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Combustion Institute (British Section) : Combustion technologies for reducing emissions of CO_2 to the atmosphere : Cambridge, December 2006

Burning Velocities and Combustion Characteristics of Hydrogen-rich Syngases

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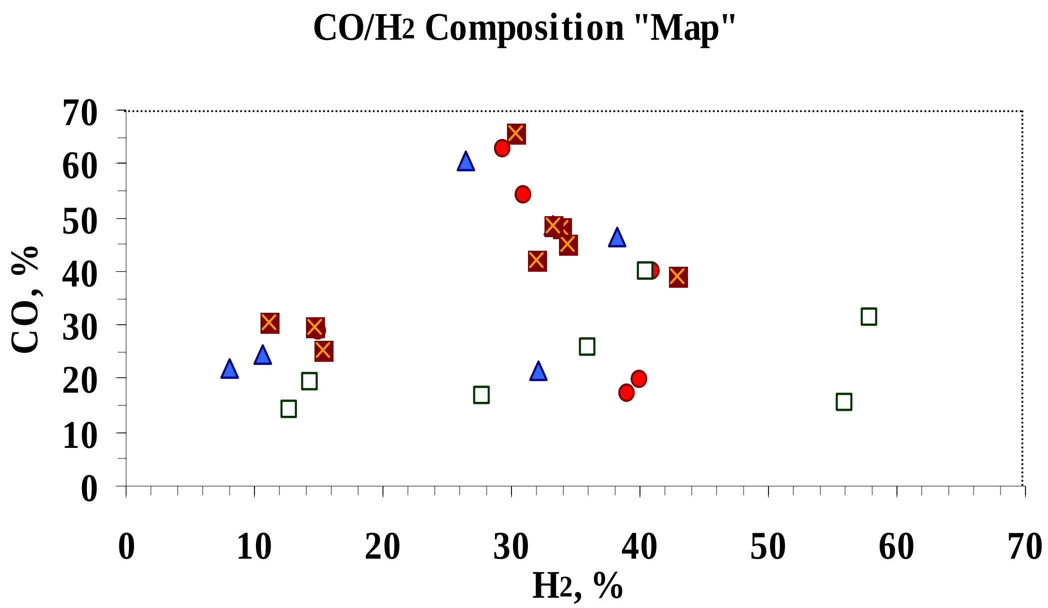
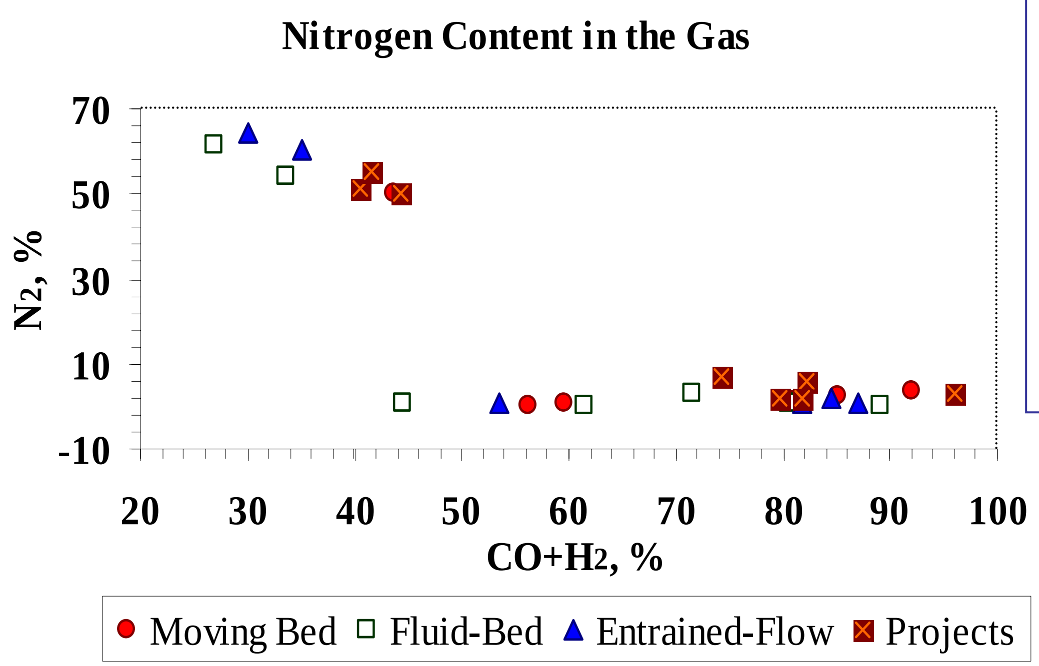


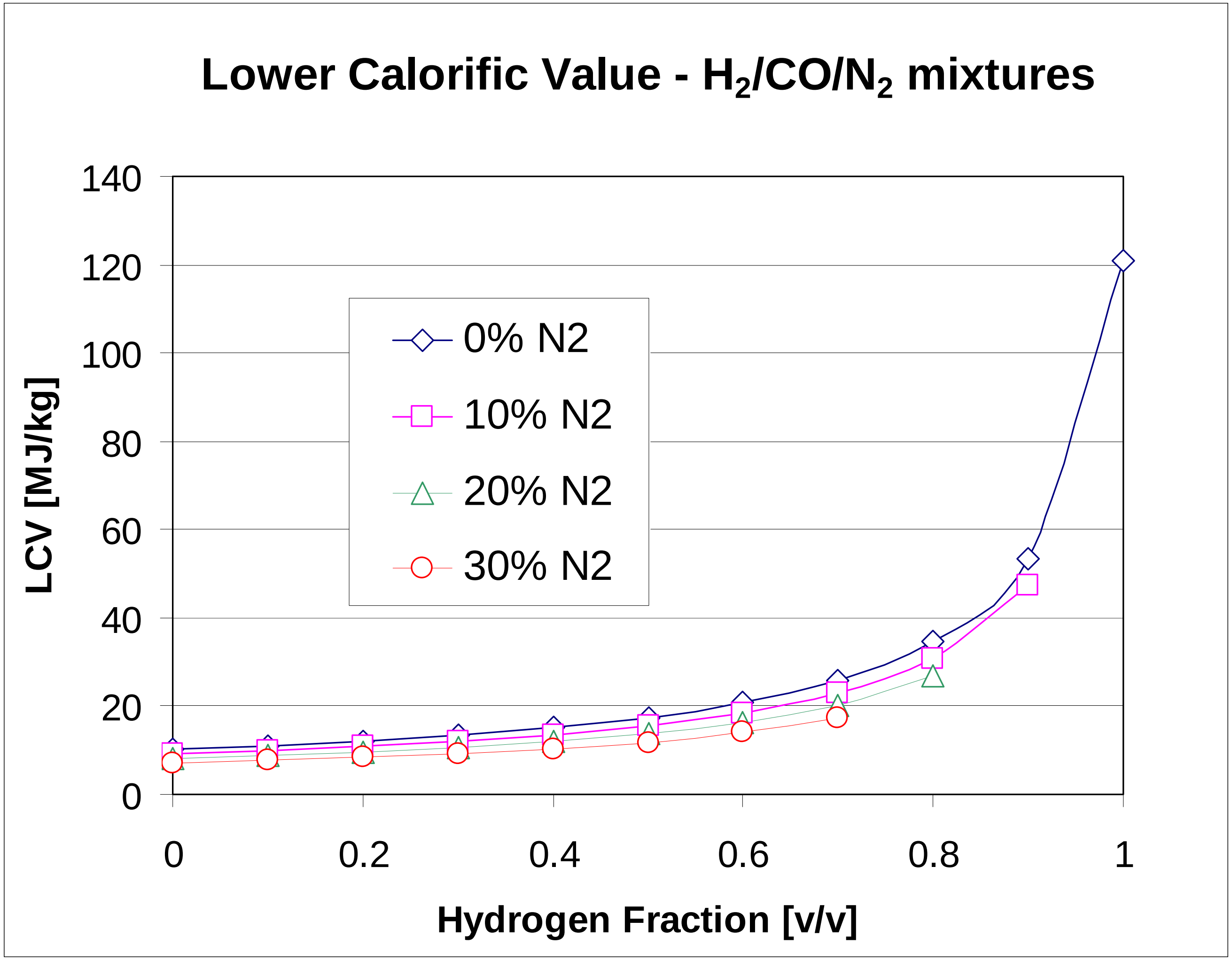


Typical IGCC syngas mixtures

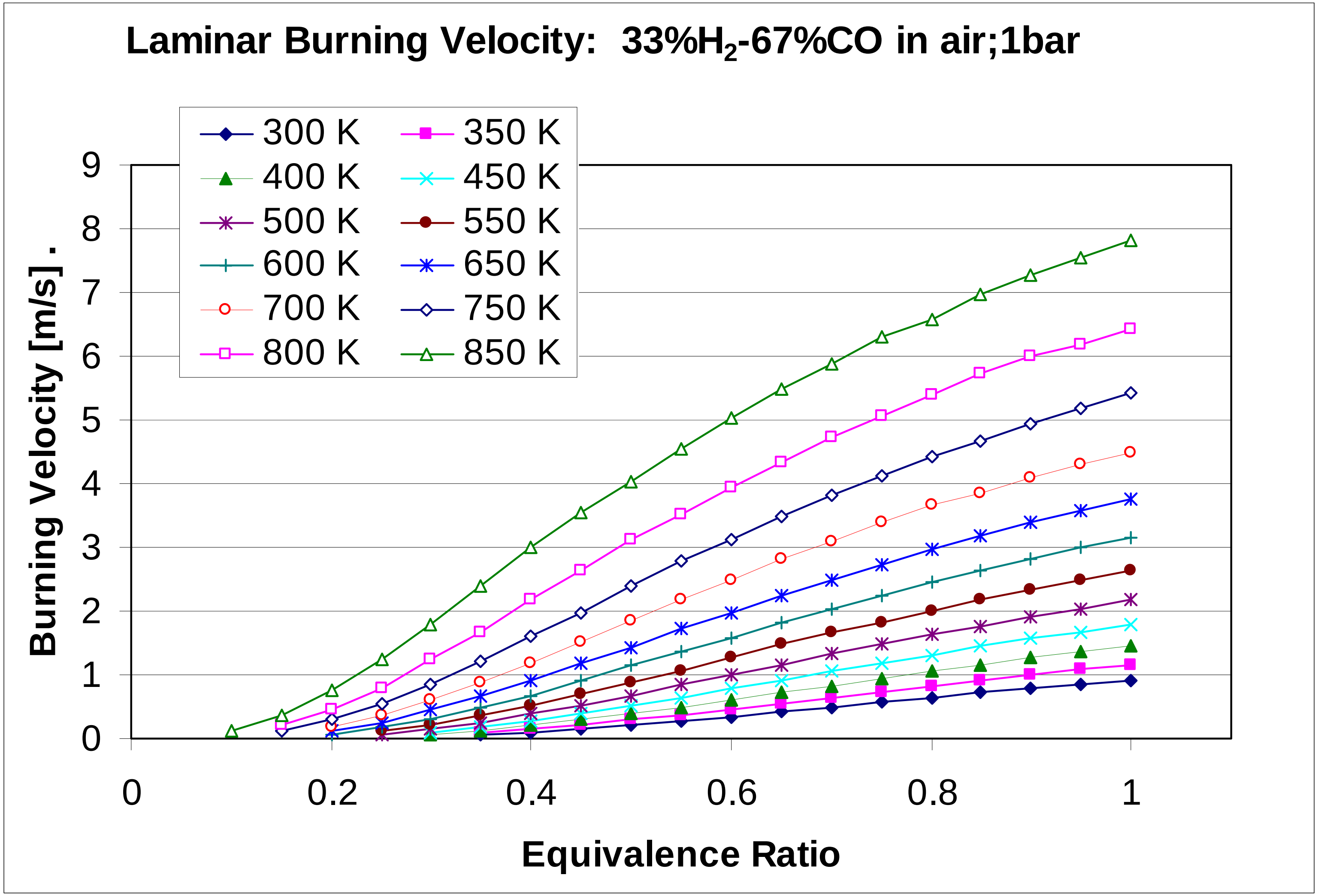
Coal Gasification

Typical syngas compositions - though primarily CO and H_2 (from the water gas reaction) - will vary (amongst other factors) according to :

- **the nature of the coal feed**
- **the relative proportions of steam and oxygen or steam and air employed**
- **the carrier gas for coal particles**
- **the operating temperatures and pressures**



Lower Calorific Value - $H_2/CO/N_2$ mixtures
140
120
100
80
60
40
20
0
LCV [MJ/kg]
0% N2
10% N2
20% N2
30% N2
0
0.2
0.4
0.6
0.8
1
Hydrogen Fraction [v/v]



Numerical simulation : GRI mechanism

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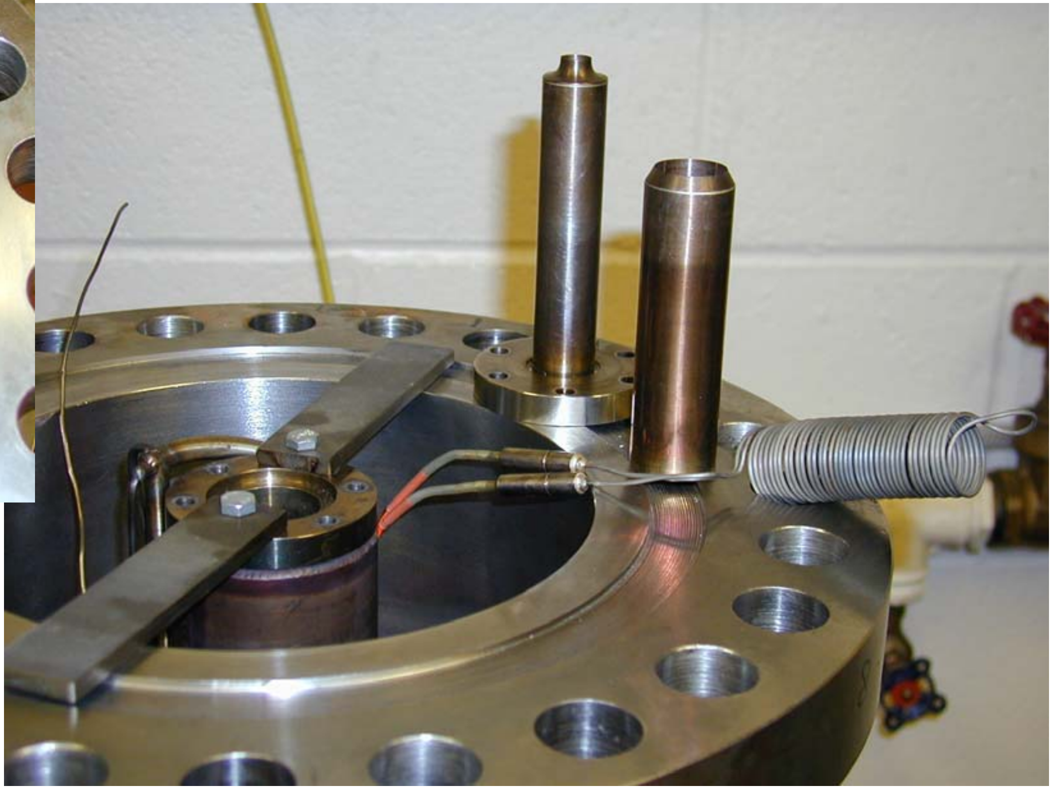

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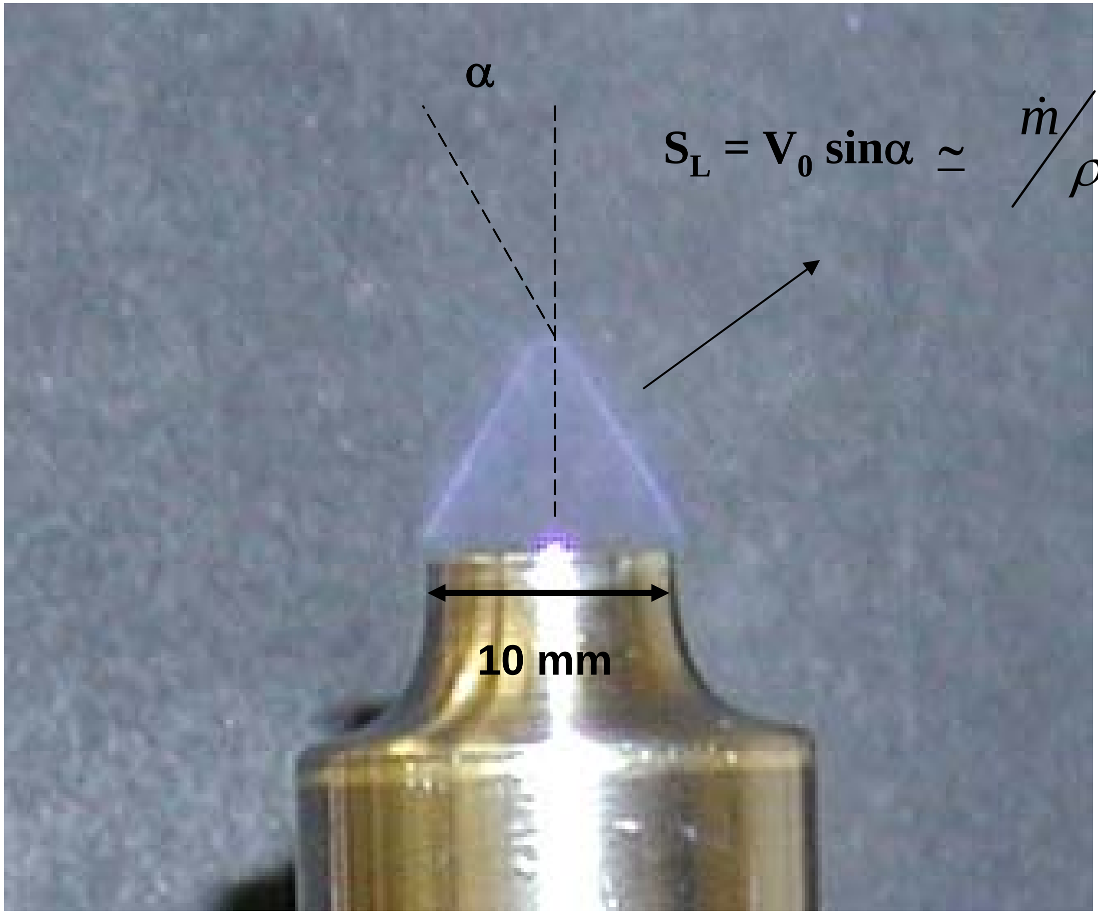

Lean premixed propane-air flame

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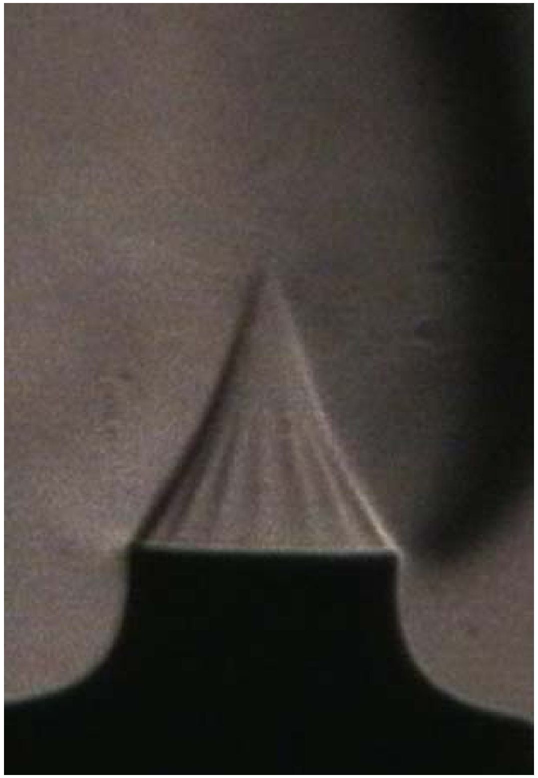
Illustrative Schlieren images : 33% H_2 - 67% CO : 1bar,20^0C



Equivalence ratio

Φ = 0.534 0.542 0.611

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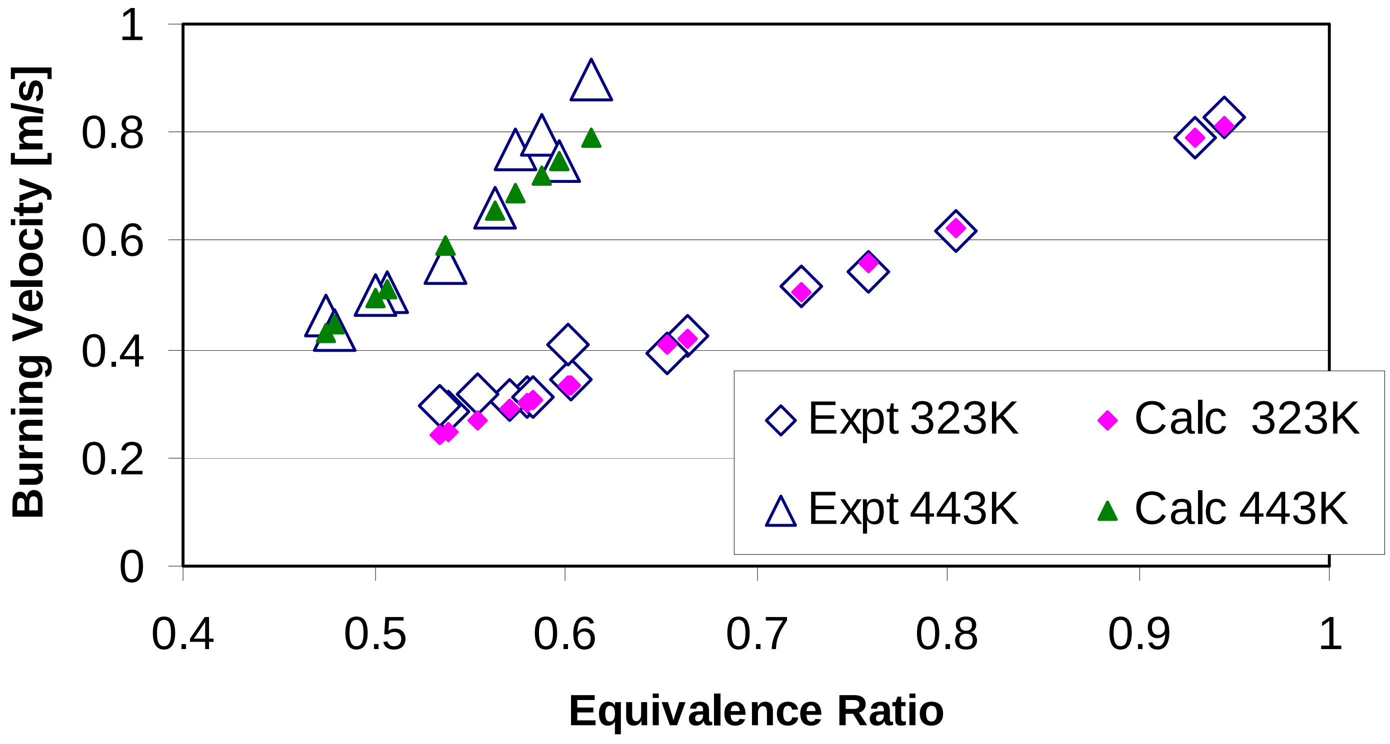
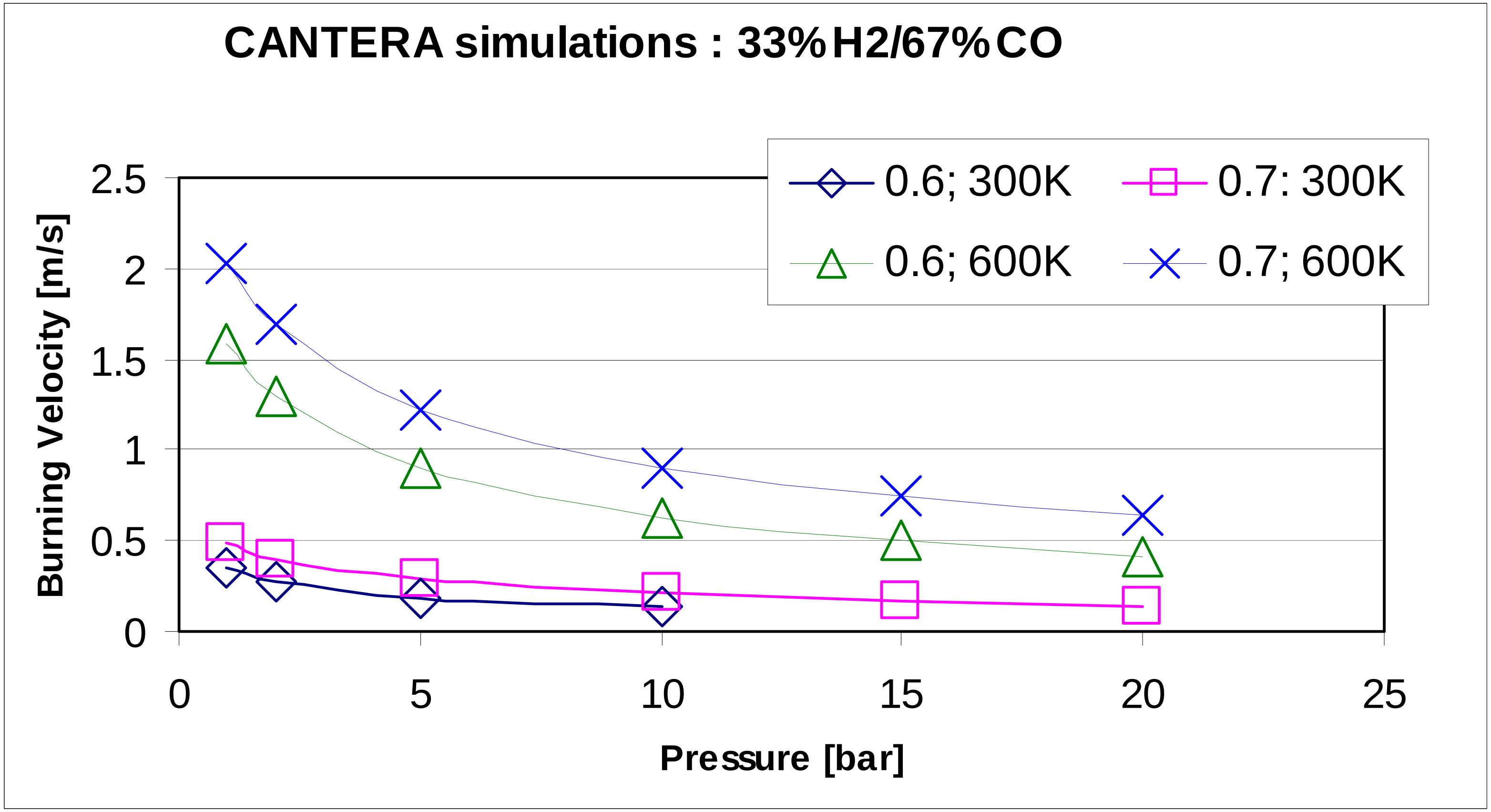
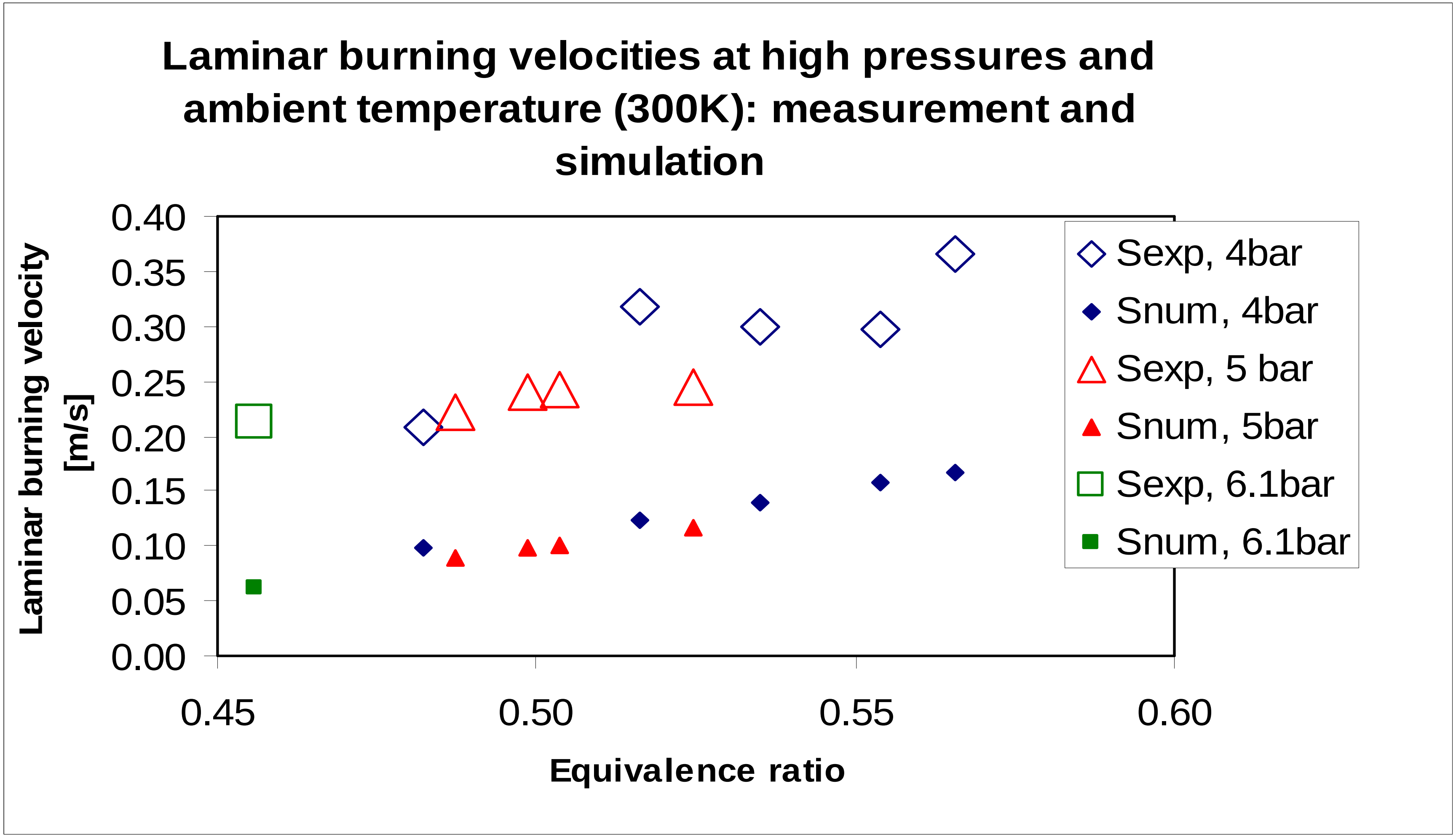
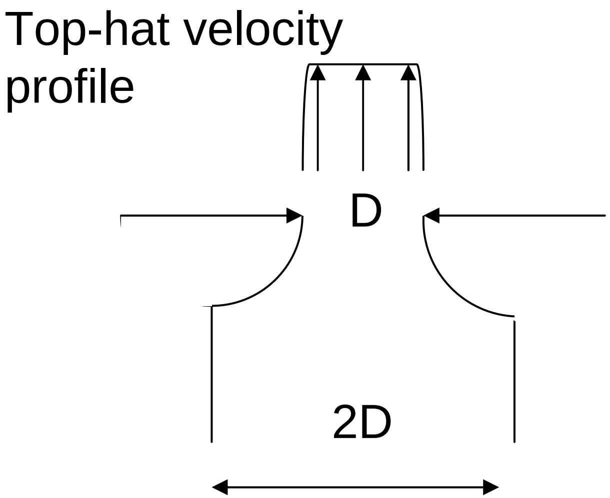
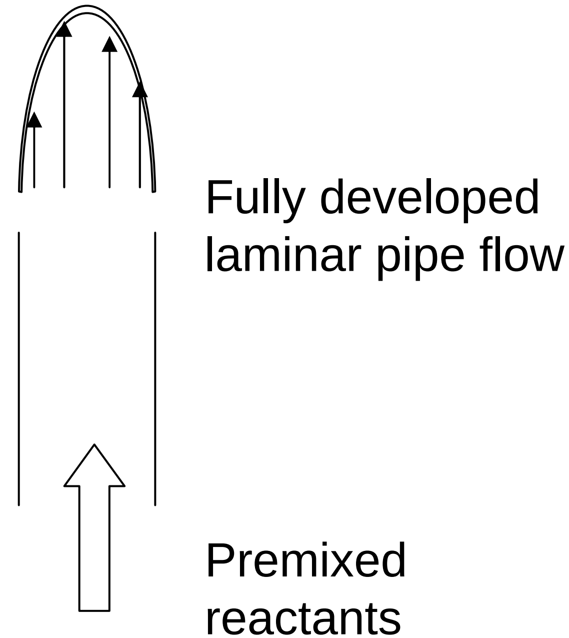
Laminar burning velocity : 33% H2 - 67% CO; 1 bar




CANTERA simulations : 33% H2/67% CO
Burning Velocity [m/s]
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Pressure [bar]
0.6; 300K
0.7: 300K
0.6; 600K
0.7; 600K


Laminar burning velocities at high pressures and ambient temperature (300K): measurement and simulation
Laminar burning velocity [m/s]
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.45
0.50
0.55
0.60
Equivalence ratio
Sexp, 4bar
Snum, 4bar
Sexp, 5 bar
Snum, 5bar
Sexp, 6.1bar
Snum, 6.1bar





Alternative nozzle exit flows introducing different hydrodynamic strain fields :

increasing strain inhibits thermo-diffusive flame distortion?

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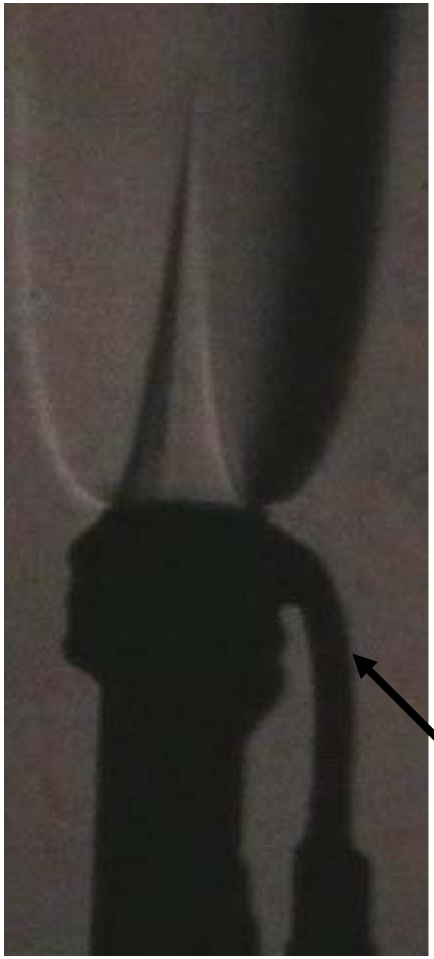
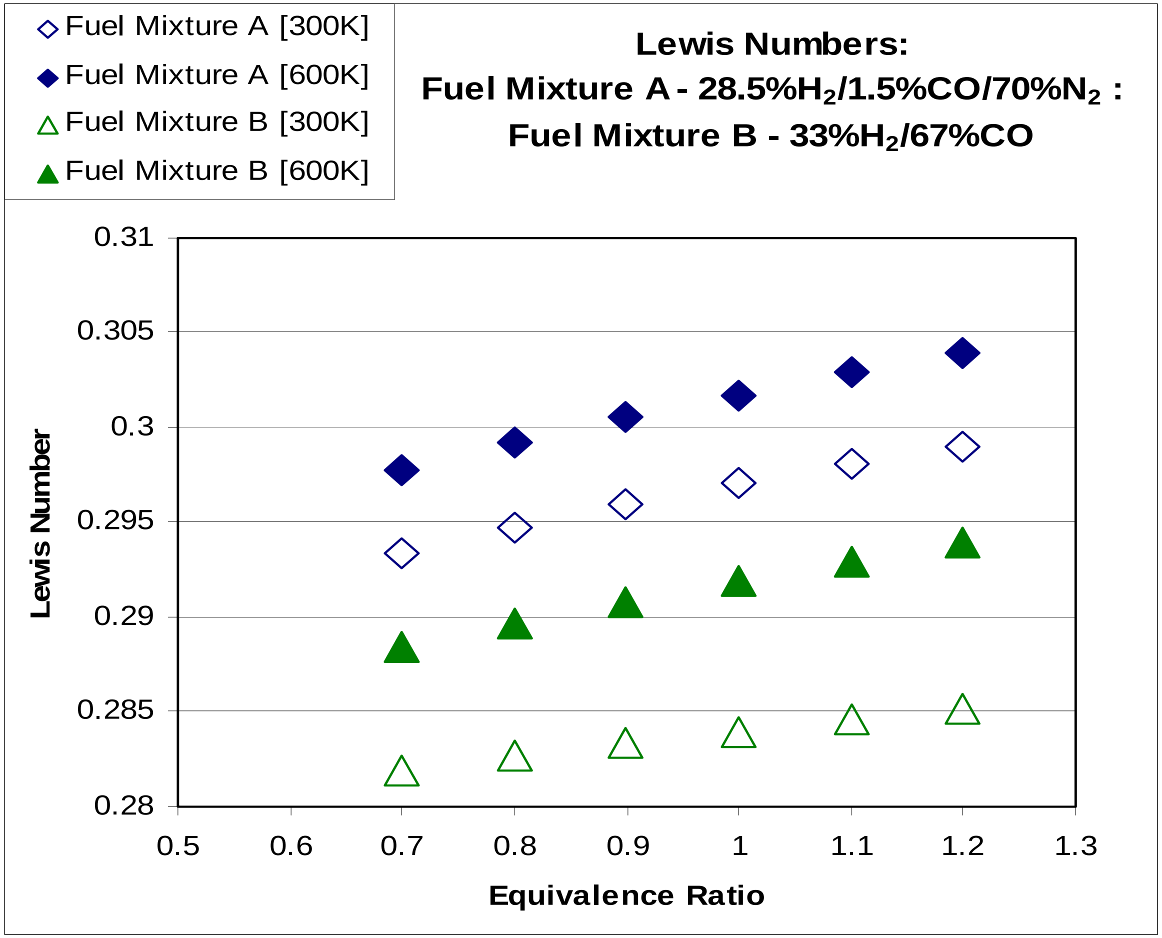
Illustrative Schlieren images: 5mm bore ; 50D length

$\Phi = 0.505$; 1.94 bar



0.538 ; 1.8 bar

Water jacket



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Will the increased sensitivity to Lewis number in lean hydrogen-rich flames have any significance in turbulent syngas flames at high pressure and temperature?