2010 NETL CO_2 Capture Technology Meeting

Oxygen Transport Membrane Based OxyCombustion for CO_2 Capture from Coal Power Plants NT43088

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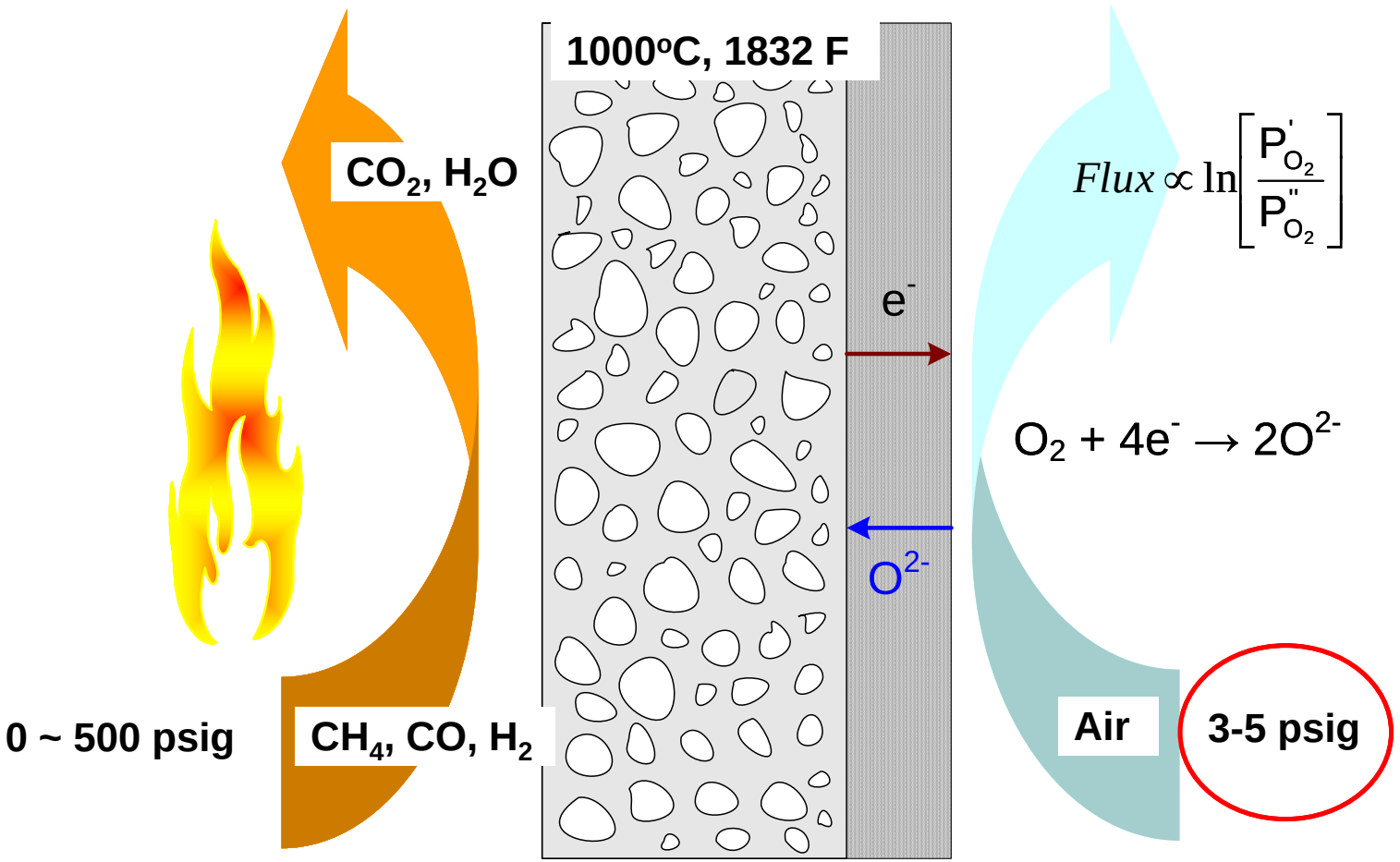
OTM Principle of Operation



Oxy-Combustion Without Producing Oxygen

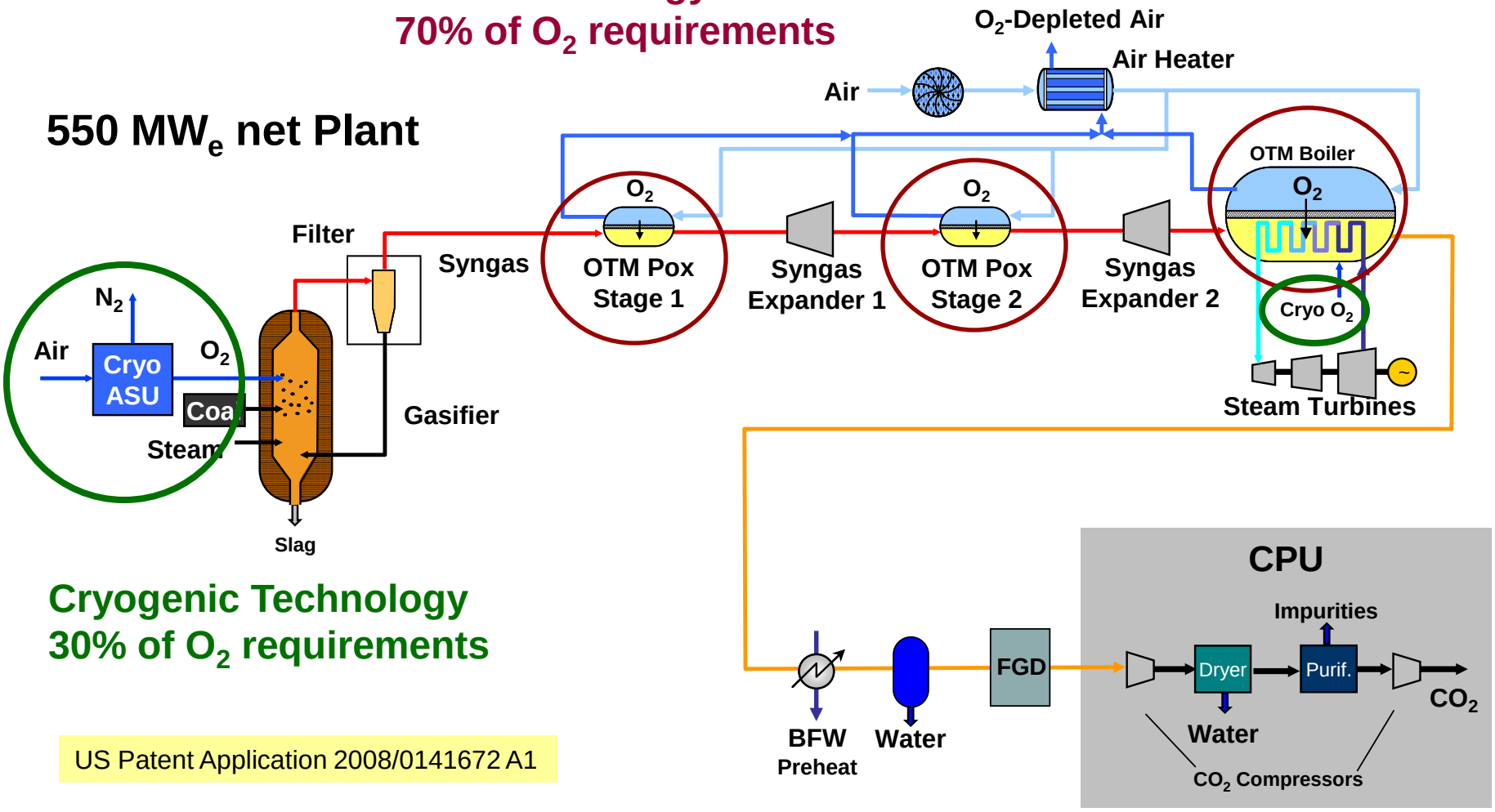
Project Overview (NT43088)

- Contracted April 2007
- $9.5M (65%, $6.2M DOE/NETL)
- Phase 1: 05/07 – 12/09
  - Process and system economic analysis
  - Laboratory scale membrane development and testing
- Phase 2: 01/10 – 12/10
  - Membrane manufacturing development
  - Conceptual design of OTM integrated equipment
- Sub-contracts
  - University of Utah, OTM coal reactor
  - ENrG, Inc. OTM substrate development ($0.75M NYSERDA)

OTM Advanced Power Cycle

OTM Technology
70% of O_2 requirements

550 MW_e net Plant



Cryogenic Technology
30% of O_2 requirements

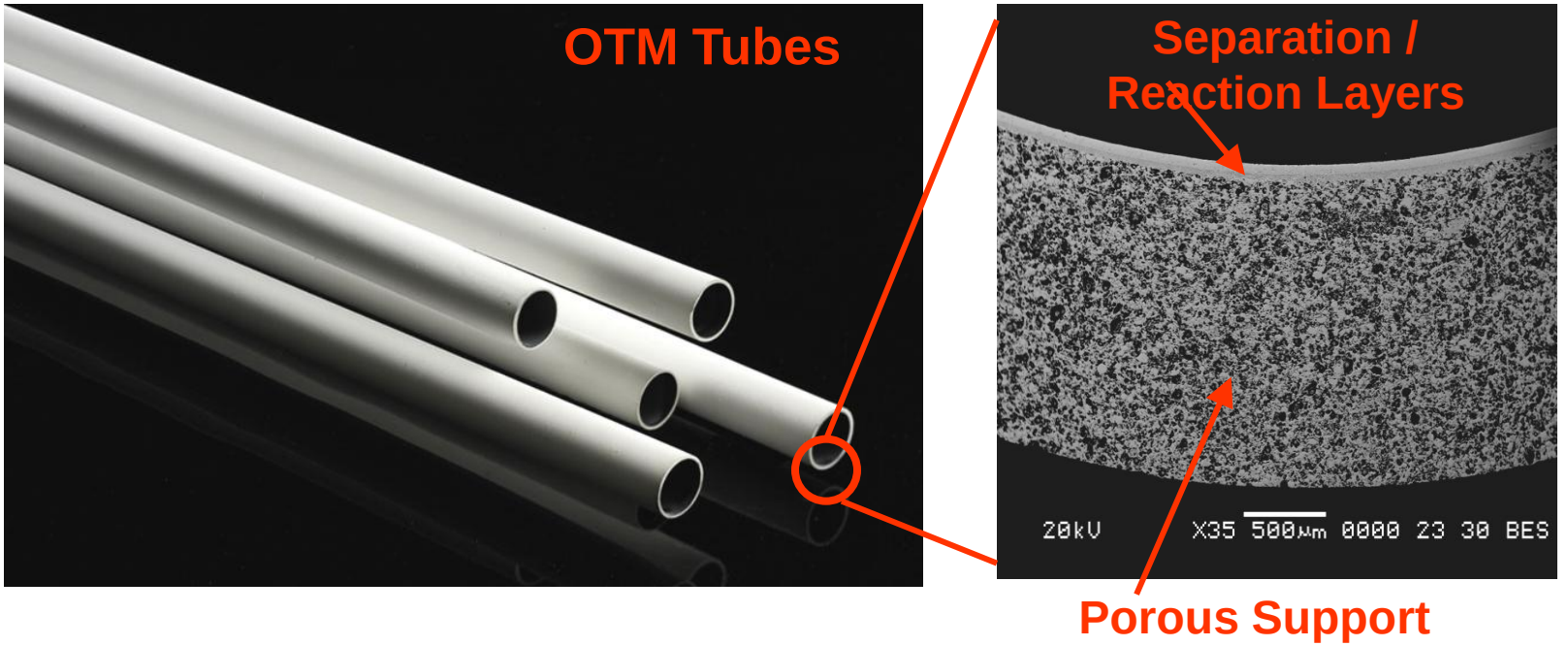
US Patent Application 2008/0141672 A1

Systems Analysis / % Increase in COE

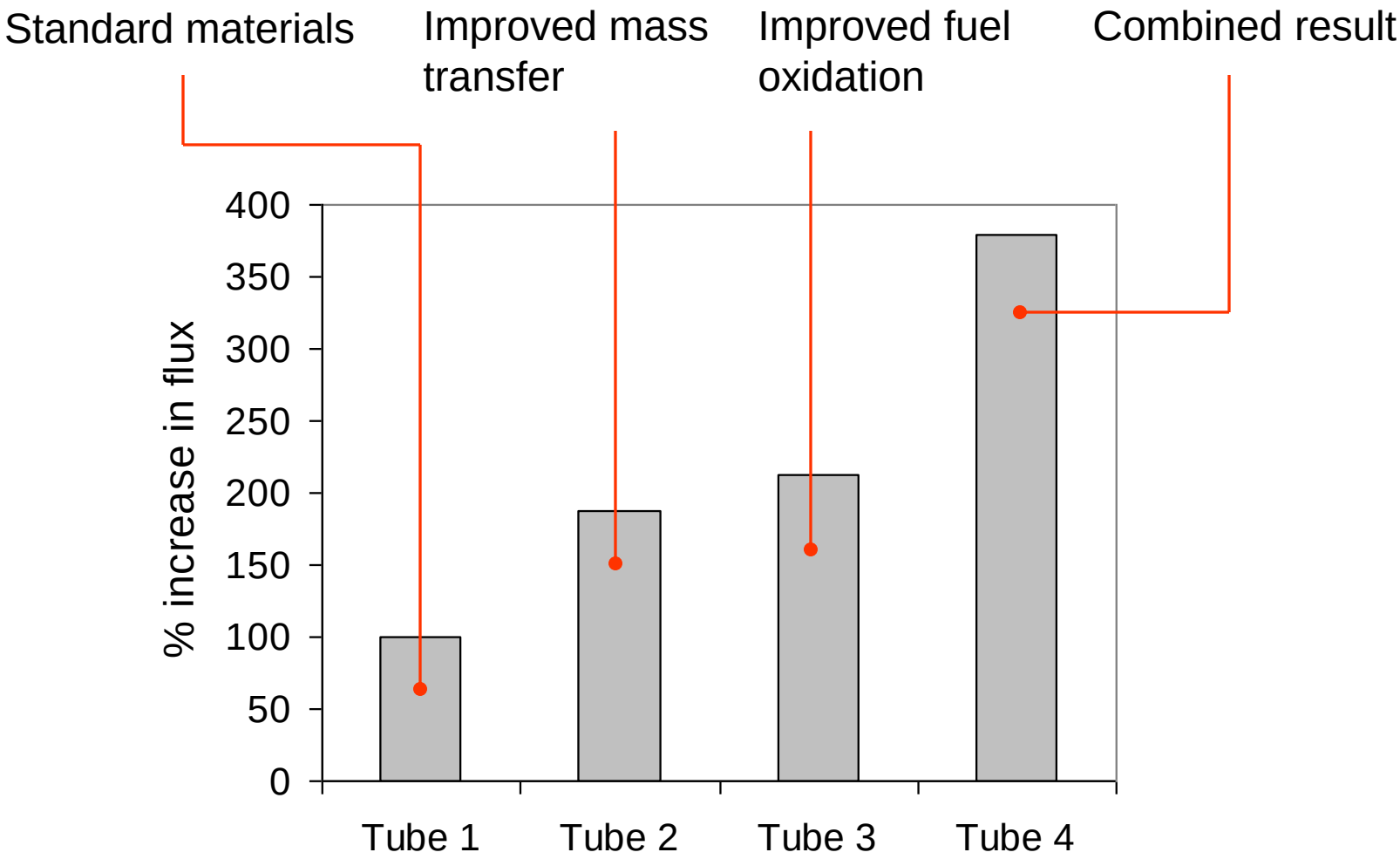
		OTM FGD Process CASES			Air-PC Case
Case		**1 SC**	**2 USC**	**3 AdUSC**	**Praxair/DOE No CCS SC**
Net Efficiency (HHV)		36.3	37.2	39.7	39.7
Cost Basis (Year)		3/2008	3/2008	3/2008	3/2008
Plant Cost ($/kW)		$2,894	$2,887	$2,997	$1,908
	Coal Price ($/MMbtu)				
Increase in COE	1.8	39.4%	38.4%	39.7%	
	3.0	34.9%	33.8%	33.8%	
	4.0	32.1%	30.8%	30.0%	

OTM Materials

- Robust zirconia Porous Support
- Dual phase zirconia and metal oxide separation layer
- US Patent 7,556,676

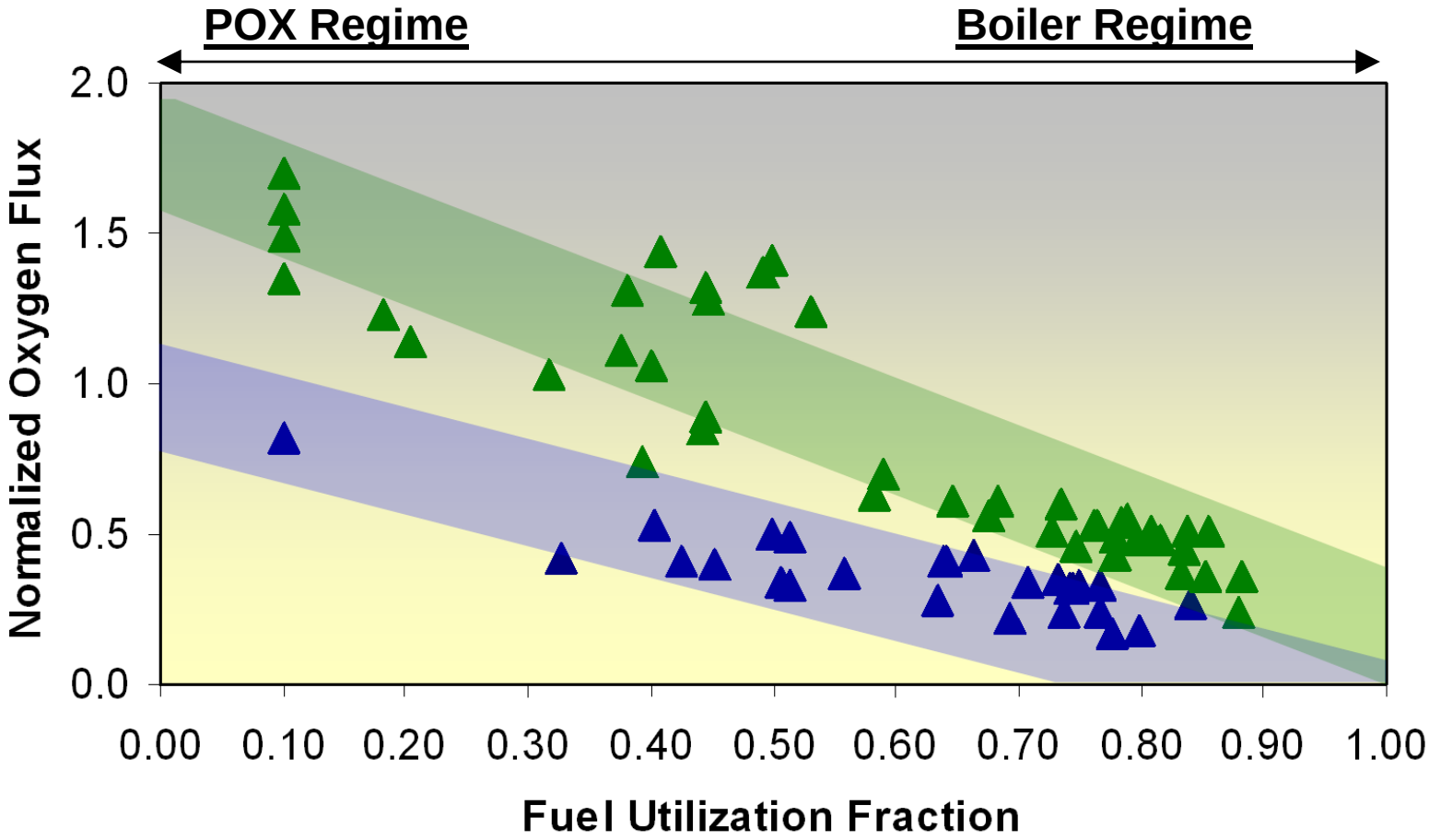


Performance



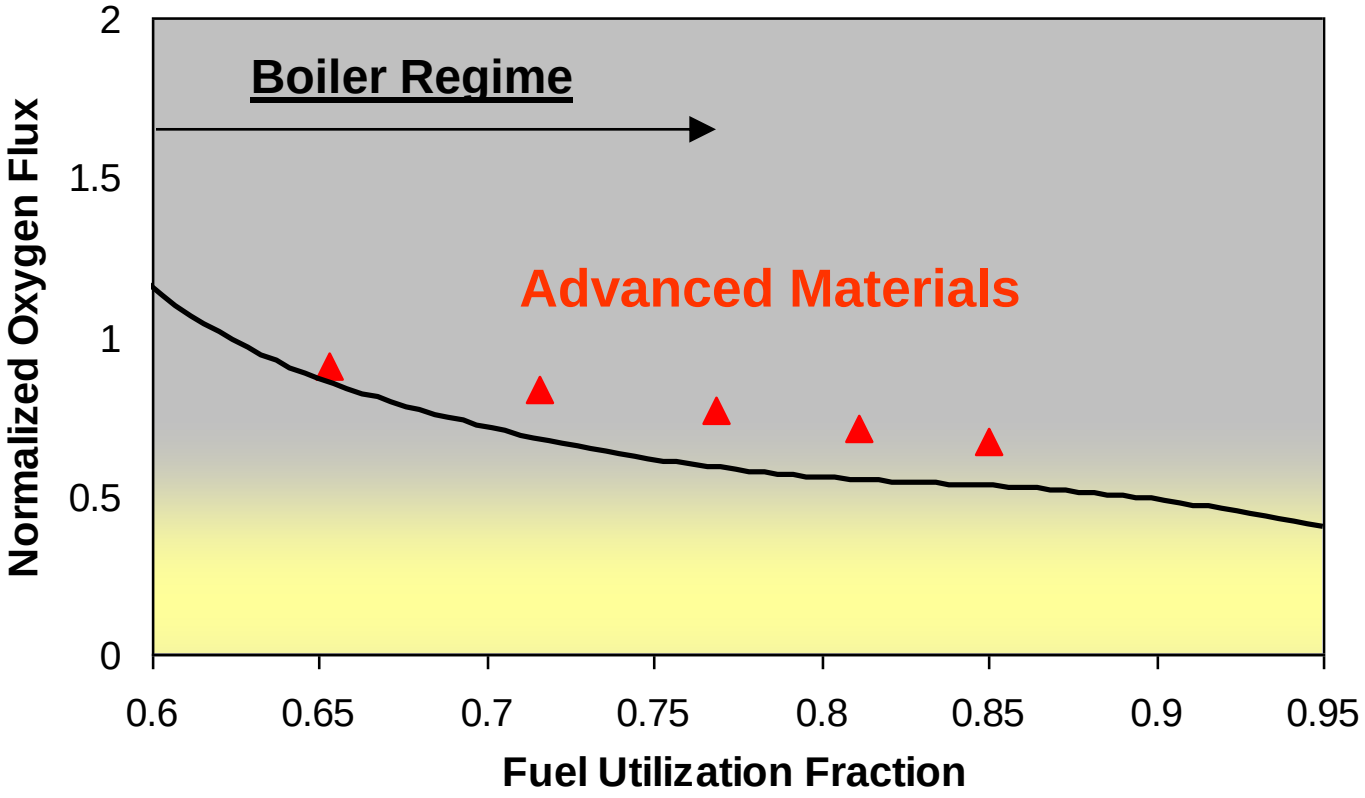
Data for 6”, 1”OD tubes at 50% Uf, gas composition (CH_4, CO, H_2, CO_2, H_2O)

OTM Performance



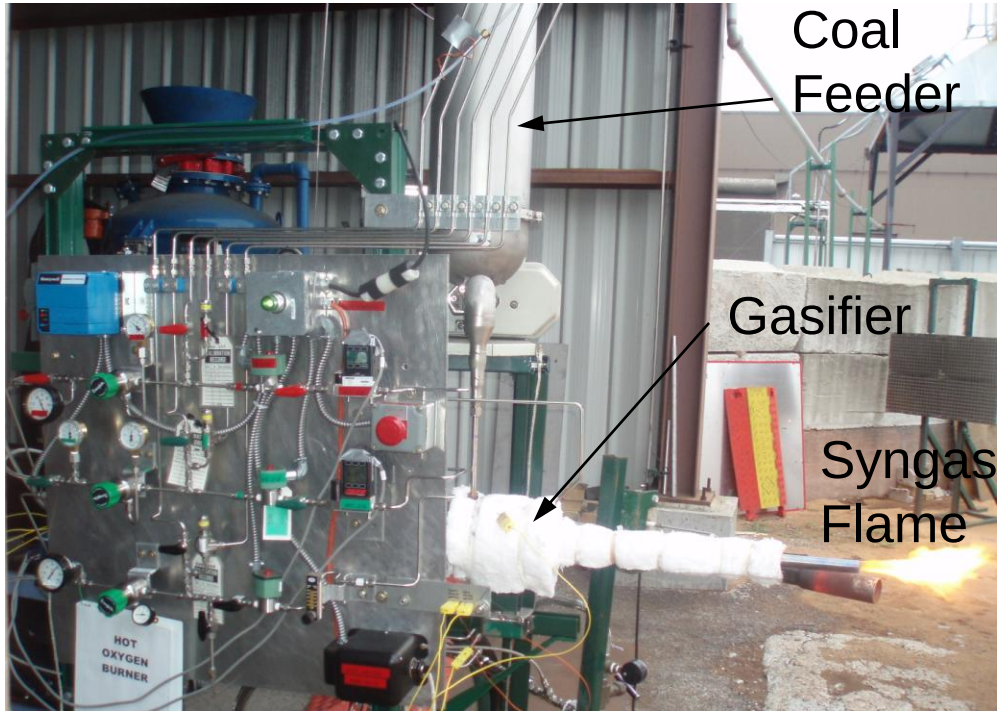
- Standard materials shaded blue, advanced materials shaded green
- Each data point obtained from single “Average O2 Flux” Measurement

OTM Performance



- Triangles: “Average flux” results derived from instantaneous flux measurements for advanced materials
- Line: Oxygen flux target for DOE goal of <35% increase in COE
  - Target based on coal price $3/MMBTU and prelim. estimate of OTM Cost

Lab-scale OTM Coal Reactor



- Problems attaining temperature in OTM coal reactor at University of Utah
- Praxair HOB technology developed for control of jet momentum in large scale combustion applications
- Lab-scale (coal feed rate < 30 g/hr.) HOB constructed and tested at Praxair
- Scheduled for installation on OTM coal reactor in Utah

Path Forward

- Developing Industry Partners
  - Engineering contractor for design of OTM reactor equipment
    - Sub-contract on existing award anticipated October 2010
  - Ceramics manufacturing corporation for design of OTM module and volume manufacturing
  - Customers of OTM integrated processes

- Proceed with Phase 3
  - Development and testing of OTM modules that will be the basic building block for subsequent systems (POx, reformers, boilers, etc.)
  - Demonstration of the OTM modules in a pilot scale reactively driven system producing syngas and combusting a fuel

Thank you.

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