COAL TO WOOD PELLET CONVERSION

OPTIMIZING WOOD PELLET TRANSPORTATION BY CFD SIMULATION

BY
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PROJECT DIRECTOR
OVERVIEW

- Ramboll in brief
- Which areas does a bioconversion affect?
- Optimizing biomass handling by simulation
  - Tools
  - Case study
- Conclusion
RAMBOLL IN BRIEF

- Independent engineering and design consultancy and provider of management consultancy
- Founded 1945 in Denmark
- +13,000 experts
- +300 offices in 35 countries
- Significant presence in the Nordics, North America, the UK, Continental Europe, Middle East, Asia, Australia, South America and Sub-Saharan Africa
- EUR 1.5 billion revenue
- Owned by Ramboll Foundation

Services across the markets:
- Buildings
- Transport
- Planning & Urban Design
- Environment & Health
- Water
- Energy
- Management Consulting
POWER ENGINEERING SERVICES – CONCEPT TO OPERATIONS

LIFE EXTENSION
- Remnant life assessment
- Life extension & plant upgrade evaluation
- Tendering
- Project management
- Site supervision

PROJECT DEVELOPMENT
- Feasibility studies
- Conceptual design & FEED
- Contracting strategy
- Tender document preparation
- Tender evaluation

O&M SUPPORT
- Specialist technical support
- Online process optimisation
- Outage planning & management
- Training
- Trouble shooting & root cause analysis

ENVIRONMENTAL SERVICES
- Due diligence
- QA and inspections
- Health & Safety
- Detailed design/FEED
- Specialisms

OWNERS ENGINEER & EPCM
- Project management
- Design Review
- Interface management
- Factory inspections
- Site supervision
- Performance guarantee tests
Coal to biomass conversion

Performance achievable:
85 – 100%
Of Maximum Continuous Rating

Emissions:
CO2 reduced by >90%
SO2 significantly reduced
NOx reduced by >50%

+ 25 more, related projects like wood pellet import terminals, e.g. Immingham, Gladstone, Avedore, Port of Tyne
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NEW FUEL MEANS NEW CHALLENGES & OPPORTUNITIES

Performance issues
- Milling throughput
- De-rating
- Slagging

Storage
- Stores
- Transportation
- Dust management

Safety
- Dust explosion mitigation measures
- Fire prevention, detection & control systems

Emissions reductions!
CO2, SO2, NOx
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Emissions reductions!
CO2, SO2, NOx
BIOCONVERSION - SOLUTIONS & ADAPTATIONS

- Major modifications:
  - Fuel transport and storage
  - Fuel preparation (feeding and milling)
  - PA system

- Other areas:
  - Fuel combustion (PF-tubes and burners)
  - Flue gas treatment

- Bio fuel combustion may though give rise to other types of problems than those seen with coal combustion
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BIOCONVERSION - SOLUTIONS & ADAPTATIONS

Is it possible to use the existing coal conveyor systems?

Solution:

Optimizing the conveyor system - by use of 3D-MODELLING AND NUMERICAL SIMULATION
OPTIMIZING BIOMASS HANDLING

CONTENTS

- Transfer design in brief – typical flaws and means of optimization
- Benefits of using DEM/CFD simulation
- Implementing design using 3D-scanning
- Case study
Main components of conveyor transfer for dusty products

- **Feed belt**
- **Receiving belt**
- **Chute**
- **Dust settlement zone**
- **Filter and dust feed**
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**OPTIMIZING BIOMASS HANDLING TOOLS - NUMERICAL SIMULATION**

- **DEM** *(Discrete Element Method)*
  - Simulation of particle movements

- **CFD** *(Computational Fluid Dynamics)*
  - Simulation of fluid dynamics, heat transfer, combustion etc.

- **Combined** DEM and CFD
  - Simulation of the interaction between particles and fluids

- **Calibration in our test lab**
As designed  

As is  

Basically 3D-scanning can save designers, employers and contractors tremendous amounts of time and money
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OPTIMIZING BIOMASS HANDLING
CASE STUDY - CONVEYOR OPTIMIZATION

Project objective:
- Increase wood pellet logistic capacity to account for increased wood pellet consumption
- Reduce dust emissions

Ramboll scope of services
- Conveyor plant baseline analysis
- Concept development and scope definition
- Transfer design and simulation
- 3D-scanning and point cloud modelling
- Review on contractors detail design
- General OE services
Scope:
1. Screening transfer UED09
2. Conveyor transfer UEDLL
3. Belt to silo transfer EAC70
4. Silo discharge belt feeder EBA19
5. Conveyor transfer UED29
6. Conveyor transfer UED39
7. Conveyor transfer UED59
8. Conveyor transfer UED69
OPTIMIZING BIOMASS HANDLING
BEFORE AND AFTER – ADAPTATIONS

Implementations:
- Guide vane added
- Spillage conveyor added
- Chute redesigned
- Filter capacity increased – spot filters removed and transfer connected to central filter
- Dust settlement zone and impact bars added
OPTIMIZING BIOMASS HANDLING
BEFORE AND AFTER - OPERATION
BULK SOLIDS HANDLING
DUST HANDLING & FILTER LOADING
OPTIMIZING BIOMASS HANDLING
CASE STUDY - CONVEYOR OPTIMIZATION

Scope of works:

- 7 conveyor transfers refurbished, including
  - Guide vanes
  - Chutes
  - Dust settlement zones
  - Impact bars
  - Spillage conveyors

- Disc screen modified
  - Guide vane
  - Disc speed reduced
  - Chute
  - Internal dust extraction
  - Filter ducting modified
  - Explosion safety concept and measures revised and modified

- Belt speed of 3 conveyors increased 20%
  - Gears replaced
  - VFD’s added

- 2 dividing gates added
- 2 central filters added
- Pneumatic dust conveying added
- 1 filter refurbished
- 1 customized belt feeder added
- Platforms, instrumentation, insulation, minor civil works etc.
OPTIMIZING BIOMASS HANDLING
BEFORE AND AFTER – ADAPTATIONS AND RESULTS

Implementations:
- Guide vane added
- Spillage conveyor added
- Chute redesigned
- Filter capacity increased – spot filters removed and transfer connected to central filter
- Dust settlement zone and impact bars added

Results:
- Sustainable capacity increased from ca. 380 t/h to +450 t/h
- Drastic reduction of dust emissions
- Reduction of product degradation
- Reduced risk
- Reduced wear
Project status September 2018 after two years of operation:

- Capacity from quay to storage silos increased from ca. 400 t/h to +600 t/h, peaking at 800 t/h. Exceeds business case criteria of 550 t/h

- Capacity from silos to day-silos increased from ca. 380 t/h to 450 t/h, peaking at 500 t/h. Meets and partly exceeds business case criteria of 450 t/h

- Dust emissions significantly reduced
Client benefits

- Significant savings
  - Approx. 15 million EUR saved compared to installation of new conveying system
  - Savings on OPEX, due to reduction in housekeeping and maintenance

- A thoroughly engineered plant that works
  - Which is not necessarily the case when investing in a new plant

- Continuation of existing O&M and procurement routines and utilization of existing inventory
  - As opposed to a new plant, that would require a large amount of staff training and replacement of spare parts, consumables, etc.
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CONCLUSION

Can you re-use existing fuel handling equipment for biomass and still obtain:

- Same plant thermal capacity?
- Fuel flexibility and fast fuel change-over (if required)?
- Increased conveying capacity?
- Reduced dust from fuel handling?

SURE YOU CAN – WITH PROPER CARE AND SMART ENGINEERING!
THANKS FOR YOUR ATTENTION

QUESTIONS?

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