A New Competitive Liquid Biofuel for Heating
COMBIO

Yrjö Solantausta, VTT Processes, Finland
Steven Gust, Fortum Oil and Gas Oy, Finland
Piero Baglioni, CSGI, Italy
Patrizio Massoli, Istituto Motori - CNR, Italy
Eva-Katrin Lindman, Fortum Värme AB, Sweden
Timo Nyrönen, Vapo Oy, Finland
Gianluca Tondi, ETA, Italy

BIO-ENERGY
ENLARGED PERSPECTIVES

Budapest ,16-17 October 2003

Introduction

- The aim of the project is to verify a new liquid biofuel chain for heat production in existing boilers currently fired with mineral heating oils.
- Project duration 36 monts, started 1.1.2003
- Project budget 2 350 000 €, EC support 1 295 000 €

Objectives

- Generation of process performance data of bioenergy chain
  - Feedstock production and preparation
  - Pyrolysis liquid production (pilot-scale)
  - Pyrolysis liquid in boiler use (fundamentals, boiler tests, field tests)
- Improving pyrolysis liquid fuel quality. Two main technologies are studied: emulsions and hot vapour filtration (HVF).
- Improving economic competitiveness of the bioenergy chain. The target is to produce close to fuel oil prices, and to compete with other renewable alternatives (chips, wood pellets).

Partners

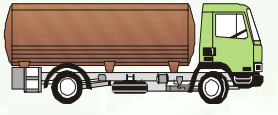
Participants	Role	Nature
VTT Processes	Co-ordinator PL specifications as fuel PL quality improvement, HVF	R&D organisation (3000 employers, turnover EUR 200 million) specialised in bioenergy applications
Fortum Oil & Gas	Commercial aspects Pilot-production of PL Boiler tests	Industrial company (net sales EUR 11,026 million, employees 16,200) with a business plan to consider commercial PL production
CGSI	Production of emulsions Design/construction of the emulsifier	A leading European Institution working on emulsions, dispersions, ect with a recent patent on PL emulsions
IM - CNR	Reduction of PL combustion emissions	A leading laboratory studying fundamentals of combustion
Fortum Värme	PL utilisation	One of the largest utilities in Sweden, provides district heat in Stockholm
Vapo Oy	Feedstock delivery and development Assessment of feedstcok potential	The leading Finnish bioenergy producer developing PL together with Fortum
ETA	Case study for Southern Europe Dissemination: Web-site and brochure	ETA has applied GIS models to simulate the production, collection and transport of biomass to bio-energy plants

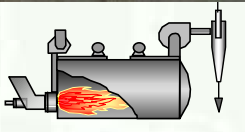
Advantages of Fast Pyrolysis

- The possibility to decouple solid biofuel handling from utilisation (reduced capital & operation costs)
- Storability of liquid fuels
- Transportation of liquids is cost effective
- Use of pyrolysis liquid in existing boilers
- Less emissions in boiler use compared to solid fuels due to better control
- Intermittent operation feasible
- Pyrolysis liquid is the least cost liquid biofuel, and its CO_2-balance is clearly positive
- Light fuel oil may be replaced, which releases middle distillates to be used for transportation

One Example of Biofuel Use: Heating Within a City

Use of Biofuel





Pyrolysis

Resource supply

- Residues from wood industry (incl. forestry residues) are used as feedstock
- Conversion to pyrolysis liquid preferably at an existing plant site
- Transportation of liquid fuel to users
- Potential users medium size boilers (0.2 - 1 MWth) replacing preferably light fuel oil

Work Packages within the Project

WP No	WP title	WP leader
1	**Pilot production**	
1.1	Feedstock delivery and assessment	Vapo
1.2	Pilot performance	Fortum OG
2	**Specifications for PL**	VTT
3	**Utilisation**	
3.1	Laboratory scale combustion	IM
3.2	Medium boiler	Fortum OG
3.3	Small boiler	Fortum OG
3.4	Large boiler	Fortum Värme
4	**Quality improvement**	
4.1	Emulsion production	CSGI
4.2	Hot vapour filtration	VTT
5	**Co-ordination**	
5.1	Techno-economic assessment and case studies	VTT
5.2	Dissemination	ETA
5.3	Co-ordination	VTT

Renewable Heating Oil

CO_2

CO_2 neutral = no CO_2 tax

Liquid biofuel = simple, easy to use

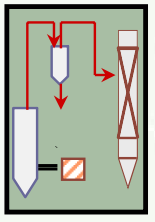
Efficient processes = economical heating

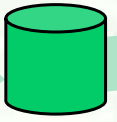
Low emissions = use in urban areas

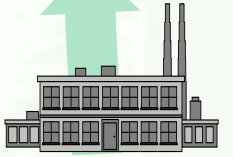
Forest industry residues and wastes

Heating

Forestera™ plant

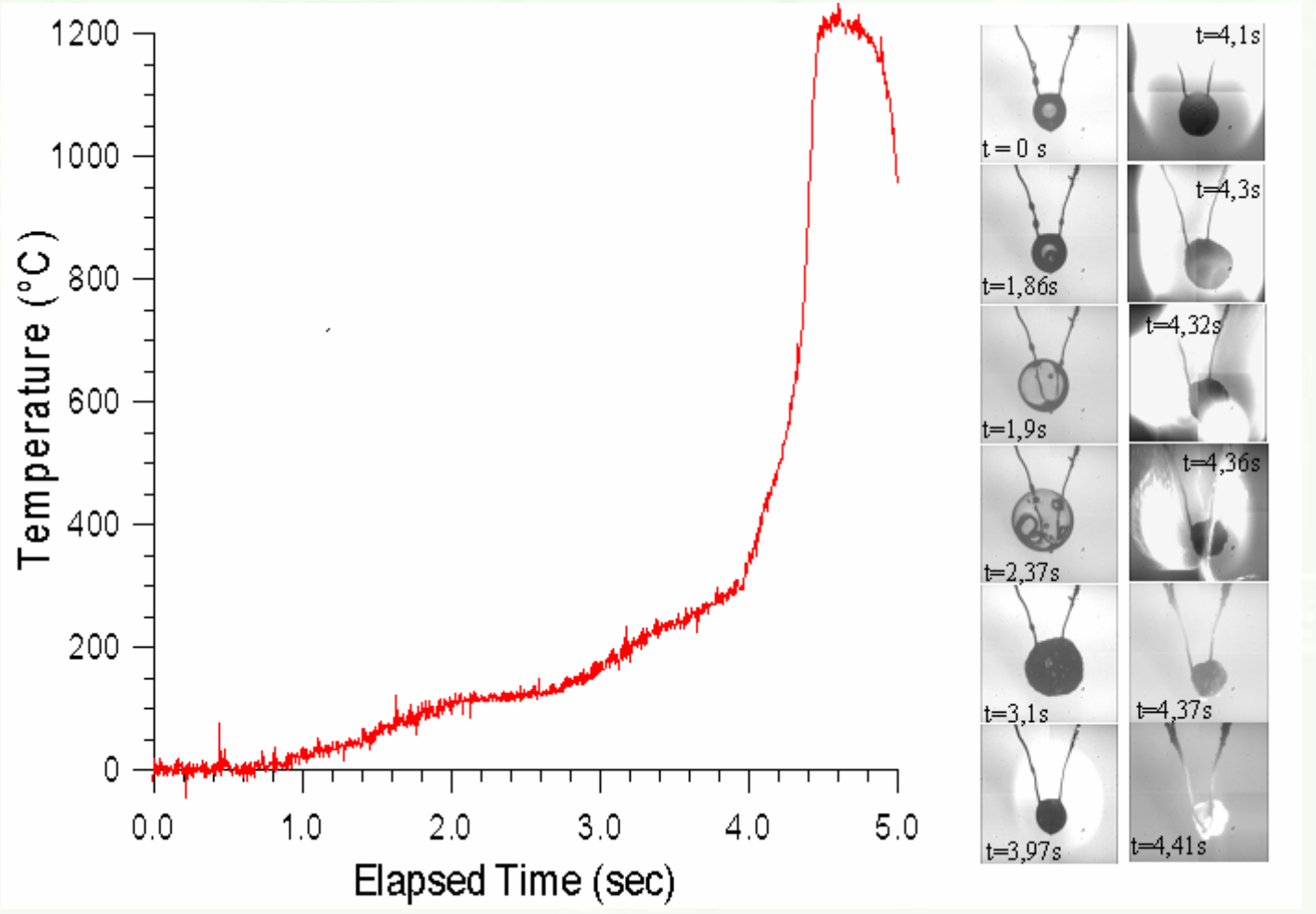






Production of Pyrolysis Liquid in Pilot Scale

Combustion Stages of Pure Pyrolysis Liquid



Typical Emissions from Small Scale Combustion

Forestera™ data from test production

	Heating oil Tempera ™ 15	Forestera ™	Heavy fuel oil Mastera ™ 180	Wood chips	Wood pellets
Boiler size	500 kW	300 kW	1 MW	1,5 MW	20 kW
Flue gas oxygen (%)	4	4	4	5-10	8-12
CO (mg/ MJ)	10	15	15	100-5000	50-1000
NO_x (mg/MJ)	30	30-100 3)	100-150	30-100 3)	30-100 3)
Tar (mg/MJ)	0	~0 1)	0	<20 2)	<10 2)
PAH (mg/MJ)	0	8 4)	1	2000 5)	1000 5)

1) Method used SP-1686. Difference Between measured value and background were too small. Background ~1 mg / MJ
2) Measuring method used not known
3) NO_x comes from biomass N, typically 50 - 300 mg/MJ. In bigger boiler (10-300 MW) one can use NO_x reduction technology
4) Method used SP-1686, Analysis EPA 610
5) Information from 1986

Comparison of LFO-PL emulsions with (left) and without (right) additive

First Tasks

- First 4 m^3 (approximately 5 tonnes) pyrolysis liquid produced and shipped to user sites
- The solids content during production varied from 0.15 to 0.25 weight percent.
- Solids were reduced to less than 0.05 % for field tests, which are carried out in a LFO boiler.
- Two initial emulsions have been produced and shipped for laboratory combustion tests.
- Laboratory combustion, HFO-boiler, emulsion production, and hot-vapour filtration units are modified or under construction.
- First version of web-pages published.

Contacts http://www.combio-project.com/

VTT Processes PO Box 1601 FIN-02044 VTT, Espoo	Yrjö Solantausta yrjo.solantausta@vtt.fi
Fortum Oil and Gas Oy P.O. Box 310 FIN-06101 Porvoo	Steven Gust steven.gust@fortum.com
Conzorzio interuniversitario per lo Sviluppo dei Sistemi a Grande Interfase - CSGI Via della Lastruccia 3 I-50119 Sesto Fiorentino - Florence	Piero Baglioni baglioni@apple.csgi.unifi.it
Istituto Motori - CNR Viale Marconi 8 I-80125 Napoli	Patrizio Massoli p.massoli@im.na.cnr.it
AB Fortum Värme samägt med Stockholms stad Tegeluddsvägen 1 S-11577 Stockholm	Eva-Katrin Lindman eva.katrin.lindman@fortum.com
Vapo Oy PL 20 FIN-40101 Jyväskylä	Timo Nyrönen timo.nyronen@vapo.fi
ETA - Energia Transporti Agricolture S.r.l. Piazza Savonarola 10 I-50132 Florence	Gianluca Tondi gianluca.tondi@etaflorence.it

Objectives

- Generation of process **performance data** (proof of a concept) of pilot-scale **pyrolysis liquid (PL) production**.
- Defining three classes of preliminary PL **fuel specifications**.
- Generation and reporting of **performance and emission data** of various boilers **in long term tests**. Three sizes of boilers are used: 2-10 MWth, 0.2 - 1 MWth, and 10-20 kWth. Generation of **fundamental PL combustion data** to assist in developing higher quality fuels with less emissions is performed.
- **Improving PL fuel quality** in PDU-scale. The fuel properties, which need most development, are homogeneity, stability, solids content, pH, heating value, and viscosity. Two main technologies are studied: emulsions and hot vapour filtration (HVF).
- **Improving economic competitiveness** of the bioenergy chain. The target is to be able to produce close to fuel oil prices (October 2002 price for light fuel oil without taxes in EU was about 8 Euro/GJ, or 28 Euro/MWh), and to compete with other renewable alternatives (chips, wood pellets).