

An integrated network on thermal biomass conversion for power, heat and transport fuels

ThermalNet Final Report

Work Package: 3.D

WP Title: Environment, Health & Safety

WP Leader: CIRAD (Philippe Girard)

HSE issues related to **pyrolysis, gasification and combustion of biomass.**

- Create and improve awareness that HSE is important in order to reduce objections against the use of biomass
- Establish a “state of the art procedure” to assess and avoid risks in gasifier plants
- Harmonise and accelerate the permitting procedure in small scale gasification
- Assess toxicity and eco-toxicity of pyrolysis liquids
- Support the development of guidelines for safe and eco-friendly biomass technologies
- Disseminate knowledge on how to reduce the emissions, with a focus on biomass combustion on PM10 and NOx

WP 3D

Work Programme

- State of the art review
- Environment, health and safety issues assessment in gasification : plant case studies
- Elaborate a General framework of a risk assessment methodology
 - » manufacturers survey/discussions, workshops
 - » Small scale gasifier only (<5 MWth)
 - » **Support H&S guideline elaboration** (in collaboration with gasification guide project)
- Assess tar/bio-oils biodegradability

State of the Art

Introduction

- In biomass gasification and pyrolysis, the state of the art is low regarding risk assessment and risk reduction & harmonisation in HSE regulation.
- State of the art of these topics was collected in close collaboration with IEA Task 33 and the Technical University of Graz. TU Graz was the leader of a previous Austrian HSE project.

HSE ThermalNet / IEA 33 Workshop in Innsbruck, September 2005 (www.gasnet.uk.net).

GASIFICATION

State of the Art

Emission regulations

Country	CO [mg/Nm ³]	NO _x [mg/Nm ³]	Ref. O ₂ %
Denmark	3000 (1900)	550	5 (11)
Germany	250 (155)	400	5 (11)
Netherlands	50	130	11
Switzerland	650 (405)	400	5 (11)
Italy	350	500	11
United Kingdom	50	400	11
Portugal	1000	-	?
Austria	650 (405)	400	5 (11)
Sweden	250 (166)	-	6 (11)
Spain	625	-	-
Belgium	250	400	11

Source H.A.M. Knoef
HSE of Biomass Gasification,
International Workshop, Innsbrück

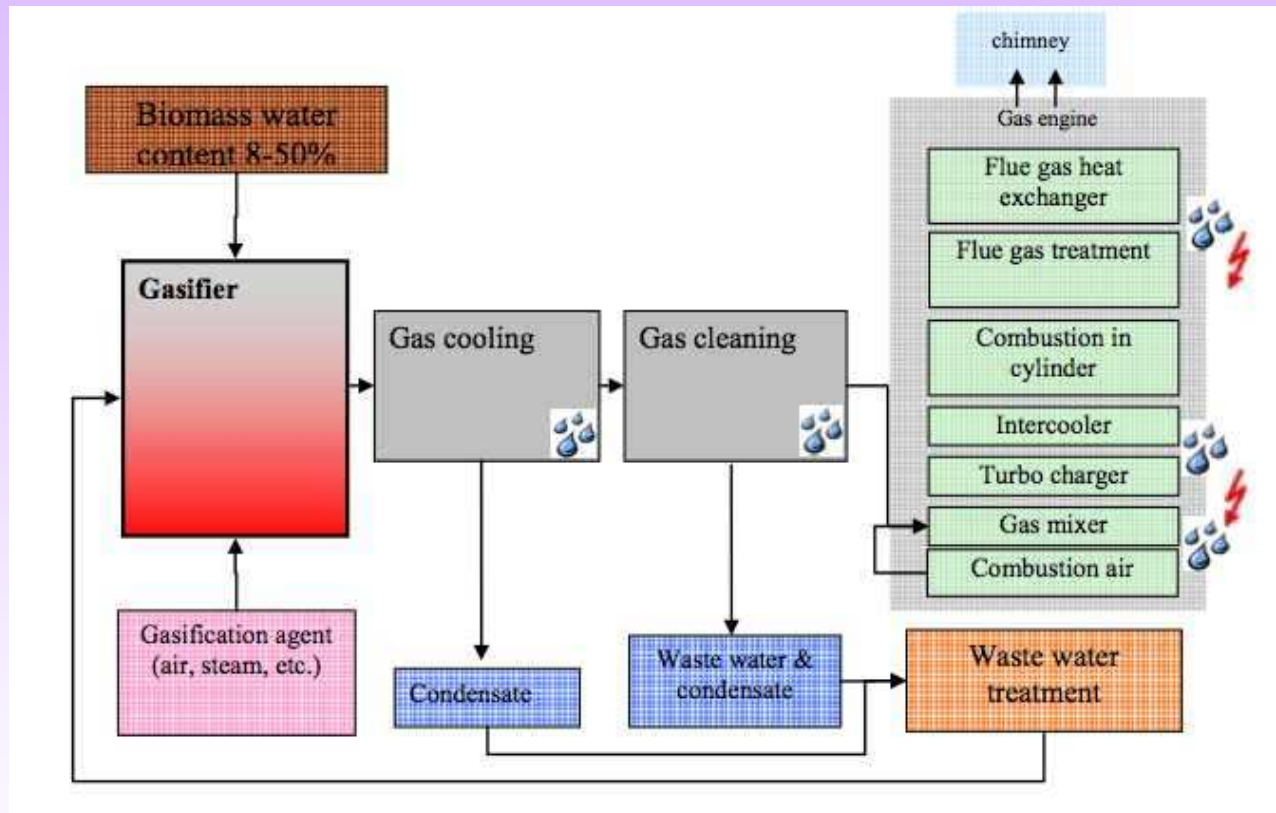
Wide range of emission limits for gas engines, which use gas from biomass gasification.

→ **necessary to harmonize the emission regulations.**

GASIFICATION

State of the Art

waste water



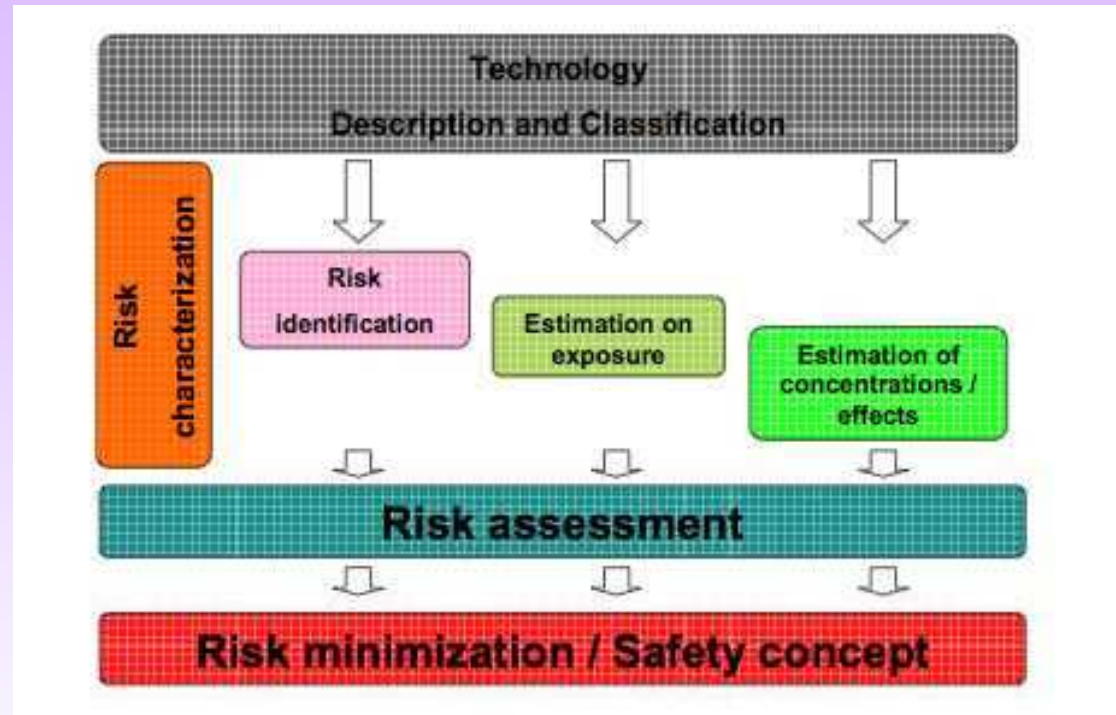
Source R. Rauch
HSE of Biomass Gasification,
International Workshop, Innsbrück

- Waste water can contain toxic organic and inorganic substances.
- Figure shows many possible points in a biomass gasification plant where condensation may occur and contaminated waste water might be produced.

GASIFICATION

State of the Art

Risk Assessment and Risk Reduction

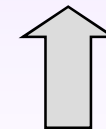
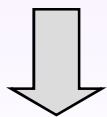


Source H. Timmerer, F. Lettner
HSE of Biomass Gasification,
International Workshop, Innsbruck

EX TEST	$P_{max, 20^{\circ}C}$	$P_{max, 100^{\circ}C}$
	[bar _{abs}]	[bar _{abs}]
Mixture I	8	6,5
Mixture II	6	5

maximum explosion pressure on
gas composition and gas
temperature of the producer gas

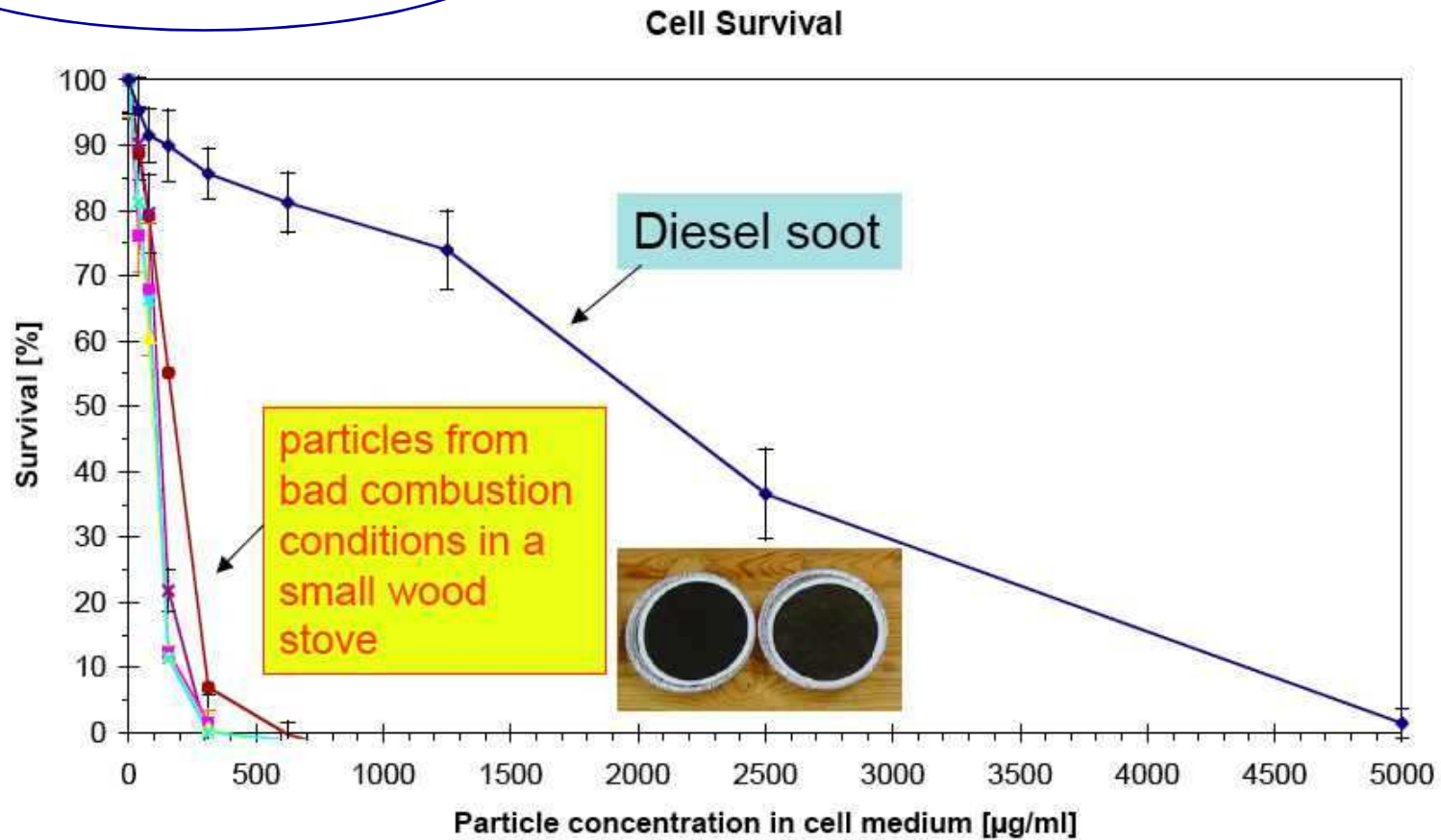
overview of principles and systematic in general for the
possible risk assessment approach



For a reliable assessment of the explosion and fire risks in biomass gasification plants, the explosion parameters of the produced gas must be known.

COMBUSTION

State of the Art



Cell toxicity particles from bad combustion in a small wood stove is largely higher than diesel soot
Toxicity (Nussbaumer)

PYROLYSIS

State of the Art

- Increasing interest in pyrolysis technologies and bio-oils
 - greater demand for the transportation of the liquids, by all possible routes (air, road, rail and sea or combination).
- Need of improved knowledge on bio-oil biodegradability in order to provide a basis for the understanding of their environmental impact in case of accidental spillage or release into the environment.

PYROLYSIS

Results

- BioTox project : evaluation of toxicity, eco-toxicity and biodegradability of bio-oils (standard methods).
 - > no eco-toxicity, better biodegradability than fossil fuels, but mutagenic.
- Comprehensive documents (www.thermalnet.co.uk) :
 - appropriate transportation code for pyrolysis liquids,
 - procedures for the treatment of spills,
 - guide for the preparation of samples for shipment.
- New tests have been performed to test the biodegradability in seawater :
 - adaptation of a protocole (Courtes et al.) using synthetic seawater to allow reproducibility
 - Series of tests with 3 different bio-oils
 - Results indicated no or insufficient activity of bacteria
 - Additional tests are required to improve the protocole

GASIFICATION

Results

Risk assessment methodology

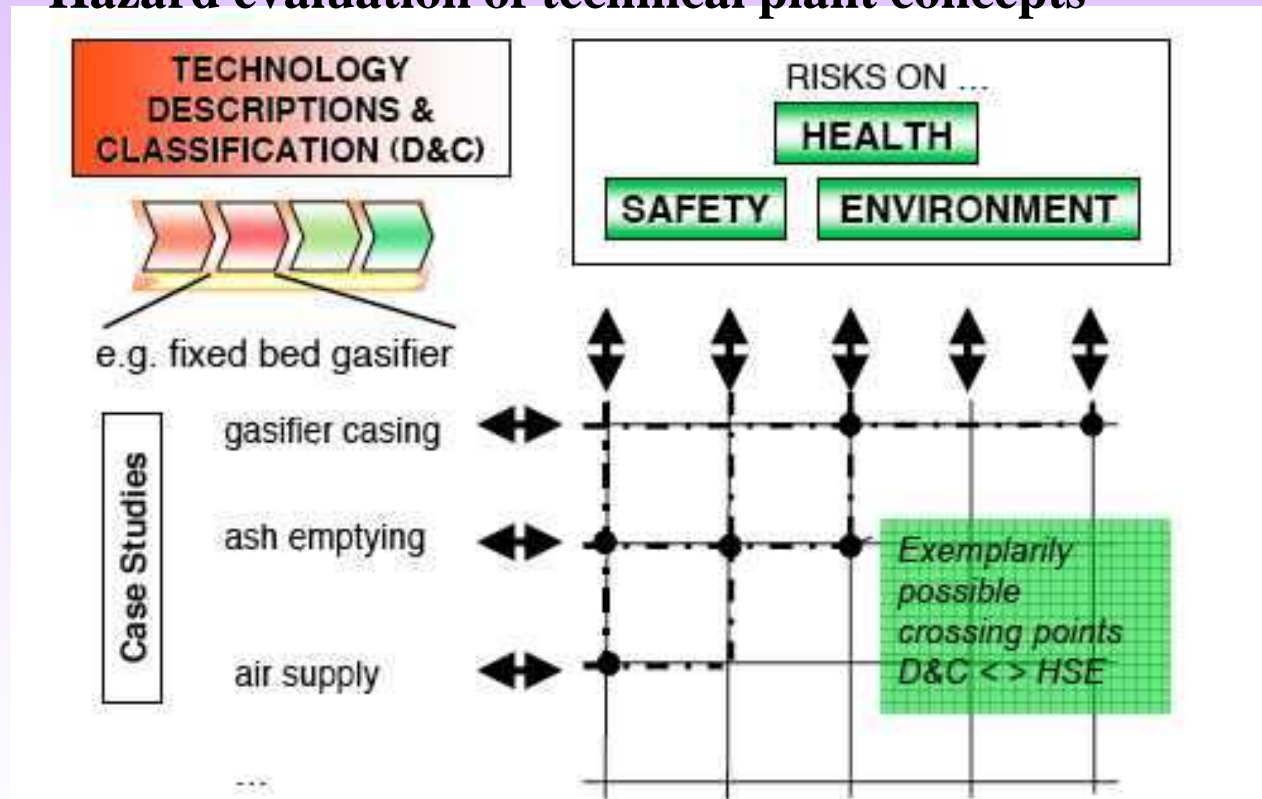
→ Theoretical aspects of the risk assessment are described in chapter 4 of the draft guideline

GASIFICATION

Results

Risk assessment methodology

- Hazard evaluation of technical plant concepts



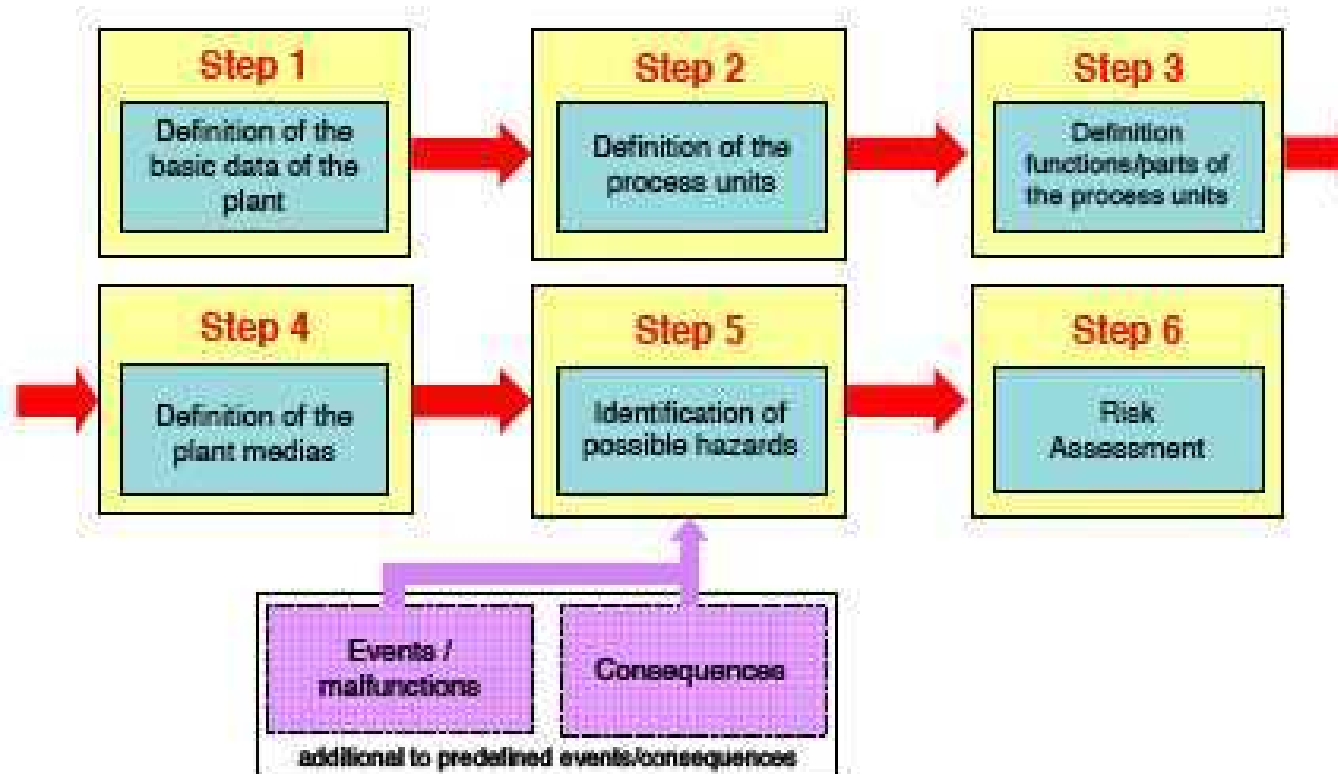
An important step was to get a complete list of possible HSE dangers.

GASIFICATION

Results

Risk assessment methodology

- Hazard evaluation of technical plant concepts
- Different steps of hazards identification and risk assessment



GASIFICATION

Results

- **Risk assessment methodology**
 - Hazard evaluation of technical plant concepts
 - Different steps of hazards identification and risk assessment
- **Review of environment and emissions regulations within all 25 EU member states**

- **Risk assessment methodology**
 - Hazard evaluation of technical plant concepts
 - Different steps of hazards identification and risk assessment
- **Review of environment and emissions regulations within all 25 EU member states**
- **Plant Case Study (4 manufacturers : questionnaires + visits)**
 - Potential hazards and good design principles **in practice**

WP 3D

Conclusions

- Workshop and seminars proceedings, task progress/final reports that review the state of the art and provide recommendations for HSE issues.
- Review of environment and emissions regulations within all 25 EU member states (deliv.).
- Risk assessment and EHS case study in gasification plants
- Help to gasification guide elaboration (collaboration with gasification guide project)
- Tar biodegradability study

Thanks

- Ruedi Bühler for his large contribution to activities and reportings
- Experts from thermalnet who contributed to workshops
- Harry Knoef and gasification guideline project actors
- For your attention