Material selection for a new process

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BL2F

Transforming Black Liquor to Biofuel

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Agenda

- Material selection for industrial process – general
- Material selection for existing process vs material selection for totally new process
- BL2F – New material issues (or what is not new?)
- Experience from material selection – new material type or new process
  - Case 1
  - Case 2
- Material selection for BL HTL
  - Starting point and expectations for the project

Material selection process for industrial plant

- Project size typically millions of Euros
- Commercial plants are delievered with commercial terms
- Warranty, besides mechanical warranty, also availability and performance warranty
- Risk levels are high if there is
  - new equipment
  - new materials
  - new process steps
- In case there is new processes
  - Suitable demo projects are not always available
  - All process issues and especially material issues can not be tested properly in pilot scale
  - Fist deliveries always have some risk
- Risk management is essential

Material selection
Normal case (=existing process) vs totally new process

- Normal case
- Totally new case (like HTL for BL)

Material selection – normal case vs totally new process

- Normal case
  - Why material selection is needed
    - Slight modification of process
    - Longer lifetime
    - Less expensive material
  - How
    - Legislation (PED, product standards, safety)
    - Own experience
      - Previous material selection from same process
      - Previous material selection from similar process
      - Understanding of the environment
    - Literature
    - Databases
    - Material suppliers
    - Existing info from Expert networks, Universities, Institutes…
    - New info from research programs
  - Risks are normally in good control – but risk still exists

Material selection – normal case vs totally new process

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- Totally new case (HTL of BL)
  - Why material selection is needed
    - Need to make a plant for a new process
  - How
    - (Legislation (PED, product standards, safety))
      - Suitable product standard may not be available
    - Own experience
      - ~~Previous material selection from same process~~
      - ~~(Previous material selection from similar process)~~
      - (Understanding of the environment)
    - (Literature)
    - (Databases)
    - (Material suppliers)
    - (Existing info from Expert networks, Universities, Institutes…)
    - New info from research programs
  - High risk level, more work for risk management

BL2F – New material issues (or what is not new?)

Main issue is corrosion in BL in HTL conditions

- What does it mean
  - Corrosion with black liquor in supercritical conditions?
  - Corrosion with end compounds in supercritical conditions?
  - Corrosion with intermediate compounds in supercritical conditions? Do we know intermediate compounds?
  - Corrosion in various locations in reaction chamber and in other parts of the process
    - heat up
    - cool down
- This is all new to us
    - Info of black liquor corrosion above ~220 C not much available
- Related processes
  - Pulp mills, evaporators, recovery boilers
  - Other biomass conversion processes
  - Other HTL, other SC
  - …

Example histories – new materials or new processes

- Note – these are not processes of Valmet Energy BU

Experience from another project - case 1

Replacing old ceramic structure with a metallic structure
Environment with combined wear and corrosion

- Old process, known environment – now use of totally different material group
- Lab phase, several years product development, materials performance ok
- Pilot phase – materials performance ok, operating times ~few weeks
- First full-size customer delivery – materials performance and process performance ok
- Second customer delivery, “similar to the first one” – total failure
  - Expected lifetime several months, experienced lifetime about one week
  - Corrosion due to chemicals used by customer but not known to us – rare corrosion phenomena with new materials
- We were able to find a material solution also for the second customer, but
- If our second delivery would have been the first delivery…
  - There might never have been a second demo, or the product
- Currently, a product for some material variants based on corrosion environment

- There is always risks, when new process or materials are used. Even if you think you know the risks

Experience from another project - case 2

- New biomass conversion process
- Piping between two process stages
  - Mixture of solid product and process fluid
  - Problems with clogging due to solid particle, mixer was added to break the grains
- H_2S was released inside the piping when pulverizing the grains
- H_2S accumulated to upper bend in piping and caused corrosion and leaking
- →Reaction kinetics may cause unexpected change of the corrosion environment
  - There is no equilibrium, it is difficult to predict local environment in all locations
- You may know what goes in and what comes out but corrosion might happen just because of something that exists only in the middle

Status and expectations

- Status and background
  - Batch reactors have faced leaks due corrosion problems – very short times
  - Some oil has been produced from BL in batch reactors
  - Environment (intermediate and final compounds) are not fully known

- Expectations
  - From this project I expect
    - Confirmation that there are materials that can withstand HTL with black liquor
    - Material selection removed from the showstopper list
  - Optimization of material selection and manufacturing methods will take place later
  - Case is challenging – there are many things we do not know yet
    - Corrosion might be one issue that affect process and equipment design

Thank you!

Get in touch with the project:

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