NORAM Cellchem™ Sulphur Burners

Presented to:
Atlantic PAPTAC
September 19 2019
Edmunston, NB, Canada
Contents

• NORAM Overview
• Technology: Cellchem™ Sulphur Burners
• Case Study: 3 to 12 MTPD Sulphur Combustion Plant
• NORAM Equipment - Photos
NORAM Overview
NORAM Overview

- Privately owned company
- Based in Vancouver, Canada
- Founded in 1988
- Approximately 200 employees
- Focused on providing novel technology, equipment and engineering packages
  - Portfolio of proprietary & patented technology
  - Focus on field execution, commissioning and client responsiveness
  - Proven ability to move technology from lab through to industrial installation
  - Executing projects world-wide
NORAM Overview

- Technology commercialization, engineering and project execution under one roof:

- Business Groups:

  Sulphuric Acid  Nitration  Electrochemical  Biosystems  Pulp & Paper  Environmental

Cellchem™ Sulphur Burner
History of the Sulphur Dioxide technology

1960
First SF Sulphur Burner sold by Celleco in Sweden. Celleco eventually becomes part of Alfa Laval Group.

1960 – 1980
~130 plants sold under Celleco name

1981
Cellchem AB acquires technology and begins marketing Cellchem Sulphur Burner

1981-2012
Cellchem continues to market SF sulphur burner and develops CF sulphur burner, ~40 units sold under Cellchem name. Eventually becomes part of Akzo Nobel and is marketed by Eka Chemicals/Engineering, a division of Akzo Nobel.

2013
Cellchem Sulphur Burner technology purchased by NORAM International AB from Akzo Nobel.
NORAM Sulphur Burners

“Cellchem” line (< 100 TPD sulfur)

NORAM furnaces (up to 1,200 TPD sulfur)

Cyclone Flame (< 8 TPD)

Chemtrade acid plant (100 TPD)

Spiral Flame (4 - 100 TPD)

Sherritt acid plant (350 TPD)
Sulphur Burners

Pulp and Paper  \( \text{ClO}_2 \) for bleaching, bisulfite/sulfite for wood digestion, \( \text{SO}_2 \)-water for neutralization

Sulphuric Acid  \( \text{SO}_2 \) for the production of \( \text{H}_2\text{SO}_4 \)

Food  Colour removal in sugar production

Chlor-Alkali  Bromine removal from sea water

Mining  Slurry contacting for metal oxide reduction and cyanide destruction

Chemicals  \( \text{SO}_2 \) for the production of miscellaneous chemicals and liquid \( \text{SO}_2 \)
Pathways

Sulphur Melting → Molten Sulphur Storage → Sulphur Burning → \( \text{SO}_2 \) Gas Cooling →

- Sulfite
- \( \text{Na}/\text{Mg}/\text{Ca} \) Bisulfite
- 18% \( \text{SO}_2 \)
- \( \text{SO}_2^- \) Water
- Liquid \( \text{SO}_2 \)
- Up to 100% \( \text{SO}_2 \)

Oxygen (PSA/VPSA or cryogenic) → Sulphur Burning → \( \text{SO}_2 \) Gas Cooling
1. $S_x(l) \rightarrow x/y \ S_y(g)$

**Evaporation:** Rate-limiting step in sulphur burning

2. $S(g) + O_2(g) \rightarrow SO_2(g)$

**Oxidation:** Fast, max 21 vol% in air

3. $SO_2(g) + \frac{1}{2}O_2(g) \rightarrow SO_3(g)$

**Oxidation:** Fast, undesirable equilibrium reaction favoured by low temperature

4. $SO_3(g) + H_2O(g) \rightarrow H_2SO_4(g)$

**Hydration:** Equilibrium reaction significant at temperatures below 400°C
NORAM Sulphur Burners

• NORAM provides:
  o Sulphur and Spent Acid Burners
  o CellChem Sulphur Burners (Business line and technology acquired from Akzo Nobel)

• Types of Atomization:
  o Pressure atomization
    ➢ up to ~17% \( \frac{v}{v} \) SO\(_2\) in air
    ➢ 7-12 bar(g) sulphur pressure
    ➢ ~1 mm droplet diameter
  o Air atomization
    ➢ up to ~19.5% \( \frac{v}{v} \) SO\(_2\) in air
    ➢ ~1 bar(g) sulphur pressure
    ➢ 1-4 bar(g) atomization air pressure
    ➢ ~0.1 mm droplet diameter
  o Oxygen enrichment
    ➢ up to 100% \( \frac{v}{v} \) SO\(_2\)
NORAM Sulphur Burners

- Sulphur Burners (Pressure Atomization):
  - Large scale furnaces typically used in sulphuric acid plants
  - Custom designed, cylindrical, horizontal vessels providing high efficiency combustion
  - Furnace residence time typically between 1-3 seconds
  - Internal baffles used for gas mixing (CFD)
  - Robust shell and refractory brick designs are used to ensure longevity of the burner
  - Bricked partitions with arched openings are used as baffle walls
NORAM Sulphur Burners

• Cellchem™ Sulphur Burners (Air/O₂ Atomization):
  o Specifically designed to provide relatively small quantities of SO₂ to a number of industries (0.5 to 100 t/d sulphur)
  o Two types available – spiral flame (SF) and cyclone flame (CF)
  o Energy recovery in the form of steam is possible
  o Advantages of Cellchem Burners include:
    ➢ Fast start-up times
    ➢ Range of SO₂ concentrations produced
    ➢ High turndown ratio
    ➢ Extensive reference list (>180 installations)
• Cellchem Sulphur Burners (Air/O₂ Atomization):
  o Furnace residence time = 0.3-1 seconds
  o Internal mixing grid may be used >18% SO₂
  o “Hot Shell” design to minimize corrosion on steel shell due to acid condensation and to permit the use of carbon steel
  o Smaller furnaces, chemicals industry
**NORAM Equipment – Burners**

- **High Concentration SO₂ Production:**
  - **CELLCHEM™ OXY-SO₂™**
    - High strength SO₂ gas with 3-5% excess O₂.
  - **CELLCHEM OXY-SO₂ PLUS™**
    - High strength SO₂ gas with <0.3% excess O₂.
  - SO₂ gas delivered at pressures up to 6 barg
  - Heat recovery 0 - 60 bar steam
  - Recovery efficiency > 90%
  - 3.7 kg steam per kg of sulphur burned
**Sulphur Burner Temperatures**

Conversion of $\text{SO}_2$ to $\text{SO}_3$ vs. SO$_2$ strength, %
**SO₂ Gas Cooling**

- Hot SO₂ gas (1300°C) from furnace cooled to 40-60°C in direct contact spray cooler

- Bulk of cooling is achieved by evaporation of circulating water, balance of cooling in external plate and frame cooler

- Refractory-lined/specialty alloy inlet duct to minimize corrosion

- Spray system designed to ensure complete wetting of shell to avoid “hot spots”
SO$_2$ Absorption

• Several downstream options for SO$_2$ gas:

  o **Bilsulfite/sulfite**: SO$_2$ absorbed into sodium/calcium/magnesium hydroxide to produce sulfite/bisulfite for use in wood digestion

  o **Ammonium sulfite**: SO$_2$ absorbed into ammonia solution to produce ammonium sulfite as a coloring agent in food industry

  o **SO$_2$-water**: SO$_2$ absorbed into chilled water to produce ~6 wt% solution of SO$_2$ in water
Skid –Mounted Construction

- Skid-mounting available for some equipment to minimize shipping and installation cost.
Case Study
Case Study: Basic SO$_2$ Process
3 to 12 MTPD Sulphur Combustion Plant

- Project Requirements:
  - Design and supply a small sulphur dioxide combustion and quench system for a large, Canadian Pulp and Paper producer
  - SO₂ to be used for their high quality corrugating medium facility
  - SO₂ produced is quenched and absorbed in an existing absorption tower for use in downstream digester
3 to 12 MTPD Sulphur Combustion Plant

- Constraints:
  - Physical space constraints
  - High SO$_2$ Concentration
  - Large turn-down capacity (between 25% and 100% of 12 MTPD design capacity)
  - Maximum ten (10) hours start-up time from cold
  - Very tight project schedule, dictated by overall plant shutdown scheduled in October 2018
3 to 12 MTPD Sulphur Combustion Plant

• Project Execution:
  o NORAM’s Cellchem™-style, Spiral-flame (SF) sulphur burner was selected as the most suitable style of burner to meet the above constraints
  o Operating Parameters:
    ➢ Feedstock: Liquid molten sulphur, delivered from an existing storage facility and positive displacement pump
    ➢ Product Gas: Between 820 kg/h and 3,500 kg/h of 18-19vol% \( \text{SO}_2 \) gas at 60°C and under slight vacuum
3 to 12 MTPD Sulphur Combustion Plant

• Project Execution:
  o NORAM completed the main process design from the inlet of liquid sulphur to the furnace to the outlet of the quench gas from the quench tower
  o All detailed design of the sulphur burner and quench tower was completed at NORAM’s fabricator, AXTON, in Vancouver
  o Balance of equipment sourced from various suppliers
  o Installation and construction of plant were completed by the Client and the Clients Constructors with NORAM’s sub-contractor installing the refractory brick under NORAM supervision
3 to 12 MTPD Sulphur Combustion Plant
3 to 12 MTPD Sulphur Combustion Plant
3 to 12 MTPD Sulphur Combustion Plant

• Commissioning and Start-up:
  o Pre-commissioning, water batching and refractory curing using the permanently installed natural gas burner were completed in two weeks prior to scheduled plant start-up date
  o A complete plant shutdown was scheduled after refractory curing to complete the final plant tie-ins
  o Plant was successfully started-up over a two day period at the end of October 2018, meeting production and schedule requirements
NORAM Equipment - Photos
NORAM Equipment – Photos