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Biogas as Fuel for a Fuel Cell System: Investigation and First Results for a Molten Carbonate Fuel Cell

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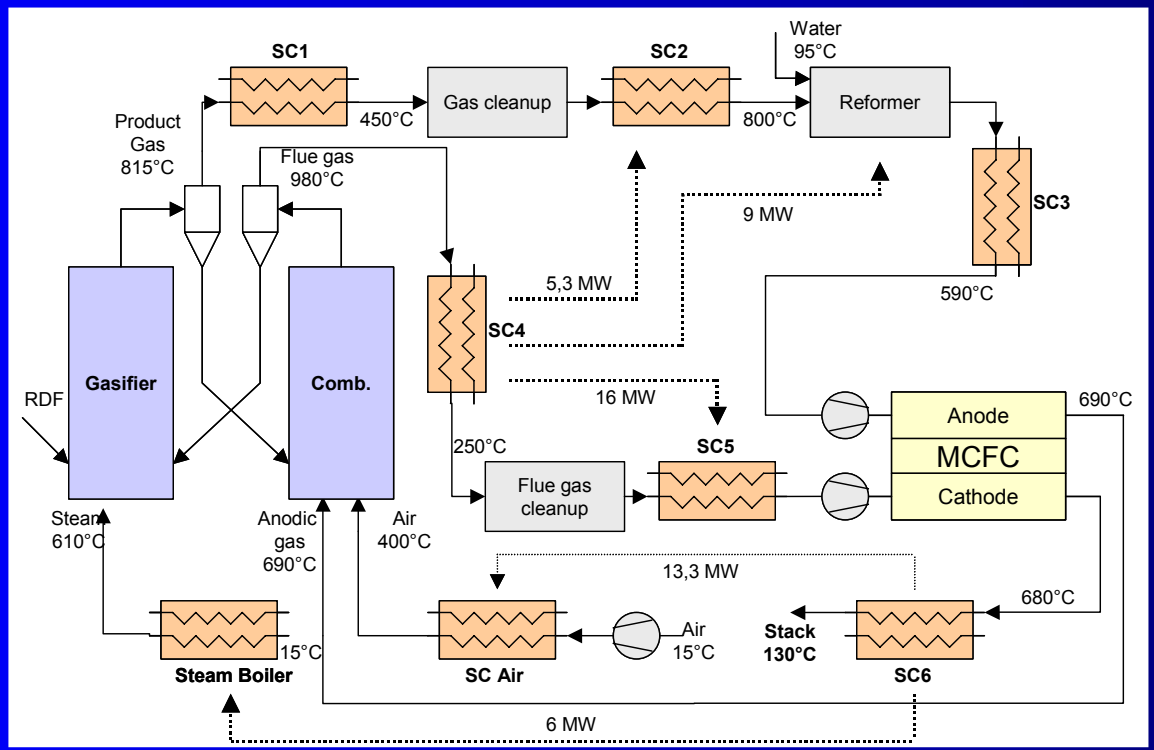
Introduction

- ✓Biogas is a gas, generally rich in CH_4 and $CO_{2,}$, derived by animal waste, human sewage or crop residues
- ✓The use as an energy source leads to several environmental and economic benefits
- ✓If a fuel cell is used as an energy conversion system, the efficiency and the relative environmental performance are very high

IGFC Systems

✓Several System Solutions of Gasifier/FC Systems have been defined and analyzed (as examples: Lobachyov and Richter 1998, Lunghi et al. 2002)



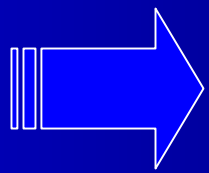
The achievable efficiency is about 50%

Integration of the Fuel Cell

- Experimental tests are conducted to evaluate the performance of an MCFC fed by a biogas derived by a steam gasification process

Reference Biomass

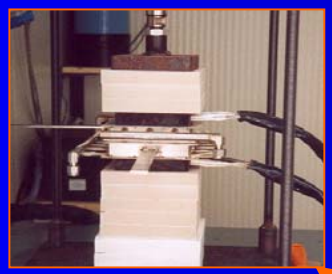
Chemical Substance	%
Carbon (C)	36%
Hydrogen (H)	4%
Oxygen (O)	33%
Nitrogen (N):	0.85%
Chlorine (Cl)	0.1%
Humidity (H2O)	20%
Mineral ash	6%
Sulphur (S)	0.05%
Lower Calorific Value: 17.5 MJ/kg (dry and ash free)	

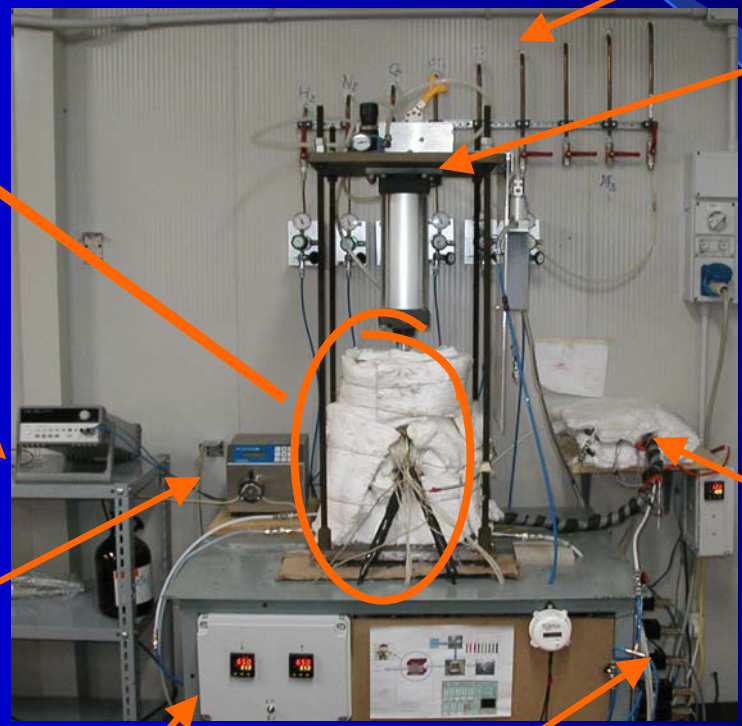


Biogas

Chemical Species	%
H_2	42.85
CO_2	7.29
CO	17.92
CH_4	2.76
H_2O	29.18

Test Facilities





Gas delivery

Mechanical load

Electronic load

Peristaltic pump

Vaporizer and control system

Mass flows control

Temperature control

Test Facilities

Flow rates calculation

Calculation percentage of the full scale flow controller

Overflow?

No

Yes

Best fit of Flow controllers setting

Flow rate reading

Set safety composition

Close recorded file

recording

Param. calculation

Visualization

Parameter variation

Parameters variation logic

Below safety limit ?

Yes

No

Voltage reading

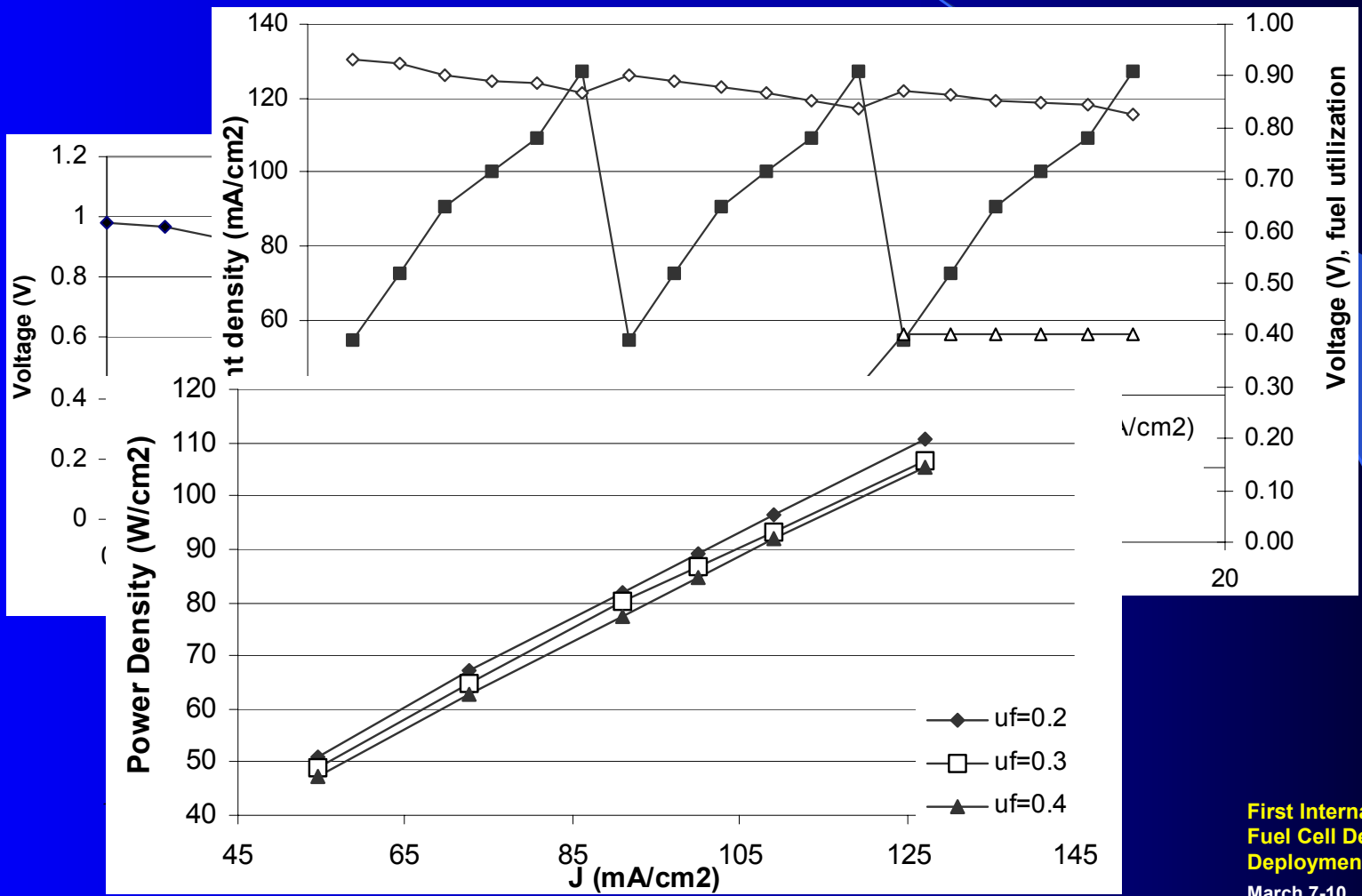
End of test?

Yes

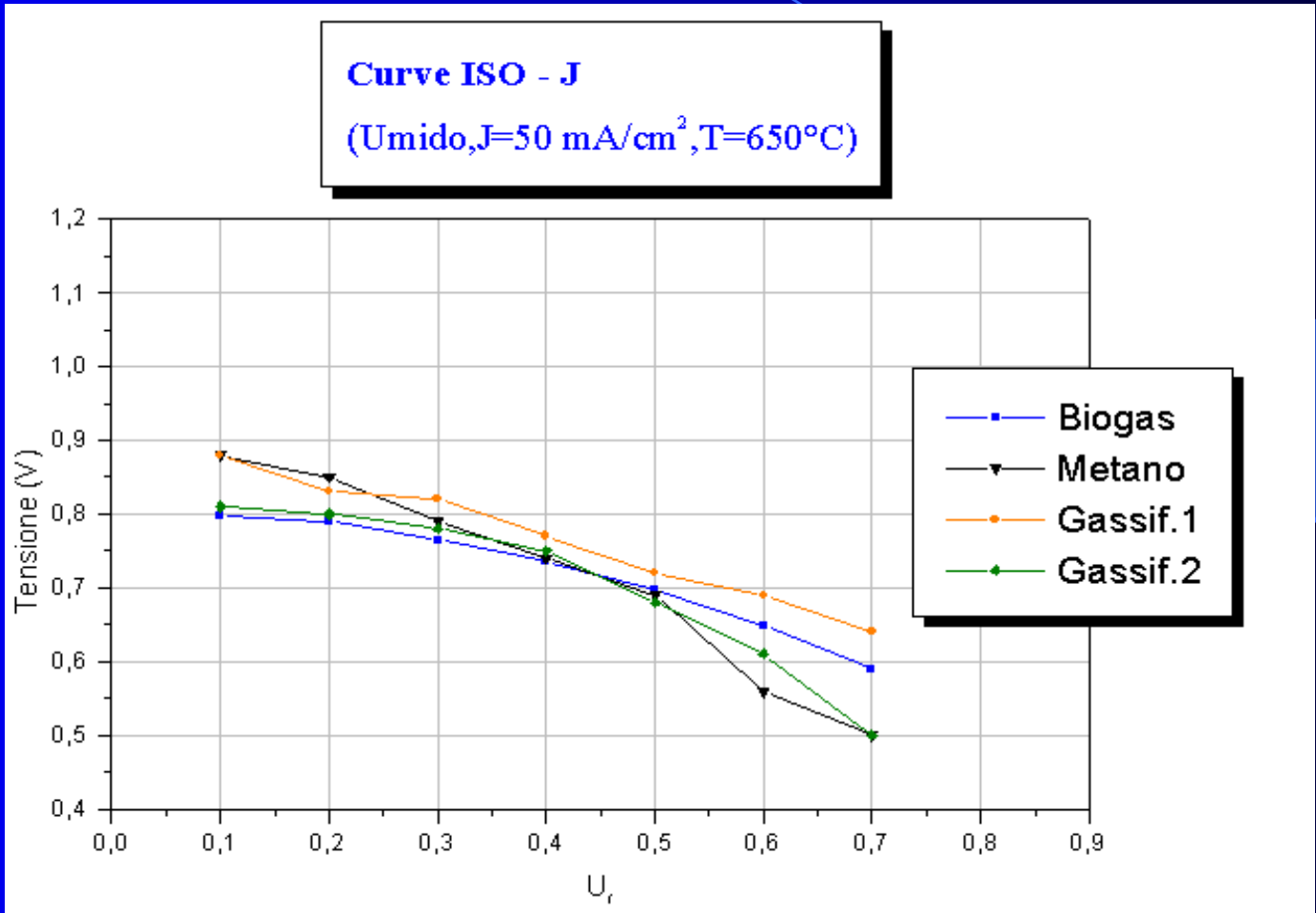
No

STOP

Test Results



Test Results: Comparison



Conclusion

- ✓Biogas from biomass gasification is confirmed to ensure good performance for MCFCs
- ✓Performance are close to that of reformed natural gas
- ✓Future investigation must focus on the impurity tolerance of the fuel cell