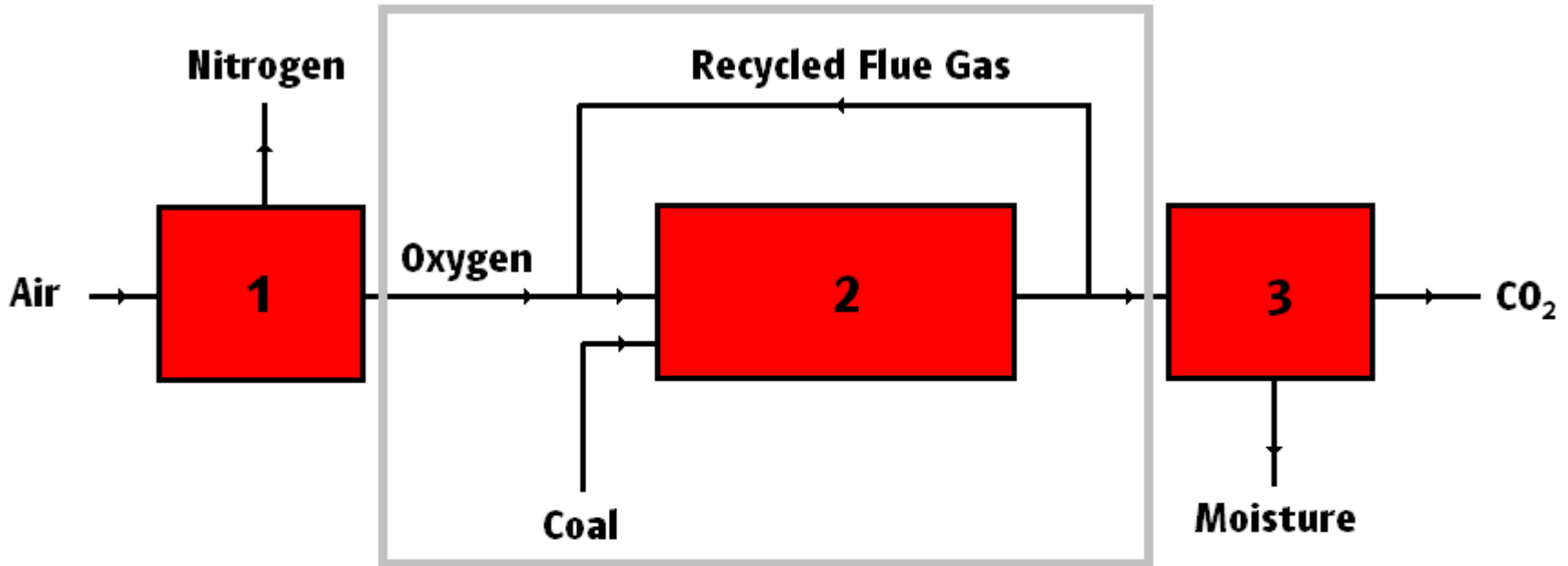
Reburn

Flue gas recycle

**Highly instrumented and controllable**

**Other capabilities added**

# Oxyfuel combustion



- 1 = Air Separation Unit**
- 2 = Boiler**
- 3 = Flue Gas Treatment**

## RFSC Project RFS-PR-02003 : “ASSOCOGS”

### “Assessment of Options for CO<sub>2</sub> Capture and Geological Sequestration”

Start date                      January 2004

Project co-ordinator      E.ON UK

Partners                      Aristotle University of Thessaloniki  
Centre For Research and Technology Hellas  
CERECO  
IMCG International  
University of Nottingham  
IVD Stuttgart

## RFSC Project RFS-PR-02003 : “ASSOCOGS”

### “Assessment of Options for CO<sub>2</sub> Capture and Geological Sequestration”

- WP1 Co-ordination
- WP2 Oxyfuel combustion
- WP3 Development of ceramic membrane support
- WP4 Catalyst development for H<sub>2</sub>S and NH<sub>3</sub> decomposition
- WP5 Catalytic decomposition membrane reactor
- WP6 Gas-liquid contact membranes
- WP7 Modelling and scale-up
- WP8 Adsorption of CO<sub>2</sub> from flue gas
- WP9 Feasibility of CO<sub>2</sub> sequestration with in-situ coals
- WP10 Comparative assessment of technologies and review of implications for full-scale plant

# RFSC Project RFS-PR-02003 : “ASSOCOGS”

## “Assessment of Options for CO<sub>2</sub> Capture and Geological Sequestration”

### WP2 Oxyfuel combustion

Review design of CTF for oxyfuel combustion

Develop revised operational procedures

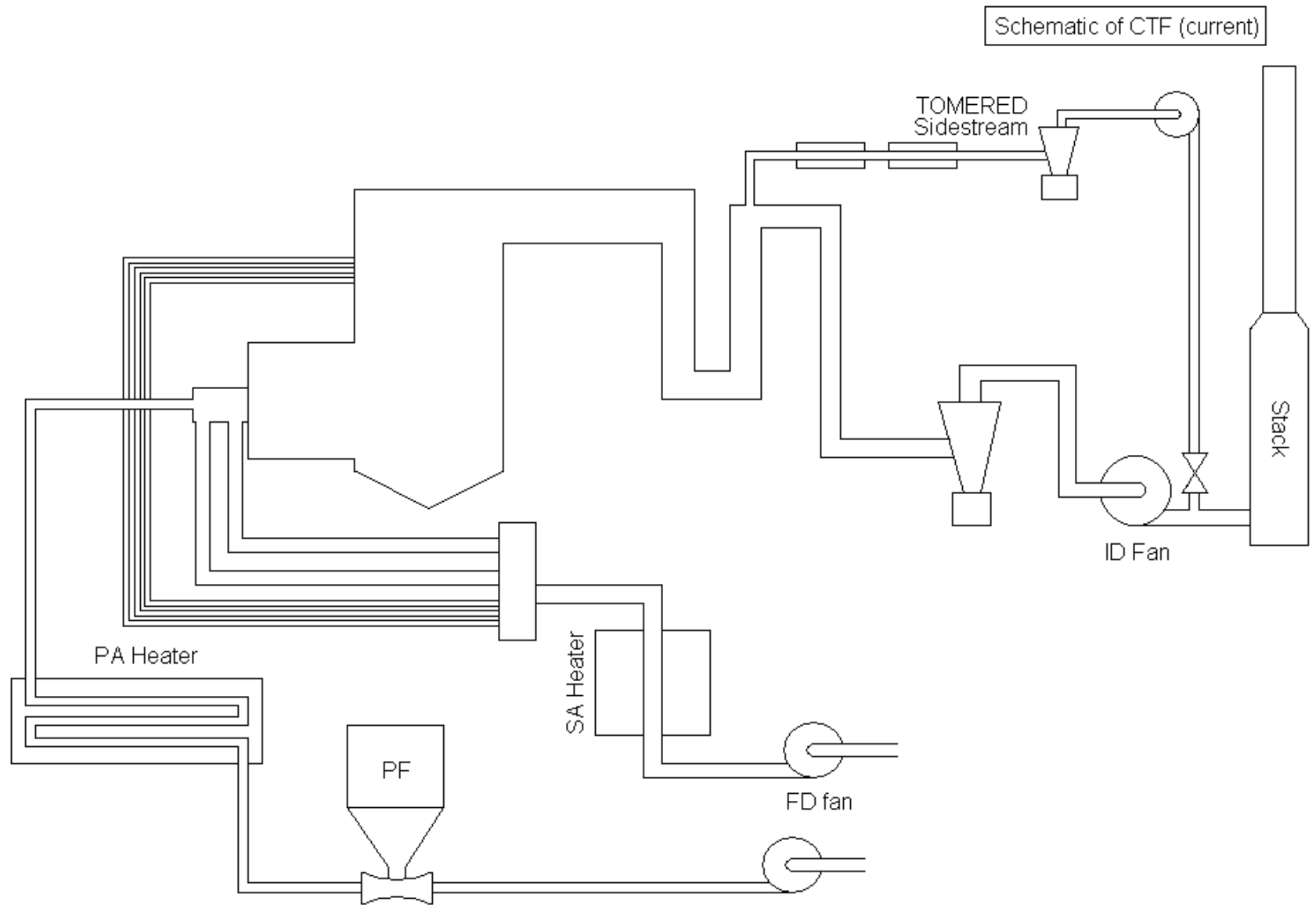
Prepare detailed redesign

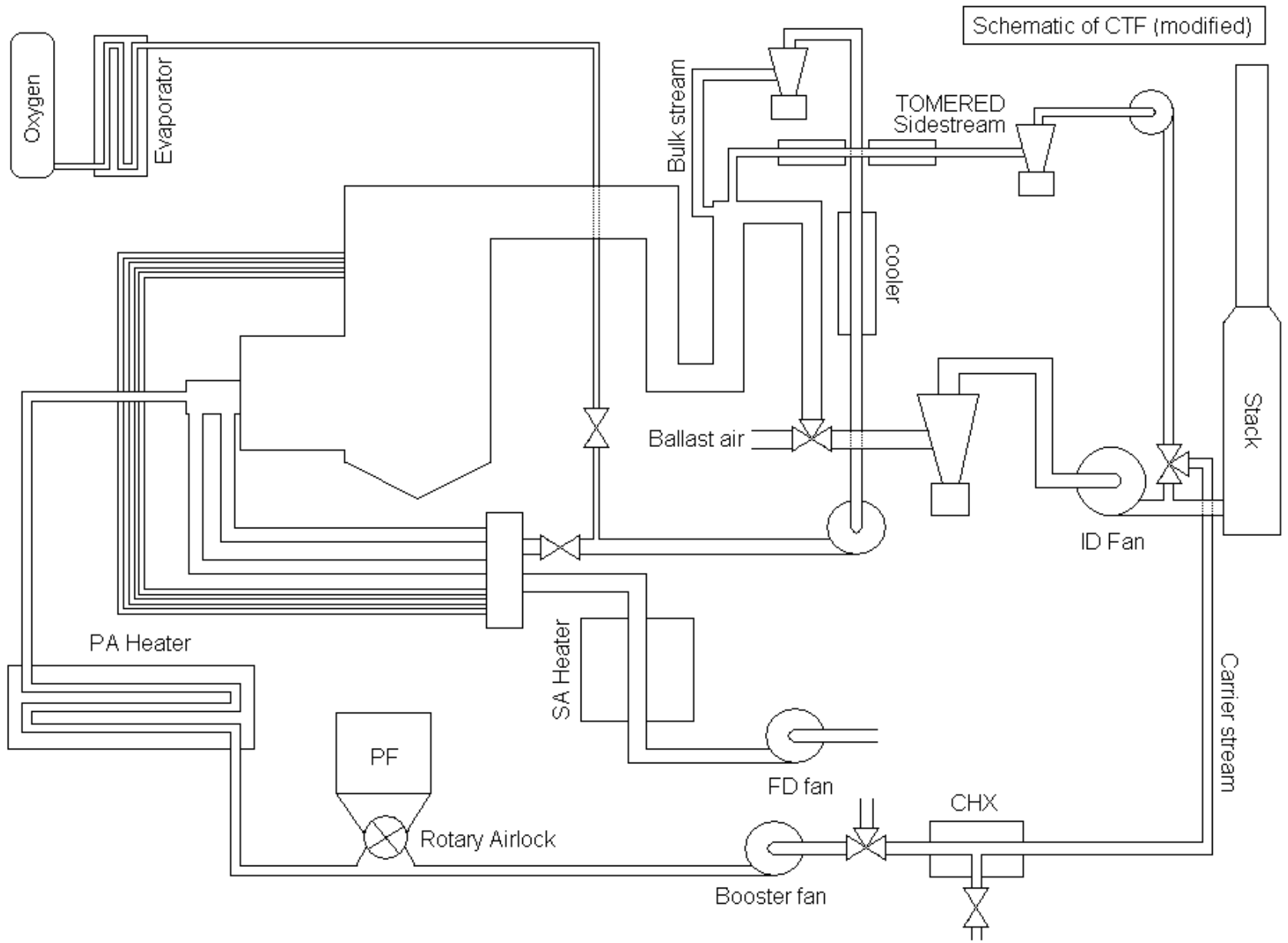
Construct and commission CTF

Refine operational procedures

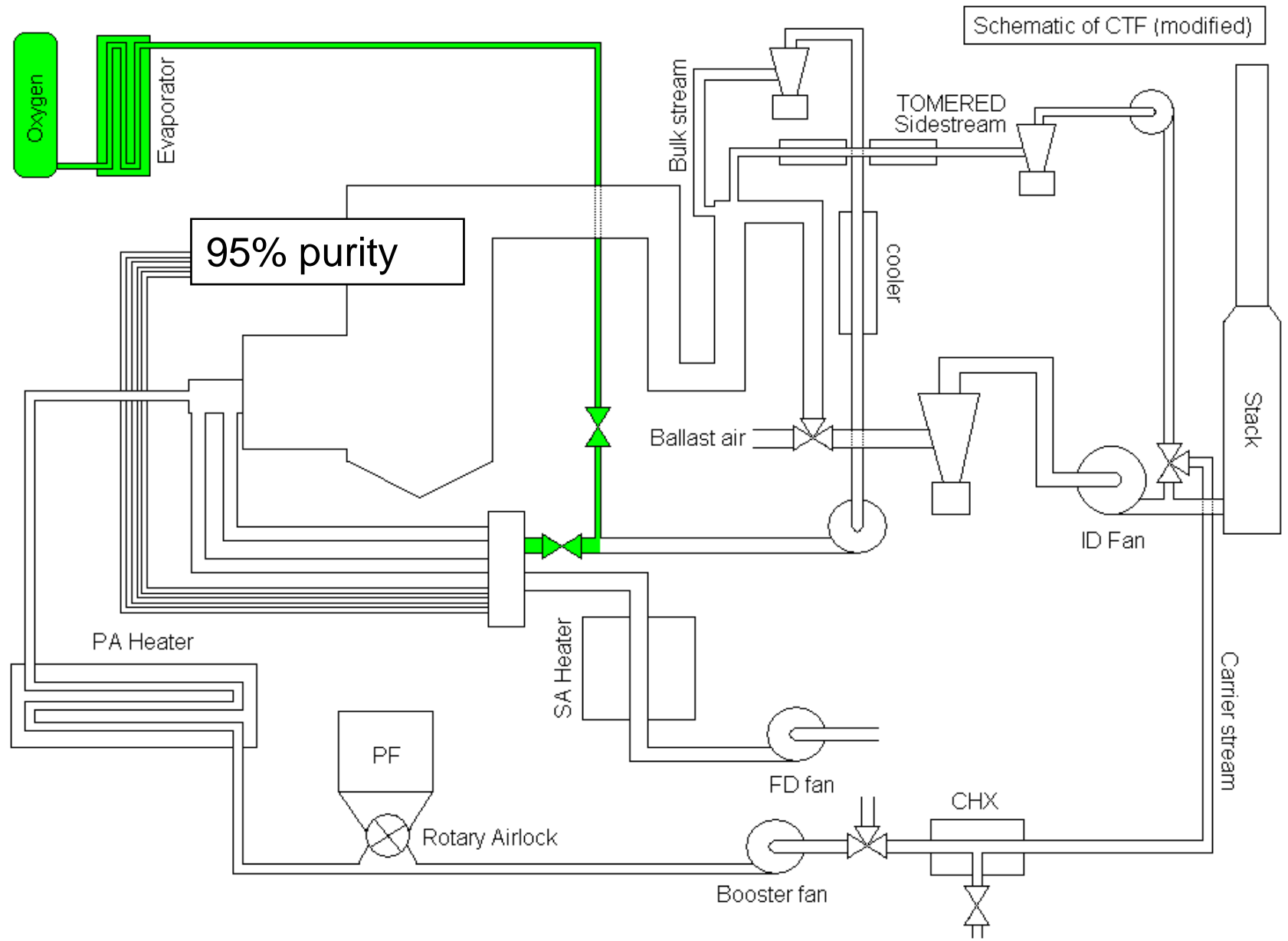
Perform parametric testing

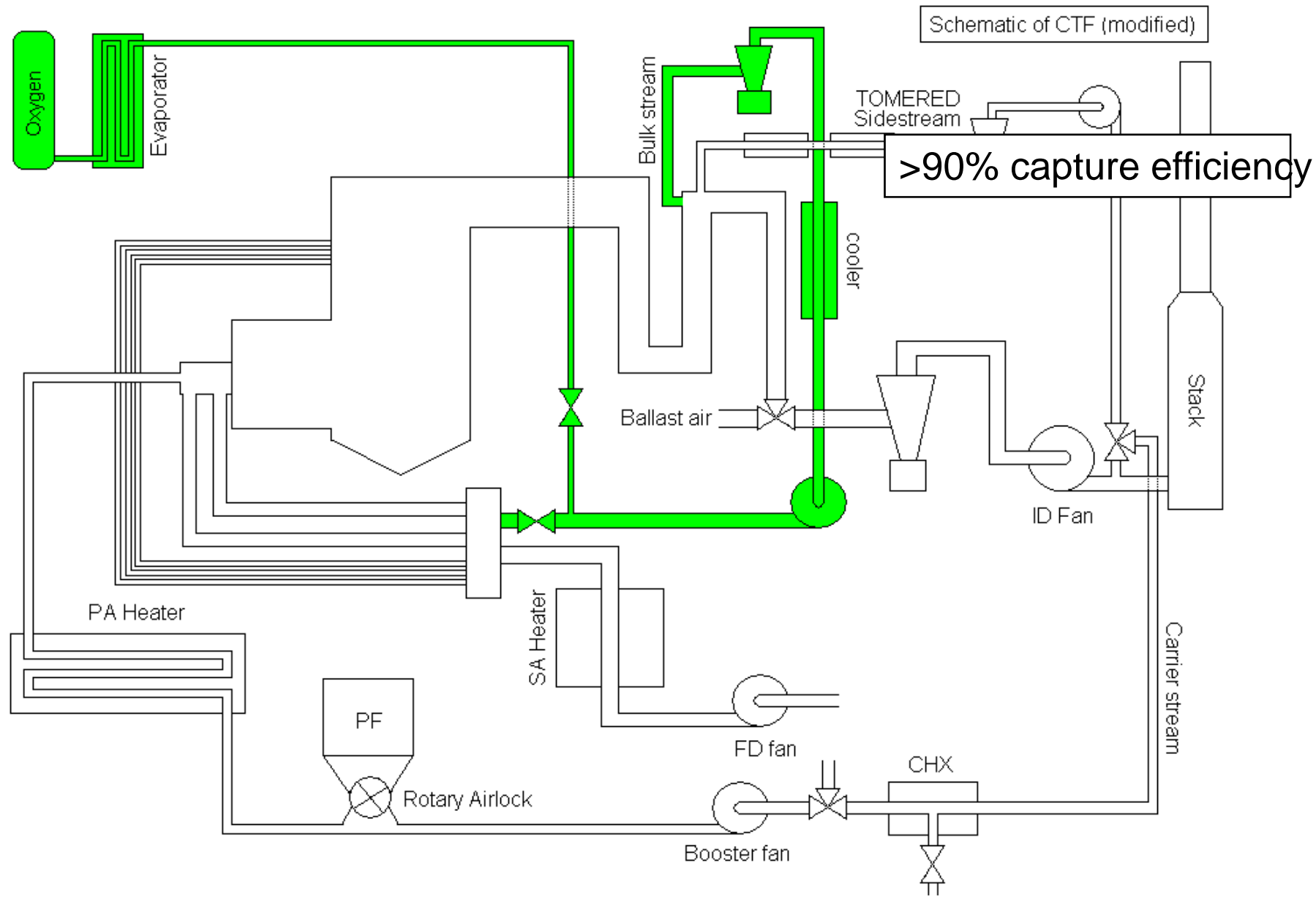
Review findings and implications

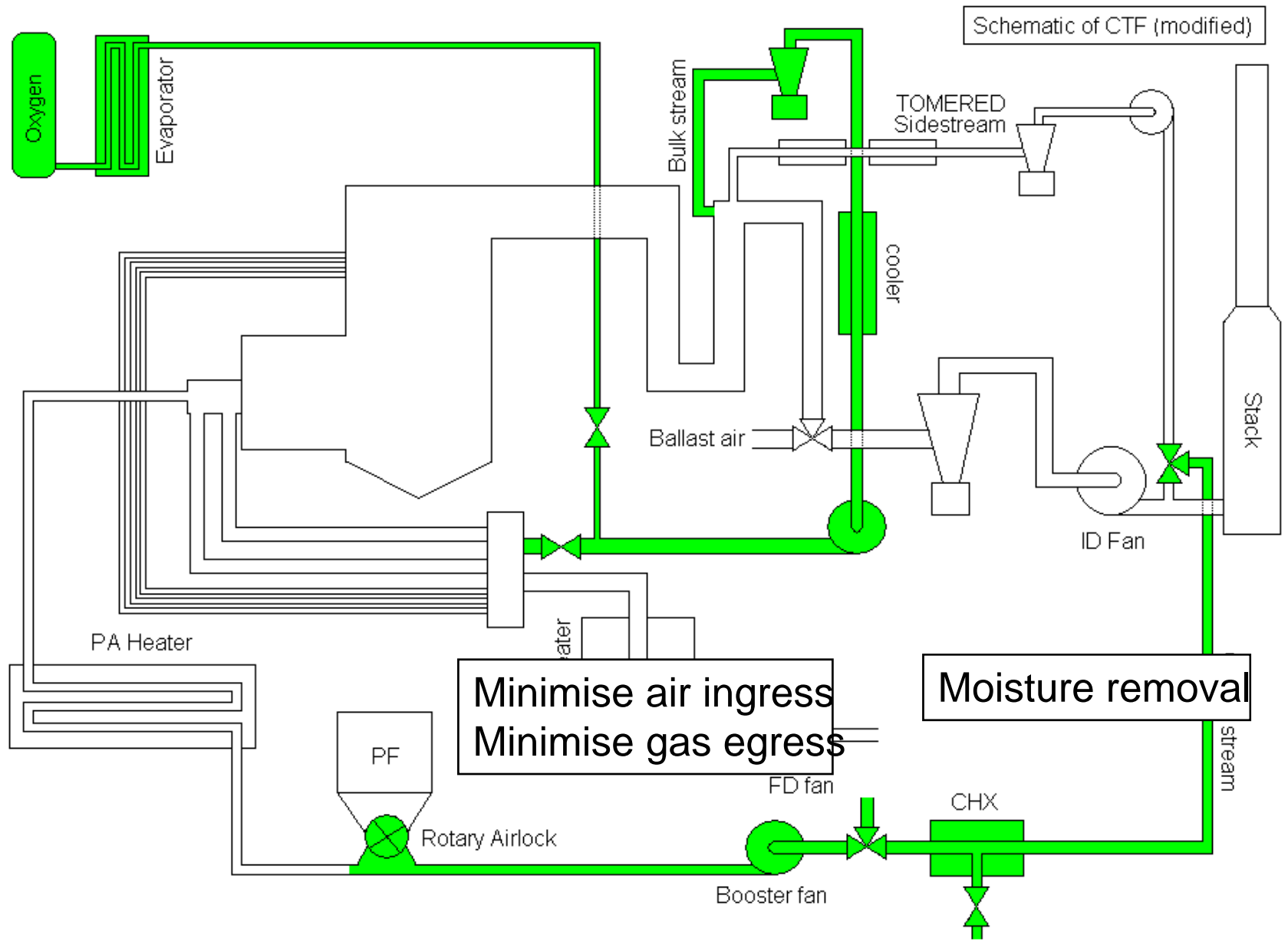


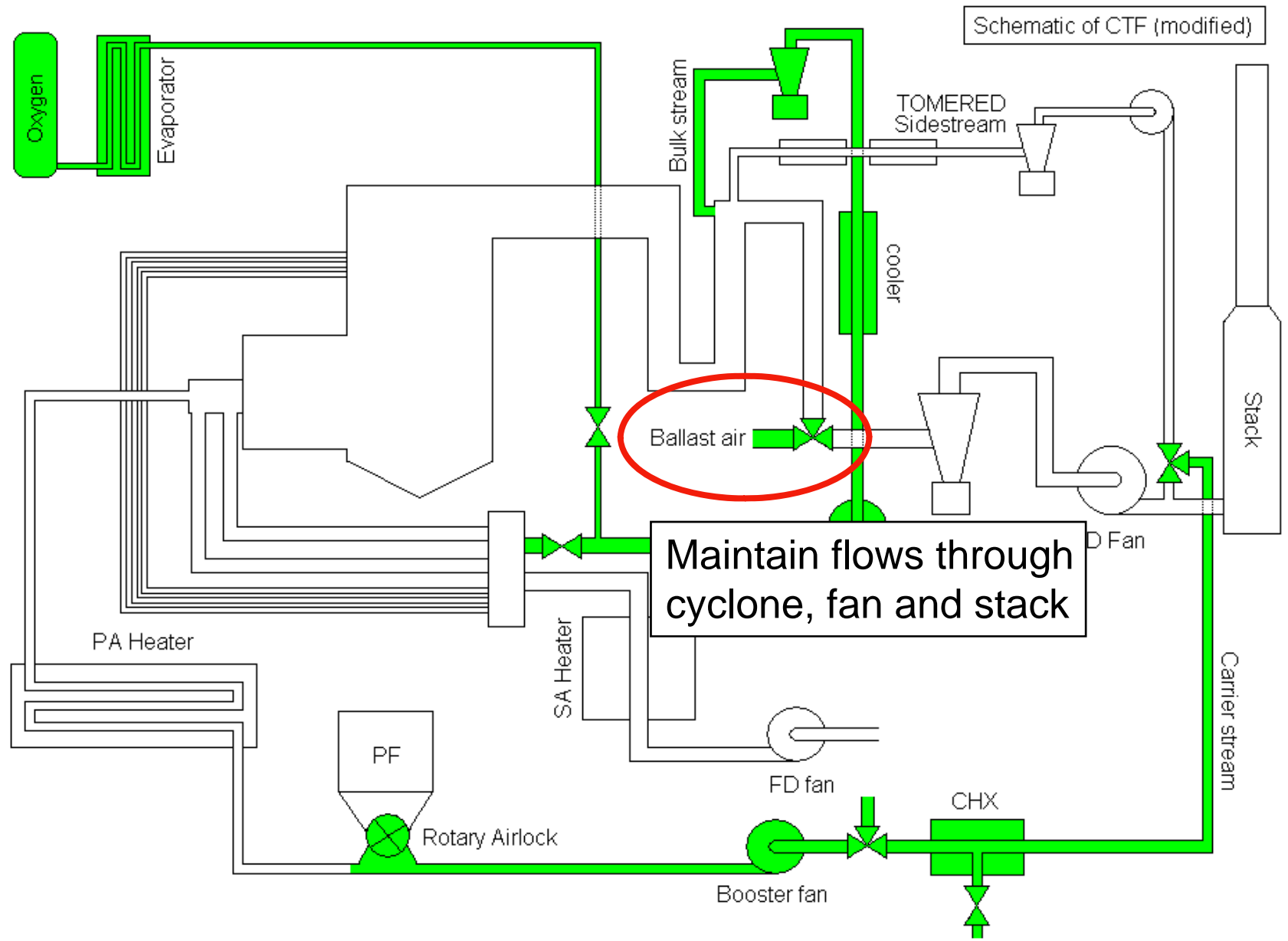












# Issues

## **Safety**

- Gas compositions
- Materials flammability, explosion risk
- Flame detection
- Interlocks

## **Process**

- Coal feeding
- Heat extraction
- Particulate removal
- Materials – high temperature, O<sub>2</sub> purity
- Air ingress
- Moisture removal

## **Control and Instrumentation**

- Mass flow – via density
- O<sub>2</sub> concentration

## **Operation**

- Switchover
- Feedback
- Trips

## **Others....**

## Oxygen storage tank : 4 tonnes (~1 day)



# Bulk stream tower



Bulk stream cyclone

Bulk stream measurement stream

Carrier stream chiller

Bulk stream cooler

O2 injection point

Bulk stream fan



## Carrier stream – first floor



Carrier stream cooler

Bulk stream tap in

Carrier stream chiller

Carrier stream 'knockout' pot



## Carrier stream – ground floor

Carrier stream final cooler



Carrier stream fan

Carrier stream condensate

# Test programme

## Conditions

O<sub>2</sub> enrichment (14 to 28% vol, wet)

Excess oxygen (1 to 4% vol, dry)

'Air' staging (0 to 25% OFA)

Fuel type (VM, S, CI)

Trip tests, changeover tests, operation/procedure

## RFSC ASSOCOGS

Kleinkopje coal – combustion

## DTI OxyCoal-UK

El Cerrejon and Thoresby – combustion, deposition, corrosion

# Test programme

## Measurements

Gaseous emissions – O<sub>2</sub>, NO, SO<sub>2</sub>, CO, CO<sub>2</sub>, others

Extractive sampling – LOI, CO, others

Ash size distribution

Extracted water composition

Heat flux

Flue gas temperature – optical pyrometer

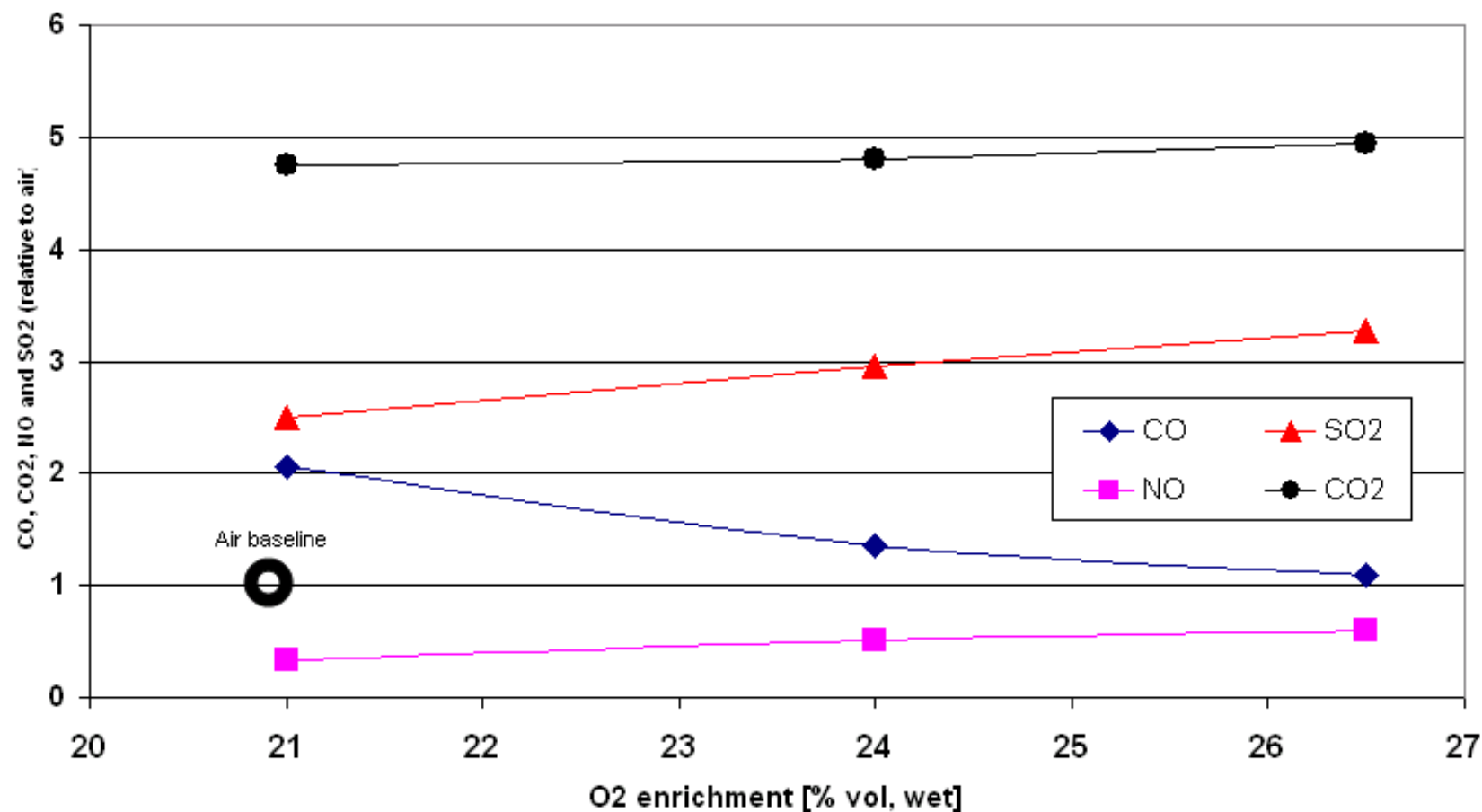
Deposition

Slagging and fouling

Corrosion – 50 hour tests

# Preliminary results

Impact of O<sub>2</sub> Enrichment on Emissions During Oxyfuel Coal Combustion



# Summary

## History

RFSC ASSOCOCS project – started

## Flows

Fuel – 1 MW pulverised coal

Carrier stream – cooled, cleaned, dried recirculated flue gas

Bulk stream – cooled, cleaned, wet recirculated flue gas

Oxygen – LOX

Output – 5X CO<sub>2</sub> (>80%), 3X SO<sub>2</sub>, 2X CO, 0.5X NO, 0.3X exhaust

## Measurement

Mass and volume flow => density – bulk and carrier streams

Temperatures

O<sub>2</sub> concentration – bulk stream pre- and post-O<sub>2</sub> injection

## Operation

Retains original air staging

O<sub>2</sub> enrichment 14 to 28% vol

Excess oxygen 0 to 4%

## Results

Still coming in...

Questions?