Advances In Sulfonation and Sulfation Technologies

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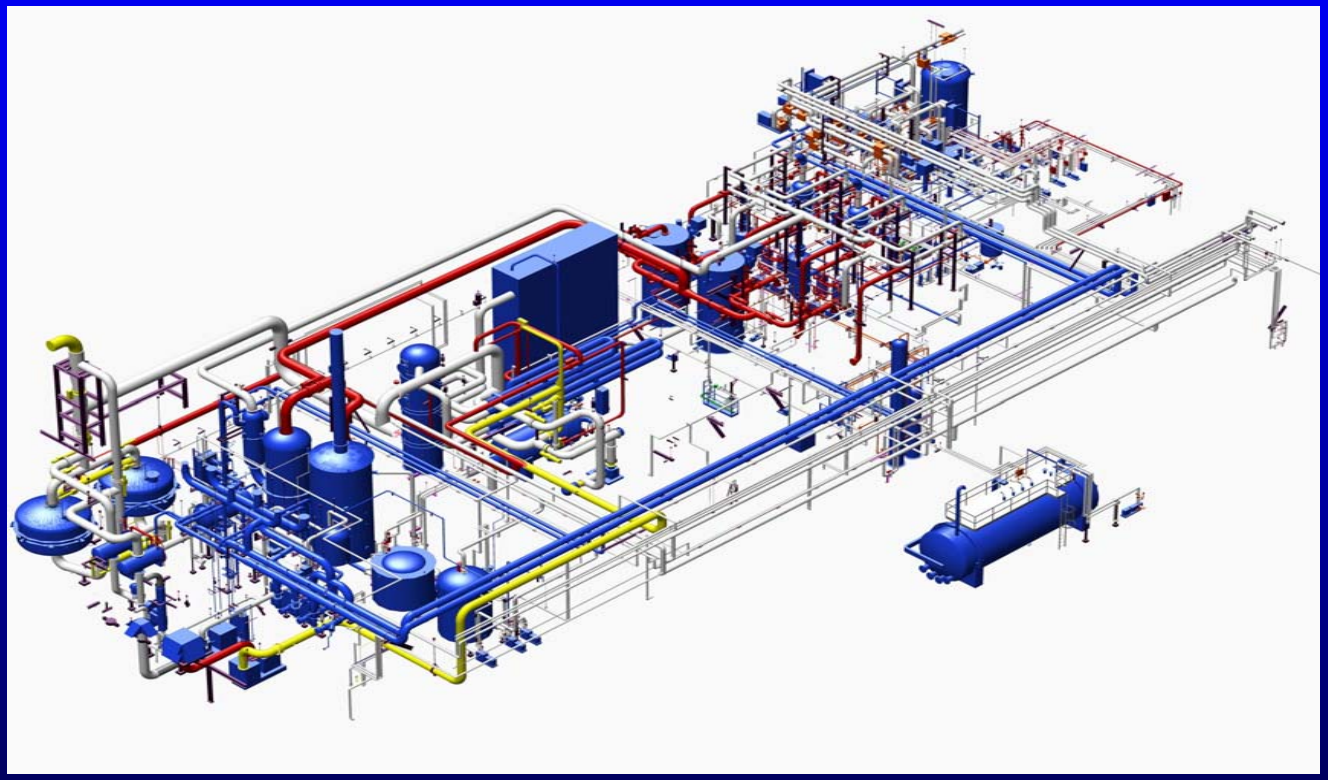
Trends

- Plants becoming larger, regional facilities
- Increased emphasis on operational economics
- More multi-product capability
- High solids production
  - **lower shipping costs**
  - **Increased formulation flexibility**

Trends

20MT Multi-Product Facility in North America

Trends



- Partial Iso for 20MT Multi-Product Facility

Trends

- Green products
  - **methyl ester sulfonates**
  - **alcohol and ethoxylate sulfates**
- Markets are demanding -
  - **wider range of higher quality products**
  - **higher yields**
  - **greater plant reliability**
  - **more automation**
  - **lower waste stream volumes**
  - **higher efficiencies**

Improving Productivity

- **Multiple reactors**
- **Gas flow splitting arrangements**
  - Symmetrical
  - Asymmetrical
- **Variable gas concentrations**

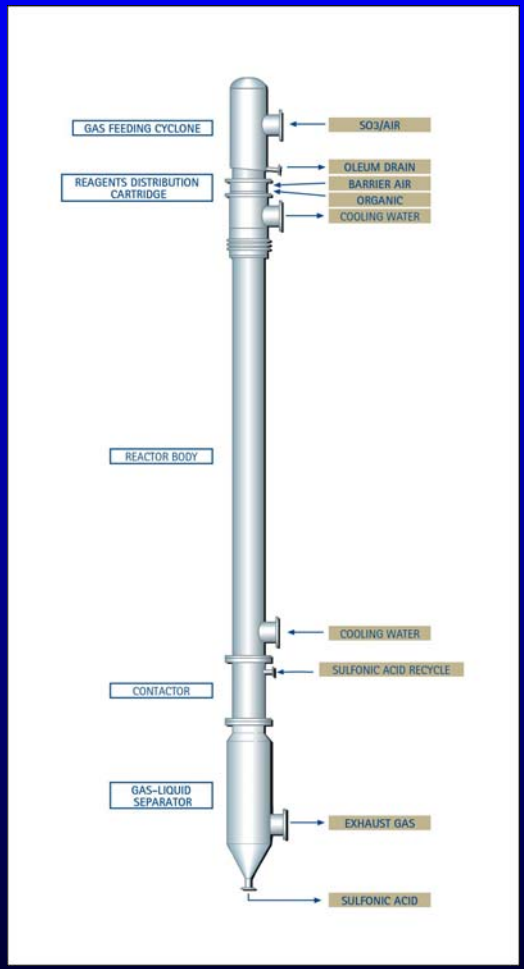
Improving Productivity

- Can use both AFFR and MTR reactors in a single plant to promote flexibility
- Can install inline spare equipment

Improving Productivity

- **“Micro” mole ratio control means**
  - Lower free oils
  - Reduced carryover
  - Better “on stream” factors
- **Reactor distribution design improvements**
- **Post reaction systems**

Improving Productivity



- MTR with reaction distribution cartridge and "post-reaction" contactor section

Energy Efficiency

- **Reducing energy consumption by**
  - Waste heat recovery systems
  - More efficient rotary equipment
  - Longer running/lower maintenance pumps and blowers
  - Turbo Tube® & other drying techniques
- **Energy vs. Yield and Quality**

Energy Efficiency

Waste Heat Recovery Boilers

Energy Efficiency

- **Use of more efficient drying methods such as**
  - Drum Dryer – a “direct contact” type
  - Wiped Film Evaporator – an “indirect” type
  - Flash Evaporator – an “indirect” type
  - Turbulent Convective Evaporation – an “indirect” type

1,4-Dioxane Reduction

- **Upgrading sulfation plants to reduce 1,4-dioxane levels**
  - Basic types for 3:1 reduction
  - Enhanced types for up to 9:1 reduction
- **Replacing older generation reactor designs**
- **Upgrading piping design to reduce 1,4-dioxane formation**

1,4-Dioxane Reduction

- One of the latest type DRS systems
- Can approach a 9:1 reduction ratio

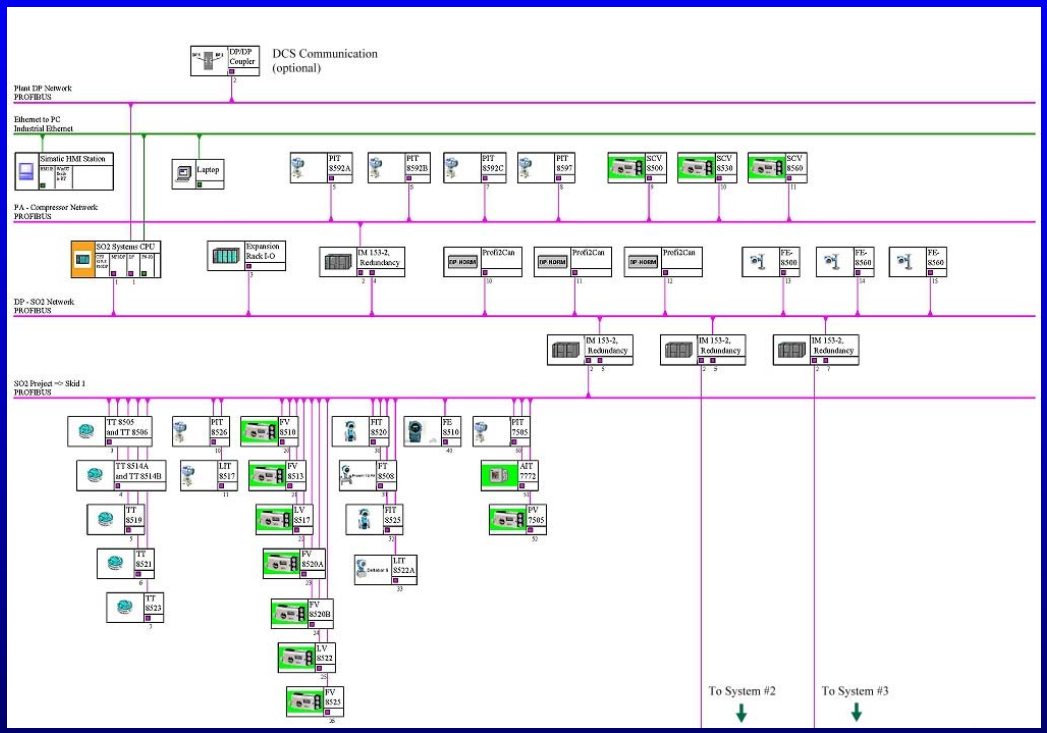
Process Control

- **Upgrading to more modern PLC standards, such as the Allen-Bradley CompactLogix and ControlLogix**
  - Faster response
  - Greater reliability
  - Additional system variables
- **Integration with plant-wide DCS systems**

Process Control

- **Premium program architectures, such as the Profibus-PA or –DP**
  - Single cable/buss type
  - Multi-task capability
  - Layered communications protocol

Process Control



- **Schematic for a Siemens Profibus-PA Multi-System Type**

Co-Actives

- **Active mixtures with synergistic detergent properties superior to a single active**
  - Such as detergency + foaming
- **Often found in LAS and MES mixtures**

Pilot Plant Studies

- Commercially scalable systems from 5 to 20 kg/hr to develop processes and formulation technologies
- Statistical designed experiments for process modeling and optimization

Pilot Plants

5 kg Research Pilot Plant