Basis of Design

CPD 3309

Design of a life-cycle chain from biomass to syngas through large-scale of gasification

Team members:
M.E. Djatmiko
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6 August 2004

Instructors:
Ir. P.L.J. Swinkels
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J.W. Coppelmans
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Coach:
Dr. P.J. Kooyman

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- BOD
- Tools
- Evaluation
- Conclusion
- Recommendation

Basis of Design:

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6 August 2004

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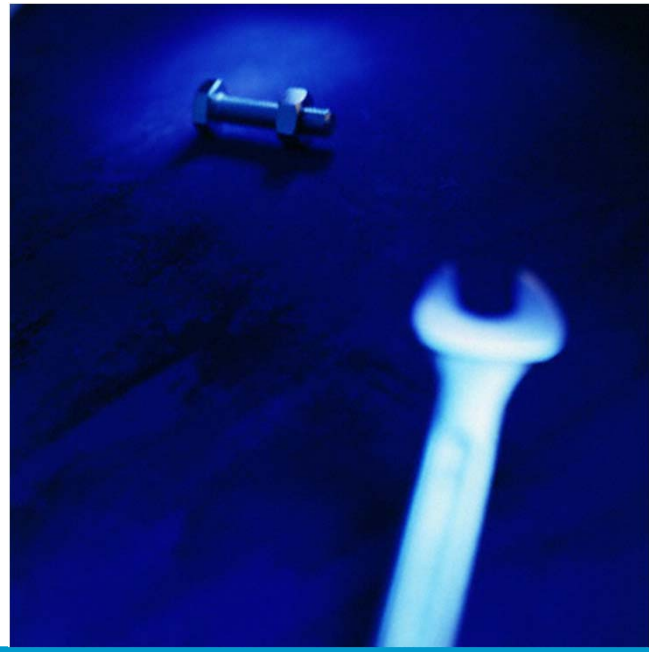
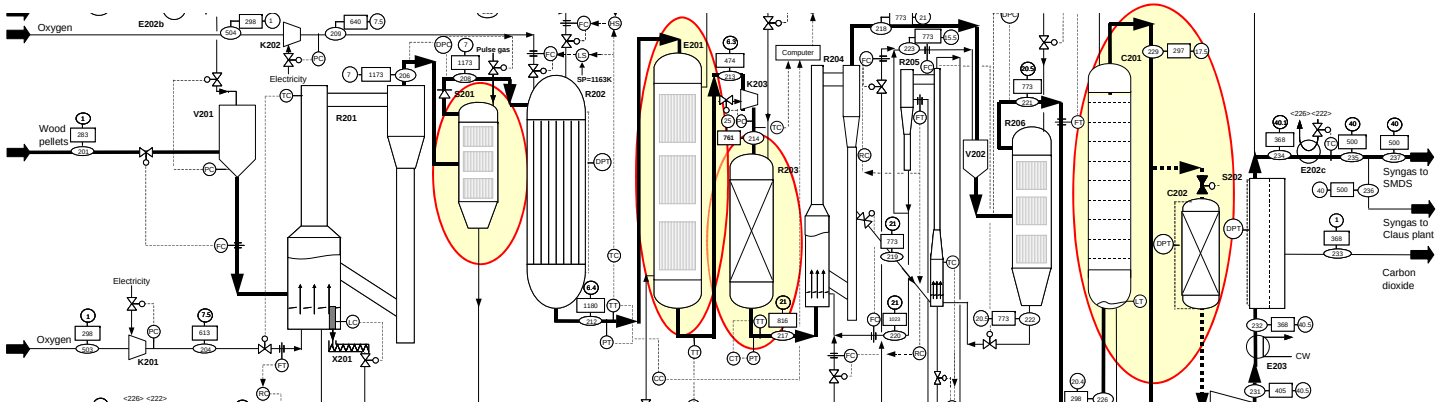


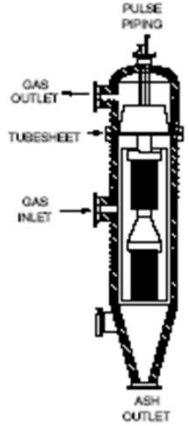
Evaluation

Several unit operations differ from the winning case of SUSDAT.

The Basis of Design differ in:

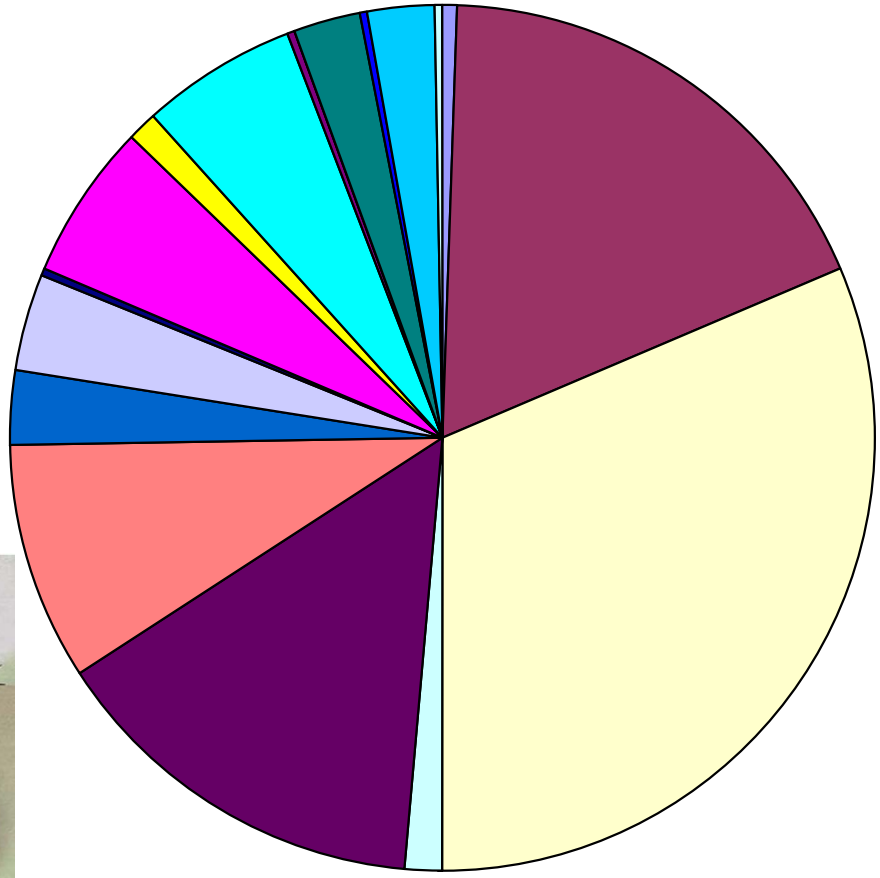
- Cyclone → Candle Filter
- Syngas cooler for high heat transfer
- WGS after hot gas cleaning → Sour WGS before desulphurizers
- ‘Hot gas cleaning’→ NH_3/HCl scrubber + active coal filter
- Low pressure (1 bar) → Moderate pressure





Evaluation

Major Equipment Cost Review



- Chipper
- Pelletiser
- Circulating Fluidised Bed
- Candle filter
- Monolith Tar Cracker
- Sour Water-Gas Shift Reactor
- Bulk desulphuriser + regenerator
- Ultra desulphuriser
- Ammonia/HCl Scrubber
- CO2-selective Membrane
- Compressor
- Air separation plant
- Claus plant
- Waste water treatment
- Steam turbine
- Storage tank
- Syngas cooler
- Active coal filter bed

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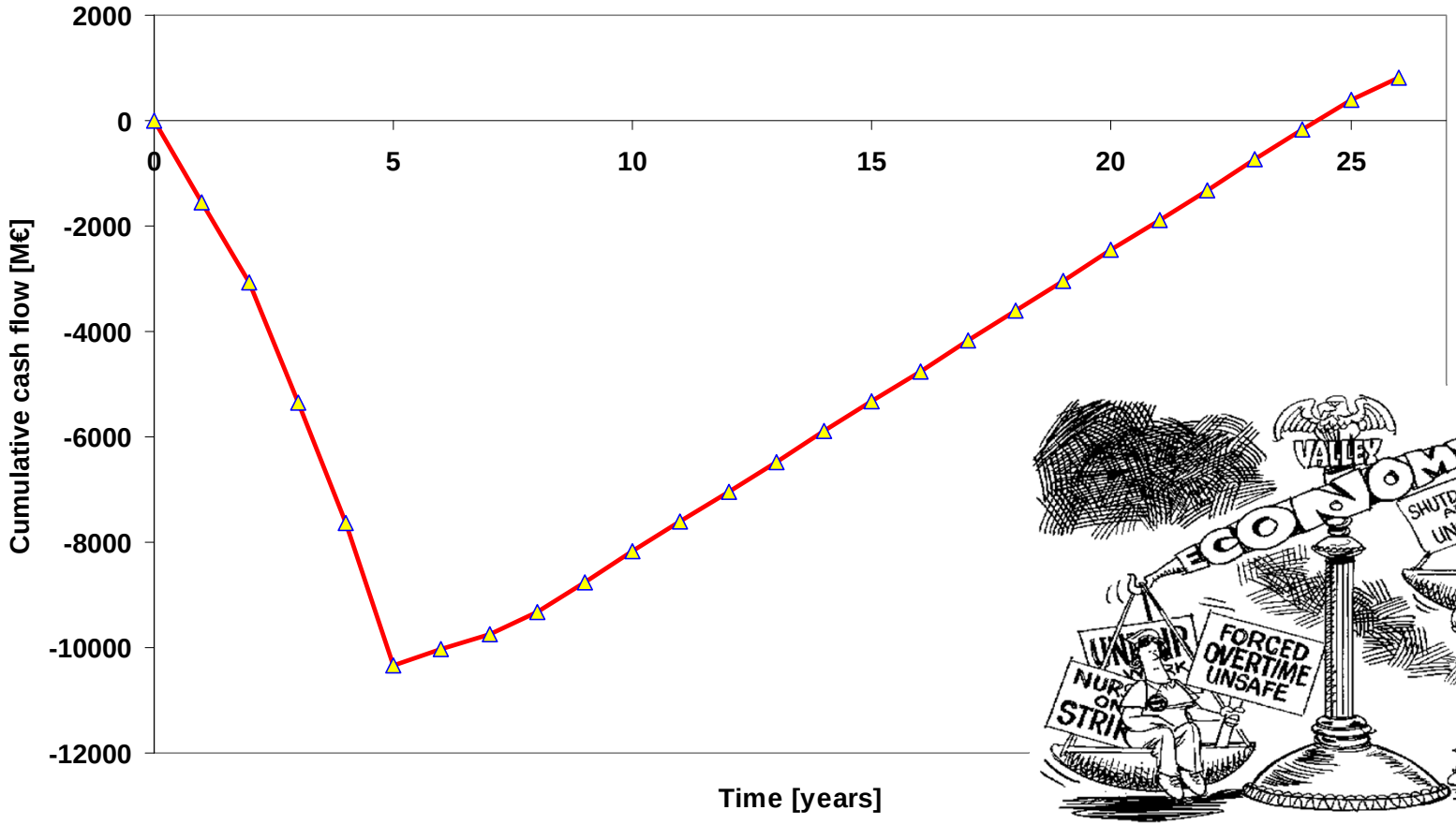
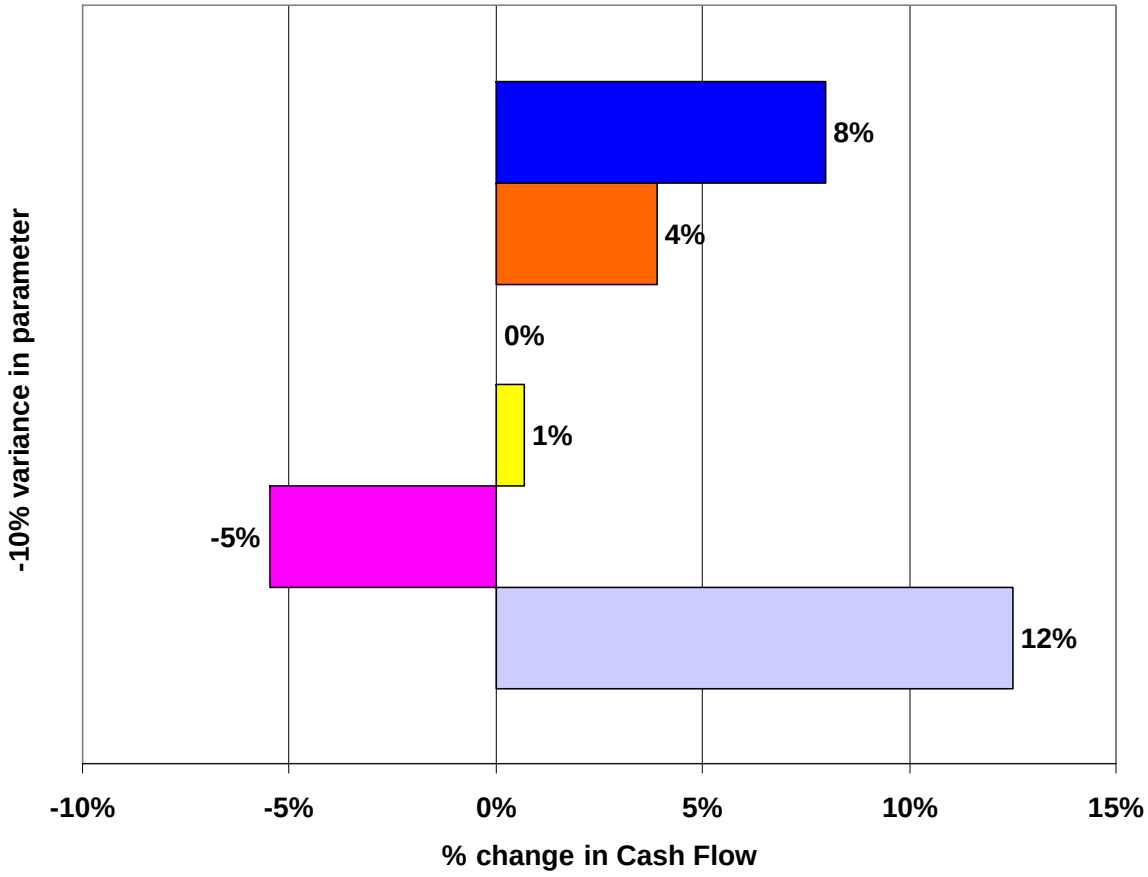
Evaluation

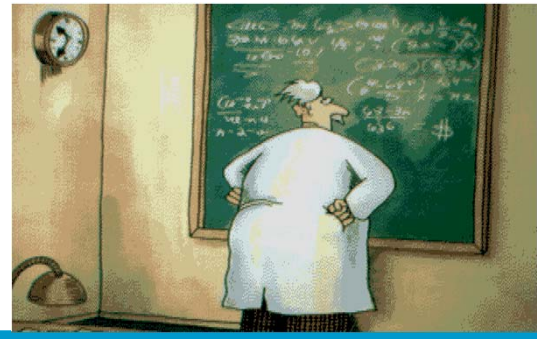
Project cash-flow diagram



Evaluation

Sensitivities Analysis

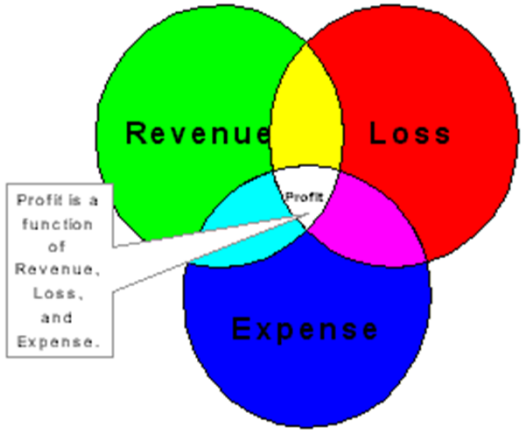




Evaluation

Proposed Cost Reduction

- A decrease in major equipment cost
- An increase in syngas price
- Income from selling CO_2 allocation
- A decrease in capital charges
- An increase in plant energy efficiency
- Taxes reduction and more governmental contributions



Evaluation

- Sustainable design
- Large capacity
- Less waste compared to normal refinery
- Diesel future standards
- Robust due to two separate trains of process

Achieved with:

- Sustainability tools
- Group creativity methods
- Experts and excursion

Evaluation

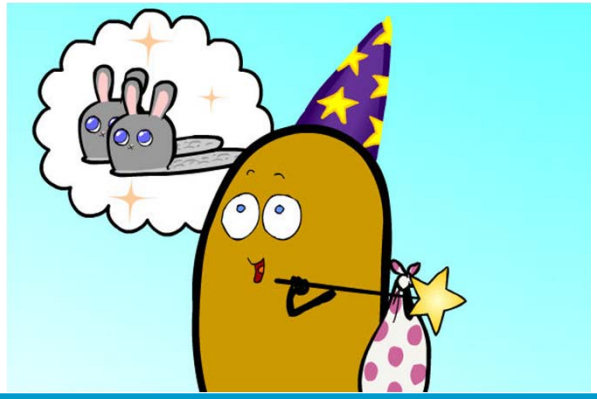
Conclusion

- High-quality and robust design, because the specification from the clients is accomplished

Impurity	Removal Level	Achieved level
H_2S + COS+ CS_2	< 1 ppmV	998 ppbV
NH_3 + HCN	< 1 ppmV	625 ppbV
HCL + HBr + HF	< 10 ppbV	9 ppbV
Alkaline Metals	< 1ppbV	Essentially zero
Solids (soot, dust, ash)	Essentially completely	Essentially zero
Organic compounds (tars including BTX)	Below dew point	Below dew point
Class 2 tars: phenol, pyridine, thiophene	< 1ppmV	~ 0
Objectives	**Desired level**	**Achieved level**
Production rate	334 kg/s	340.9 kg/s
H_2/CO ratio	2	2.0
Inerts	below 5%	3.5%

Recommendation

- Synergy with the surrounding plants in the “Tweede Maasvlakte”
- Improving the economic feasibility by CO_2 sequestration and governmental contributions (taxes)
- Flexibility of the gasification towards the feedstock
- Kinetic modelling for CFB and monolith tar cracker



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