

AMONCO Biogas - Fuel Cells



Steyr, Upper Austria



Wasserstoff und Brennstoffzellen in einem zukünftigen nachhaltigen Energiesystem
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Overview of the project



Advanced prediction, monitoring and controlling of anaerobic digestion behaviour towards Biogas usage in Fuel Cells

- **Official start:** 01. December 2001
- **Duration:** 3 years
- **Budget:** ~ 3.6 Mio Euro
- **Financing:** Own contribution, EU-Commission, bm:bwk



Overview of the project



- Consortium: 12 partners from 5 European Countries: Partner:
PROFACTOR (Austria) – Coordinator, biogas analytics and biogas cleaning
IAM (Austria) , **Uni Nitra** (Slovakia) – fermentation tests, neuronal network
E.V.A. (Austria) – dissemination activities, Business Interest Group
farmatic, **Biogas Barth**, **Saria** (all Germany),
GasCon (Denmark), **MFN** (Spain) - Biogas plant operator
EBV (Germany) – economical feasibility study
Seaborne (Germany) – biogas cleaning
CSIC (Spain) – single fuel cell tests



Objectives of the Project



The scientific and technical objectives of AMONCO are:

- Comprehensive Biogas analysis on a detailed level
- Advanced controlling of the anaerobic digestion process to hinder the formation of trace gases while keeping a high methane yield
- Suitable and cost-effective biogas cleaning processes
- Investigations of the performance of biogas in fuel cells through single cell tests



Objectives of the Project



In addition to that economical aspects are also important for a successful technology implementation.

Non technical objectives of AMONCO are:

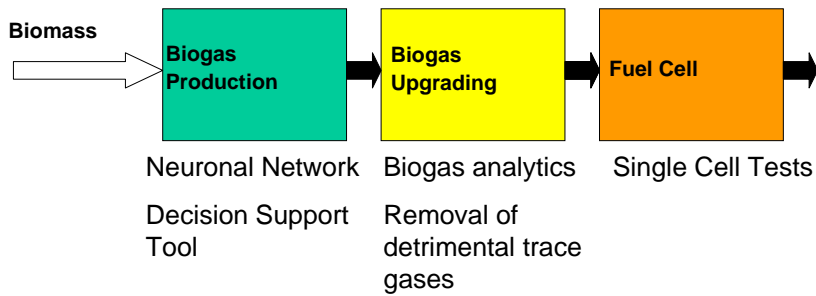
- Economic feasibility study
- Market driven implementation strategies
- Establishing a Business Interest Group



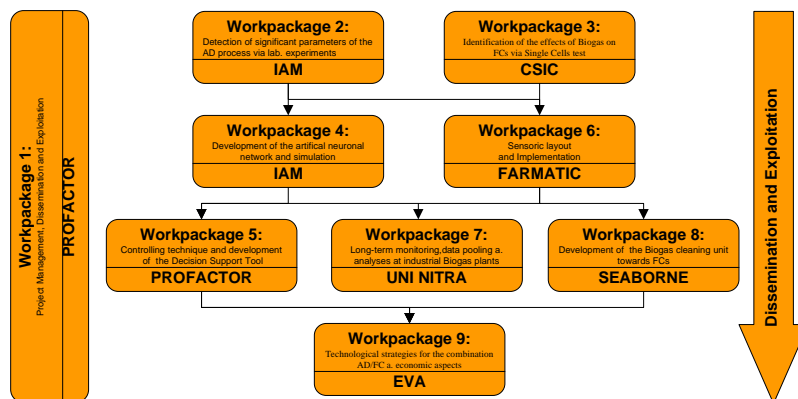
AMONCOs Approach



The optimization of the usage of biogas in fuel cells is the primary goal of the AMONCO project



Project - Workplan



Achieved Results - Biogas Components



Overview

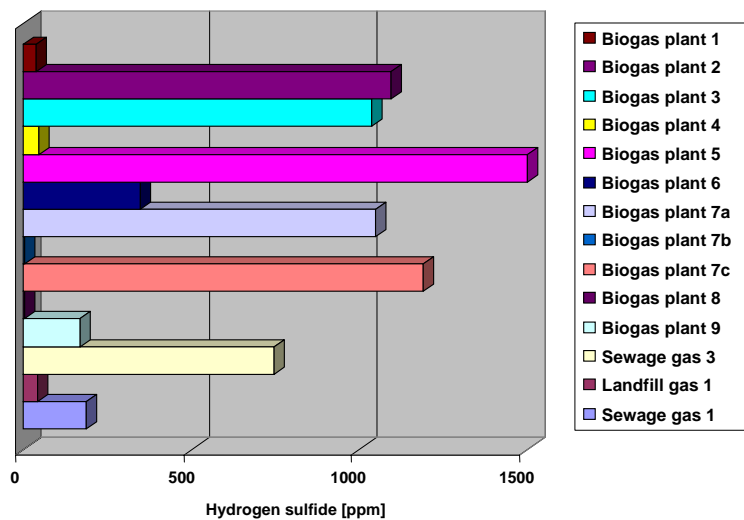
main components (% to ppm)	}	CH ₄	40 - 70 %	}	GC/TCD
		CO ₂	30 - 50 %		
		N ₂	0 - 20 %		
		O ₂	0 - 5 %		
		H ₂ S	0 - 2000 ppm		GC/FPD
		mercaptanes	0 - 100 ppm		
trace components (mg/m ³)	}	siloxanes	0 - 100 mg/m ³	}	GC/MS
		hal. hydrocarbons	0 - 100 mg/m ³		



Achieved Results – H₂S in Biogas



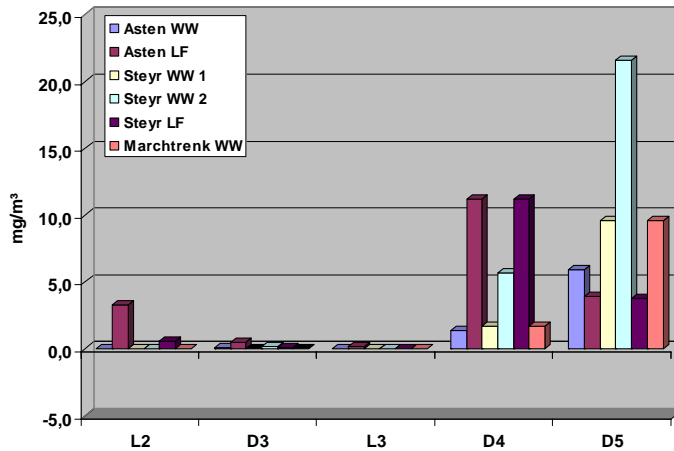
Hydrogen sulfide contents



Achieved Results - Siloxanes in Biogas



Waste water treatment plants and landfills



hexamethyldisiloxane (L2)

hexamethylcyclotrisiloxane (D3)

decamethylcyclopentasiloxane (D5)

octamethyltrisiloxane (L3)

octamethylcyclotetrasiloxane (D4)



Achieved Results - Fermentation



- For starting modelling and controlling the anaerobic process, a lot of data must be produced first. Laboratory reactors with the appropriate sensors and analyses are operated by partner IAM and Profactor.



Achieved Results - Pilot plant (Uni Nitra)



Nitras Biogas test facility



Test fermenter



Biogas tank



Achieved Results – Control program



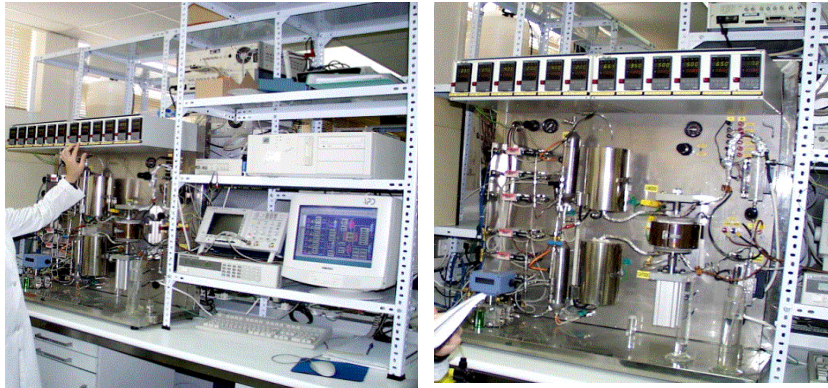
- A first client front panel for the control program was developed by partner IAM



Achieved Results – Single Cell Test



- Two fuel cell stations have been designed and constructed by partner CSIC
- First experiments with the fuel cell station are carried out



Achieved Results



- Definition of the parameters, which are collected at the five biogas plants
- Installation of sensors at biogas plants
- Data collection at the involved biogas plant has started



Achieved Results – Cleaning part



FC – Requirements towards gas quality

FC-Type Gas comp.	Temp. °C	Low temperature FC			High temperature FC	
		PEFC 80	AFC 100	PAFC 200	MCFC 650	SOFC 800-1000
H ₂		F	F	F	F	F
CH ₄ , C _n H _m		IG	poison	IG	IG/F	F
CO ₂ , H ₂ O		IG	poison	IG	React.	IG
CO		poison (<50ppm)	poison	poison (<500ppm)	F	F
H ₂ S, COS		n.d.	poison	poison (<50ppm)	poison (<0.5ppm)	poison (<1.0ppm)
NH ₃		poison	F	poison	F	F
Halogens		n.d.	n.d.	poison	poison	poison

Analysis on siloxanes, tar, dust and other components are missing!!
 n.d. ...not detected F.... Fuel, IG.... Inert gas, React....takes part in elctrode reaction

Quelle: Fuel Cell Handbook, 5th Edition, Morgantown, West Virginia, October 2000



Achieved Results – Cleaning part



Overview Gas Composition

Gas type	H ₂ Vol%	CH ₄ Vol%	C _n H _m Vol%	CO ₂ Vol%	N ₂ Vol%	CO Vol%	H ₂ S ppm	NH ₃ ppm	Others
Biogas from fermentation									
¹ Biogas from agricultural biogas plants	0	55-70	-	30-45	0-2	-	500	100	Siloxane, Oxygen
Sewage gas	-	65	-	35	-	-	1000	100	Siloxane, Oxygen
² Landfill gas	-	50-60	-	40-50	-	-	10-50	-	Aromates, Chlor comp., Siloxanes
Biogene gas from thermal gasification									
³ Biomass-gasification	4,5	14,8	-	10,6	39,6	19,1	100	2000	Dust, Tar (3000ppm)
Fossil									
Natural gas	-	93	4,9	1	1,1	-	-	-	Inert gas

- Jensen, J.K., Jensen, A.B.: Biogas and natural gas – fuel mixture for the future, 1st World Conference and Exhibition on Biomass for Energy and Industry, Sevilla, 2000
- Christenson, T.H., Cossu, R., Stegmann, R.: Landfilling of Waste, Biogas, E&FN Spon, London 1996
- Kivisaari, T., Björnbom, P., Sylwan, C.: Studies of Biomass MCFC Systems, Journal of Power Sources, 104 (2002) p. 114-124



Profactor - Biological Biogas Cleaning



Biotrickling filter system



Bubble column



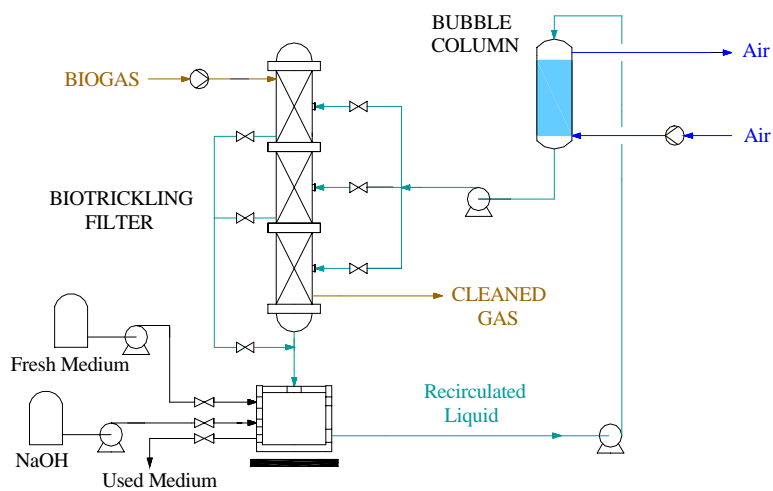
Thiobacillus



Achieved results – Biotrickling Filter



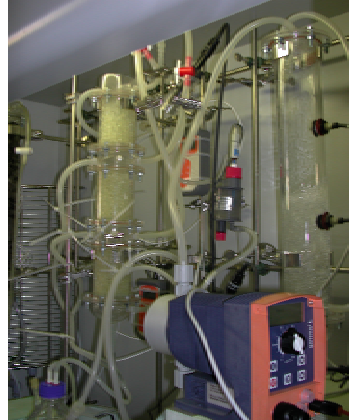
Design of the biological H₂S removal method



Achieved Results – biological cleaning



- Laboratory test facility regarding biogas cleaning processes



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Summary



- Fermentation tests are running
- Neuronal network structure is developed
- Data collection at the involved biogas plants
- First simulation with the data of the involved biogas plants were carried out
- Single Cell tests with low temperature FC were carried out
- Economic feasibility study

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Contact Details



That´s all for now ...



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... thanks for your attention !

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