Sulfur Safety Seminar
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SulfurUnit.com
More Production - Less Risk!

Sulfur Recovery Engineering

SAFE SRU
Start up & Shut downs

Why control your SRU shut downs & start-ups?

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SULFUR UNIT S/D & S/U
Near Misses, Mistakes and Mishaps

- Incorrect metering of the main combustion air resulted in severely sub-stoichiometric conditions for 24 hours causing the entire Wasteheat boiler and first condenser to fill up with soot. $1,000,000 repair
- Complete destruction of Wasteheat boiler due to uncontrollable sulfur fire. $500,000 repair.
- Complete destruction of internals and catalyst in the first converter. $500,000 repair.
- Filling the entire SRU with only fuel gas to 'snuff" out sulfur fires .
- Damage to refractory due to condensed water in the steam line dumped into the reaction furnace.

Safe SRU Shutdown and Startup Agenda

- When to shutdown SRU's
- Types of Shutdowns
- What do we need to accomplish
- SRU Shutdown Procedure
- Safety Concerns / What not to do

When To Shutdown SRU's

- **For Turnaround:**
  - Inspection/Repair:
    - Burners, refractory, tube sheets, ferrules, coalescer pads, corrosion, eductors, rundown lines, diffuser plates
  - Maintenance:
    - Orifice meters, RF opticals, flame scanners, tg analyzer, seal pots, pressure transmitters, purge air lines, etc.
- **Due To Unscheduled or Emergency Shutdown:**
  - Essential to avoid:
    - Catastrophic failure of equipment/vessels
    - Emissions violations
    - Loss of acid gas feed stream or combustion air

Types of SRU Shutdowns

- Scheduled Shutdown:
  - Turnarounds
    - Typically every 2-4 yrs & for 10-30 days
  - Scheduled Shutdown begins with fuel gas
  - Ends with cool down with inert gas steam or N2.
- Unscheduled or Emergency Shutdown:
  - Includes immediate removal of acid gas & combustion air to the reaction furnace.
  - Can be down for just a couple of hours
  - Will need fuel gas to keep it warm if down longer
  - Better to allow unit to cool naturally after fuel gas sweep than on "hot stand-by"

Shutdown Logic

The Following are some of the conditions that will initiate a Shutdown:

Acid gas K.O. Drum High-High Level	Reaction furnace High-High temperature
SWS Drum High-High Level	Flame detection (dual voting 2 of 2 flame failure)
Acid Gas or Combustion air Low-Low flow	High-High Converter Bed Temperatures
Claus WHB Steam Drum Low-Low Level	Incinerator Shutdown (optional)
Claus WHB outlet High-High temperature	DCS manual operator initiated shutdown switch
Condenser Low-Low Level (if applicable)	Local Panel operator initiated shutdown switch
Condenser outlet High-High temperature	Local (ESD) operator initiated shutdown switch
Reaction furnace high-High pressure	Plant ESD in control room

What Do We Need To Accomplish?

- Sulfur Removal:
  - All sulfur vapors & All sulfur bearing compounds must be removed from the SRU.
- Fuel Gas Combustion:
  - Deficiency in combustion air will cause Soot formation—coats the tubes & the catalyst
  - Excess combustion air conditions will result in sulfur fires & risks destroying converter internals
- SRU Cool Down:
  - With either air or N_2 .
  - N_2 is preferable for tight schedules.

Safe SRU Shutdown Procedure

Procedure for a Safe and Expedient Claus Plant Shutdown:

Fuel Gas Sweep

- Firing reaction furnace & reheaters with fuel gas
  - Need minimum 24 hrs to sweep all S vapors out of the train!
- Set stoichiometry at 95-99%
  - Avoids sooting up the beds, avoids sulfur fires, safeguards vessels & catalyst
- Steam Line must be connected to the reaction furnace
  - Necessary to temper the fuel gas burn
  - Necessary as heat from fuel gas will destroy the reaction furnace!
  - Tie in via main acid gas line if possible
- Overall, want high mass flow rate during fuel gas sweep
  - Shortens the time of the sweep

Safe SRU Shutdown Procedure

Procedure for a Safe and Expedient Claus Plant Shutdown:

- A Heat Soak of The Claus Converters--removes liquid S in converters.
- Block in and blind the acid gas line to the SRU
- Establish a fuel gas fire in the reaction furnace
- Combustion air flow must be controlled—main or trim air lines
- Fuel gas should be fired at 95 to 99 percent stoichiometry
  - This will prevent sooting, equipment and catalyst damage due to sulfur fires
- Add inert gas (steam) immediately to control temperature of reaction
  - Must not exceed 1350 ^{O}C (refractory/fire brick limitations)
- Continuous sampling of gas from waste heat boiler or condenser.
  - Establishes burn stoichiometry to keep within limits

Safe SRU Shutdown Procedure

- Examples of Stoichiometry:
  - Diagrams A, B and C represent Gas Chromatograms showing different scenarios of fuel gas burn.

Diagram A: Stoichiometric Fuel Gas Burn

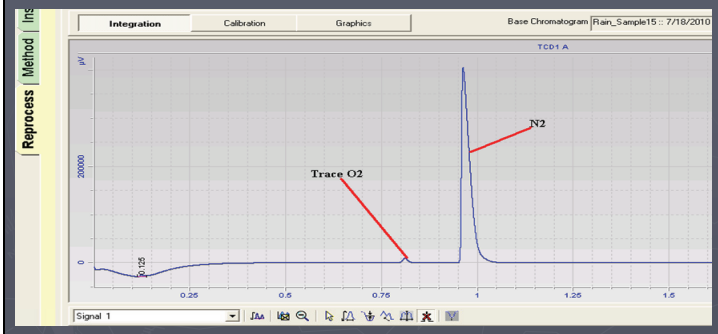


Diagram B: Above Stoichiometric Fuel Gas Burn

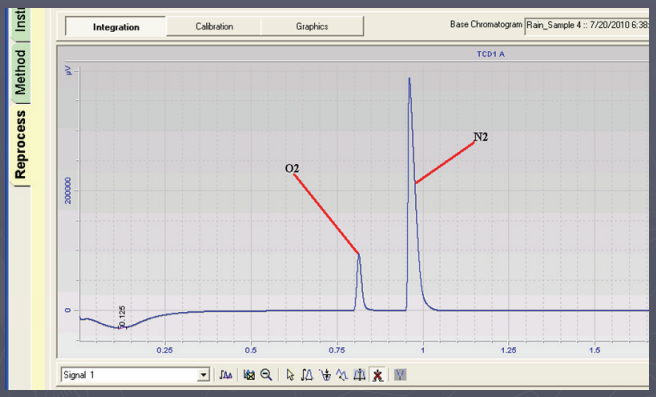
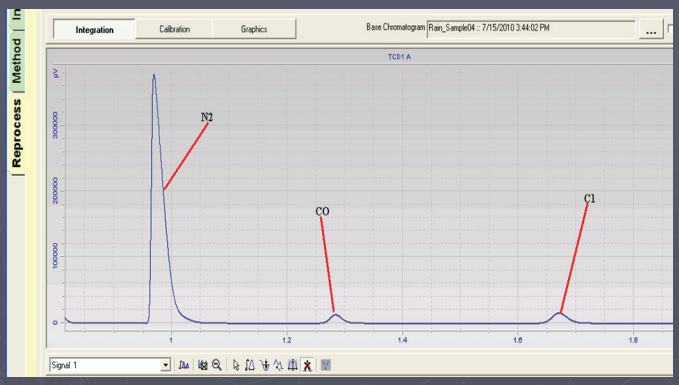


Diagram B: Highly Sub-Stoichiometric Fuel Gas Burn



Safety Concerns / What not to do

To ensure both personnel and equipment safety during shutdown and startup procedures, following should be noted:

- Possibility of Explosion
  - **NEVER** Light up without air Purge of at least one minute!
- Avoid Damage to furnace refractory and firebrick above 1350 ^{0}C
  - **ALWAYS** use steam or inert gas stream to reduce the temperature!
- Avoid Refractory shock & failure
  - **DO NOT** fire or cool down at more than 50 ^{0}Cper hour
- Avoid Sooting and Sulfur Fires
  - Firing below 95% stoichiometry will cause sooting
  - Firing above 100% stoichiometry could result in S fires & damaged internals.

Safety Concerns / What not to do

To ensure both personnel and equipment safety during shutdown and startup procedures, following should be noted:

- Control the Fuel Gas Sweep
  - **ALWAYS** use O_2 measurement & gas sampling
- Sulfur fires in the converter above 700 ^{0}C
  - can result in damage to metallugry
- Sulfur fires in the converter above 900 ^{0}C
  - Risks fusing the alumina catalyst & complete loss of catalyst
- Steam supply
  - Steam to condensers & converters should be available to snuff any sulfur fires, particularly in coalescing/mesh pads
  - BUT—remove the steam if bed temp < 150 ^{0}C to avoid water condensation.