

Allothermal gasification of high ash coals

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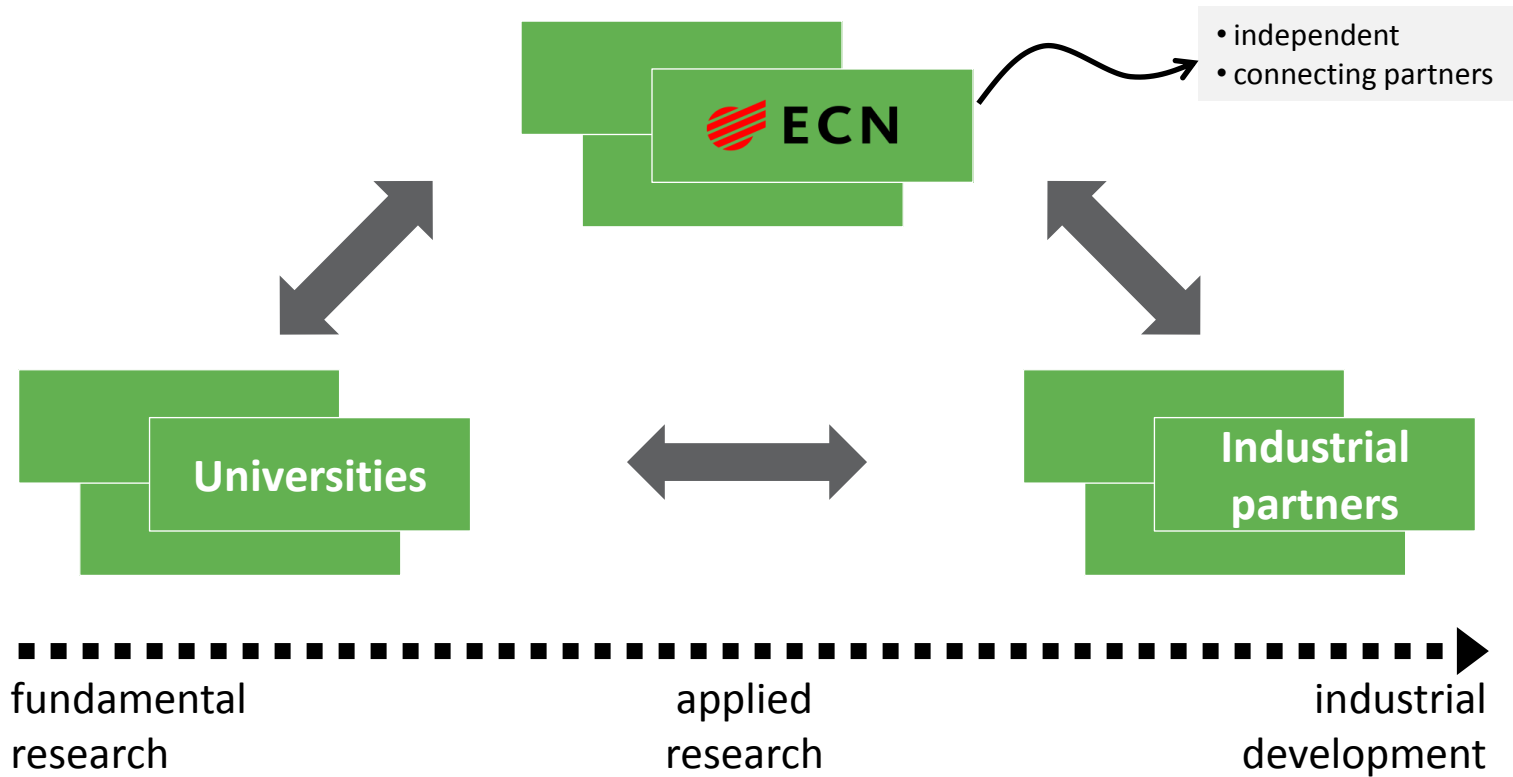
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Rotterdam 2-3-2014

Content

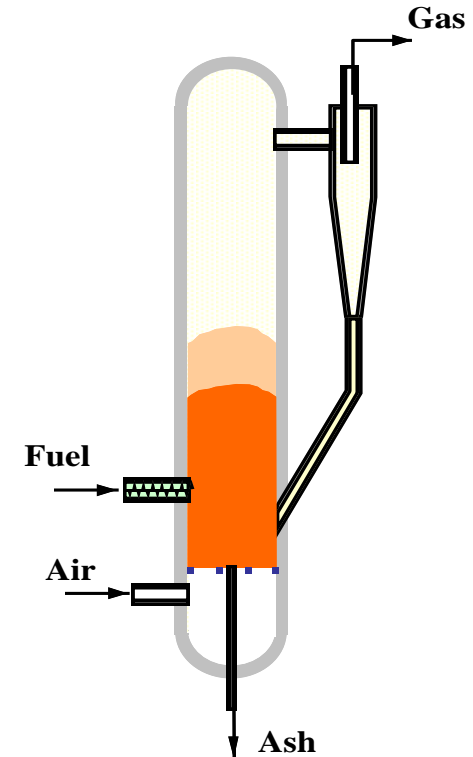
- Something about ECN
- Fluidized Bed Gasification
- Allothermal Gasification
- ECN MILENA for biomass gasification
- ECN i-MILENA for high ash coal gasification
- Test results
- Promising configurations / applications
- Further development of the i-MILENA for high ash coal
- Conclusions / outlook

Position



Fluidized Bed Gasification

- Proven technology
- Typical 850°C - 1000°C, pressurization possible.
- Air blown or steam / oxygen mixtures.
- Scale > 5 MW_{th}.
- Hydrocarbons in the gas, some tar in gas.
- Fuel flexible (also used for waste and biomass)
- No fine milling required.
- Incomplete fuel conversion.
- Examples: ThyssenKrupp HTW, TRIG, U gas – SES.
- Better suitable for high ash coals than EF
- In competition with fixed bed.



Allothermal Gasification

combustion:

+ air ($\lambda > 1$) \rightarrow flue gas + heat

Pyrolysis / gasification:

fuel + heat \rightarrow gas + char

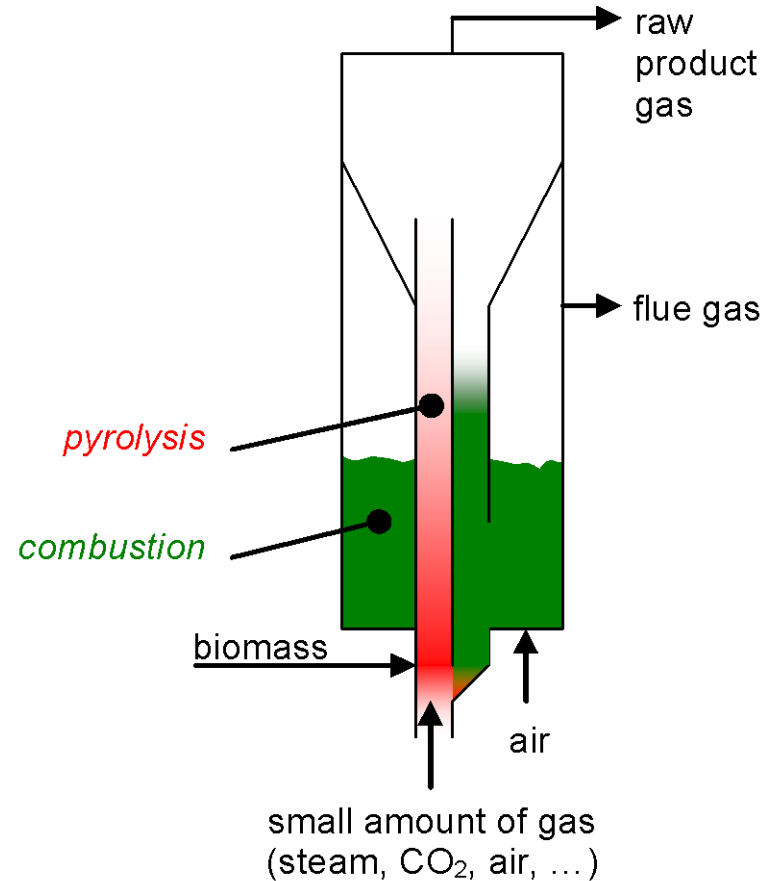
allothermal gasification:

fuel + air ($\lambda \sim 0.3$) \rightarrow gas + flue gas

electricity, heat, fuels, SNG,
chemicals, H₂, products

ECN MILENA Biomass Gasification process

- Fluidized bed gasification
- Temperature level: 850°C
- Product gas contains methane, ethylene, benzene and tars
- Complete conversion of the fuel
- No carbon in the ash
- High efficiency
- Very little nitrogen in producer gas
- Heat transfer through bed material
- One single vessel: compact design
- Fuel flexible: wood, RDF, lignite, sunflower husks, etc.

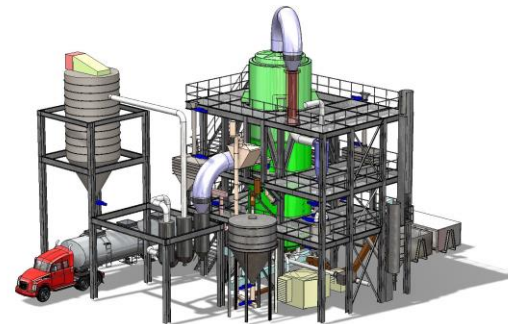
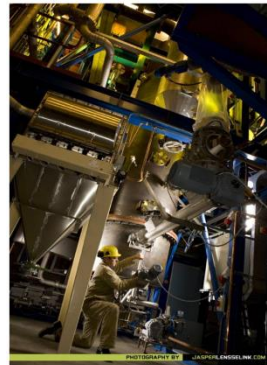


Present status MILENA for biomass gasification

- Lab-scale installation since 2004, Pilot plant since 2008

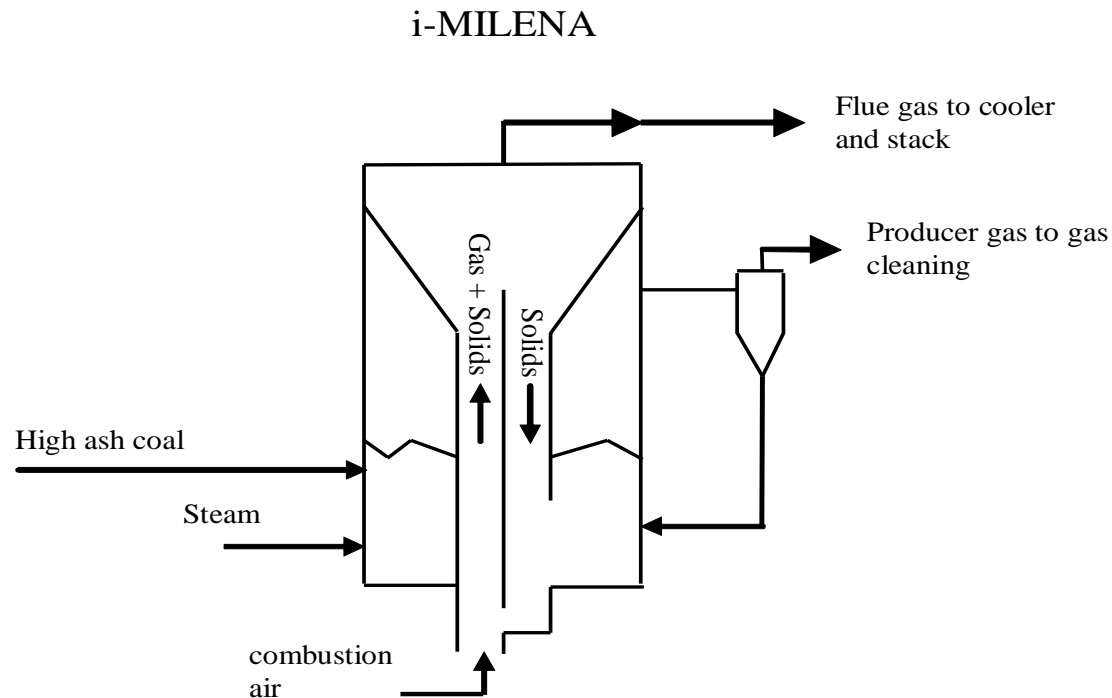
Several demonstration projects in preparation:

- Alkmaar Bio-Methane demonstration
- ETI – RDF gasification, 1st phase (pilot plant tests) finalized
- India, 1 MWe gas engine (MILENA gasifier + OLGA tar removal), under construction



i-MILENA for high ash coal

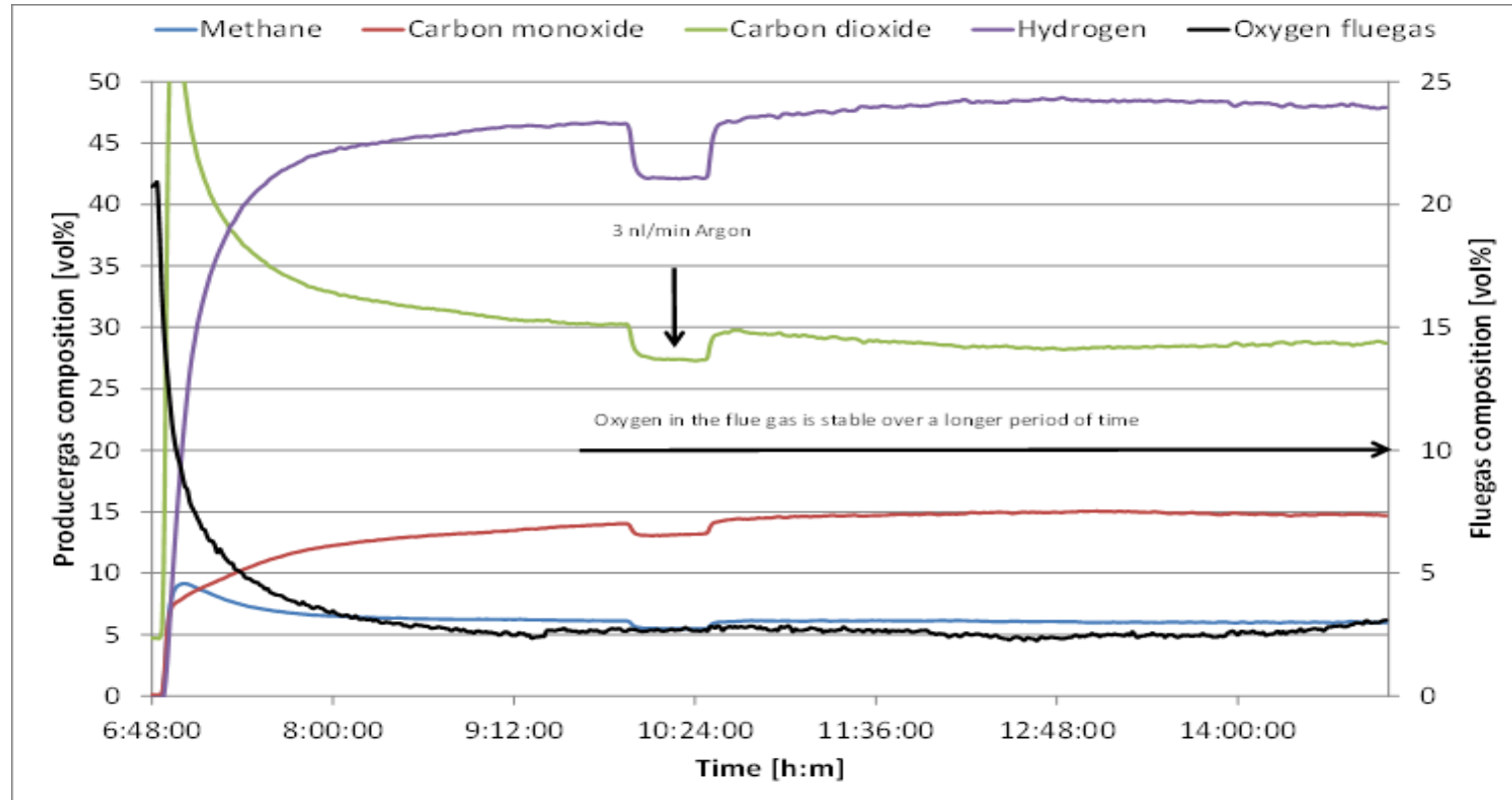
i-MILENA gasifier for high ash coal



Tests

- Extensive testing done in 2012 & 2013 as part of the Optimash project
- Several high ash coals tested
- Ash content over 50%
- Ash of coal used as bed material
- Gasifier connected to gas cleaning section (OLGA)

Measurement data using high ash coal (> 50 wth% ash)



Measurement data using high ash coal (> 50 wth% ash)



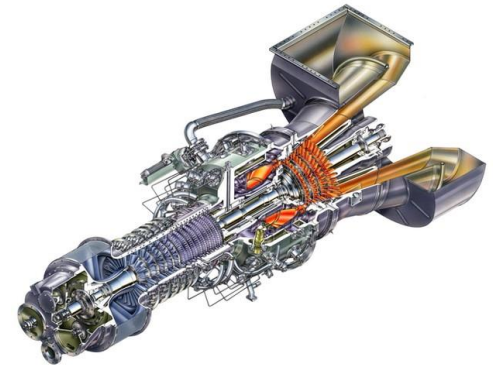
	01-05-2012	02-05-2012
CO (vol%)	17.8	14.9
H ₂ (vol%)	47.2	48.3
CO ₂ (vol%)	28.1	28.5
CH ₄ (vol%)	5.1	6.0
N ₂ (vol%)	2.7	2.6
C ₂ H _y (vol%)	0.7	1.3
C ₆ H ₆ & C ₇ H ₈ (ppmv)	2900	3200
H ₂ S & COS (ppmv)	4050	4900
Tar (mg/Nm ³)	n.m.	9066
Combustor temp. (°C)	903	889
Gasifier temp. (°C)	888	853
O ₂ combustor (vol%)	3.2	2.5
CO ₂ combustor (vol%)	14.6	16.1

Bottom ash



Foreseen applications

- (Co-)firing in boilers, scale $> 1 \text{ MW}_{\text{th}}$.
- Gas engines for combined heat and power production, limited tar removal required, scale 2 – 20 MW_e .
- Combined Cycles using gas turbines for power production, tar removal required, scale $> 6 \text{ MW}_e$.
- SNG production, preferably in combination with CCS, tar removal required, scale $> 100 \text{ MW}_{\text{th}}$.



Conclusions & Outlook:

- Tests showed that the i-MILENA is able to produce a medium calorific value producer gas without the need for an air separation unit (ASU).
- The overall carbon conversion is close to 100% (grey / white ash)
- Operated at low temperature, no ash melt.
- Simple gasifier, also suitable for small scale applications (<100 MW), low investment cost.
- High overall efficiency because of low operating temperature and complete conversion. CGE approx. 70%, which is relatively high for low grade coal.
- Next step in development: Pilot scale durations tests and preparations for demo plant with commercial partner.

THANKS FOR THE ATTENTION

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publications: www.ecn.nl/publications

fuel composition database: www.phyllis.nl

tar dew point calculator: www.thersites.nl

IEA bioenergy/gasification: www.ieatask33.org

Milena indirect gasifier: www.milenatechnology.com

OLGA: www.olgatechnology.com / www.renewableenergy.nl

SNG: www.bioSNG.com / www.bioCNG.com

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