Cold StartUp & Refractory Dryout

A New Unit

or

After Major Refractory Repairs

Cold S/U & Refractory Dryout

- Recommended controls for warmup/dryout
- Natural gas vs refinery fuel gas
- Thermal Reactor (TR) burner vs 3rd party for drying out
- Excess air/moderating steam or inert
- Warmup/dryout steps

Cold S/U & Refractory Dryout

- SRU S/U, S/D and especially refractory dryout need very good ratio control of combustion air & fuel flows to provide slow temperature ramping up and down to prevent equipment and refractory damage.
- A good burner with high turndown capability and very good mixing characteristics.
- May still have control issues at the lower temps

Cold S/U & Refractory Dryout

- Pulse firing, if system is capable, can provide a slower rate using a larger burner
- 3rd party dryout with special burner provides the best control
- Natural gas highly preferred in SRU's over refinery fuel gas due to fixed composition

Cold S/U & Refractory Dryout

Start SRU warmup using the air blower alone:

- air is at 160 to 250^{o}F [70 to 120^{o}C], depending on ambient and whether or not SRU has an air preheater
- If new SRU or major refractory repairs to the TR burner, thermal reactor or incinerator, a dryout must be done. Procedures may vary. Check with refractory supplier or installer.

Cold S/U & Refractory Dryout

Typical procedure:

- Allow a 24 hr air cure at 70-90^{o}F [21-32^{o}C] ambient temperature
- Heat to 300^{o}F [150^{o}C] at ≤50^{o}F [30^{o}C]/hr & hold *
- Heat to 700^{o}F [370^{o}C] - same rate & hold*
- Heat to 1000-1200^{o}F [540-650^{o}C] - same rate & hold*
- For one hr per inch [2.5cm] of refractory thickness

Cold S/U & Refractory Dryout

- Cooldown before service at ≤50^{o}F [30^{o}C]/hr
- Subsequent heatups or cooldowns at 100-150^{o}F [55-83^{o}C]/hr

Cold S/U & Refractory Dryout

For new converters (reactors) a typical dryout procedure is similar to that for the TR except only heat to 600^{o}F [315^{o}C] - and hold one hr per inch [2.5 cm].

The above methods are considered safe (i.e., to prevent refractory damage/ lift-off by slowly removing water)

Cold S/U & Refractory Dryout

Speeding up dryouts can/has resulted in refractory failures (partial spalling to total collapse):

- Too rapid warmup can also result in crushing of the back-up insulating refractory layer
- Hot spots after firing the TR burner
- An extended SRU outage for repairs that can cost another 4 to 6+ days of downtime at least

Shutdown Considerations

- Long Term / Opening for inspection / repair
- Acid gas heat soak
- Natural gas / fuel gas heat soak
- Nitrogen / Inert Cooling
- Sulfur pits (if time allows)

Shutdown Considerations

- Long Term Shutdowns:

  Preparation for entry (opening to atmosphere)

  Suggested order of action:

  1. With AG to TR, heat soak the catalyst beds (50 to 80^{o}F) [30^o-45^{o}C] above normal) for 48 hours.
  2. Switch TR to natural gas at 95% of stoich, with moderating steam or N_2 to the TR burner
  3. Continue the "natural gas sweep" at max until all the sulphur flows stop (typically one to two days). Rod all rundowns to ensure no flow (prevents fires later)

Shutdown Considerations

4. 12 hours after sulphur flow stops, shutdown the inline burners
5. Increase air to the TR burner **SLOWLY** holding at 1% excess O_2 for at least 6 hours (12 preferred), use O_2 analyzer. Decrease air back to 95% of stoich if reactors heat up. Reduce moderating steam when TR temps drop below 2400^{o}F [1315^{o}C]
6. When bed temps are <400^{o}F [205^{o}C], shut down TR burner. Continue air cooling until temperatures are below 250^{o}F [120^{o}C] (& de-pressure WHB /CDs)
7. Shut down blower and open the SRU manways.

NOTE: Good control essential for steps 2 to 5, above

Shutdown Considerations

- Inert Quench Method using N_2 or N_2/CO_2 mix:
  - Introduction of N_2 at 100 to 195^oF [40^o to 90^oC] via TR burner, after heat soaks … risk of freezing/ bed pluggage (risk mitigated w/ N_2 at > 250^oF [120^oC])
  - Rate at about 20% of normal flow, for about one day
  - Sulphur on/ in catalyst when complete (changeout)
  - Entry under mask only until fully air swept due to pyrophorics & possible toxic atmosphere

Some plants have used natural gas sweep (to remove sulphur) followed by nitrogen purge to cool to 120^oF [50^oC] -- to speed up the cooldown

Shutdown Considerations

- Shutdown of Sulphur Storage Pit (Tank)
  - Potential for H_2S at >LEL (~3.5% at pit temp.)
  - Concern is fire or explosion
  - Pits with normally inert vapour space:
    - Get H_2S to < 1% by increasing purge flow
    - Introduce sweep air carefully
    - Lower pit level (have snuffing steam ready … fire caused by pyrophoric FeS, present on carbon steel components)

Shutdown Considerations

- Pits with air swept vapour space:
  - Increase sweep air flow, ensure H_2S is <1%
  - Lower pit level (have snuffing steam ready … fire caused by pyrophoric FeS, present on carbon steel components)