IMPROVING SRU REACTION FURNACE RELIABILITY: BOILER TUBE PROTECTION

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WHO IS INDUSTRIAL CERAMICS LTD?

For over 70 years, INDUSTRIAL CERAMICS LTD has:

- Been the preferred manufacturer of ceramic ferrules for the Petrochemical and Sulphur industries worldwide
- Supplied tubesheet ferrules for over 25,000 SRU’s
- Worked with Engineering and Licensing companies, consultants, boiler manufacturers, refractory installers and End Users to establish optimal and reliable operation of tubesheet refractory installations in sulphur recovery units.
Tubesheet refractory linings can be difficult to construct and operate.

However,

Ferrule installations that are properly designed and installed can and do provide many years of reliable service.
FERRULE STYLE SCHEMATICS

FERRULES EMBEDDED IN CASTABLE

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<th>REG</th>
<th>Regular</th>
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<td>![Diagram 1]</td>
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<tr>
<th>DR</th>
<th>Double Ring: Type 1</th>
<th>Type 2</th>
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<td>![Diagram 2]</td>
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<tr>
<th>TAP</th>
<th>Tapered</th>
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<td>![Diagram 4]</td>
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<tr>
<th>SHT</th>
<th>Solid Head: Tapered</th>
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<td>![Diagram 5]</td>
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<th>SHR</th>
<th>Solid Head: with Ring</th>
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<td>![Diagram 6]</td>
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Regardless of ferrule style used, our experience has shown us that ferrules must be able to:

- accommodate the thermal-mechanical mismatch resulting from tubesheet temperature variations which occur in service

and

- handle the temperature extremes which occur during fuel gas firing start ups and shut downs.
FERRULES
THE FUNDAMENTALS

Ferrule design AND installation are critical to ensure optimal performance and reliability in SRU.
WHAT?
Protects carbon steel tubesheets and tube to tubesheet welds from high temperature H2S corrosion and degradation

HOW?
By maintaining maximum metal tubesheet temperatures with allowable limits
Carbon Steel Sulfidation Temperature: 650 °F (343 °C)

**Figure 3: Corrosion Curves**

Effect of temperature on corrosion of carbon steel in the presence of hydrogen sulphide

Saturated steam temperatures

- **Older designs**
  - 10-17 barg
- **New Designs**
  - 31 – 45 barg

**Higher steam pressure – smaller margin for error**
Ideal heat flow and temperature distribution

heat transfer should be through center of ferrule

Limit heat transfer to front of tube sheet
Tubesheet is the most vulnerable refractory system in the SRU

WHY?

Directly affected by all process conditions – especially extremes that can occur during start-ups and shut downs

Not surprising that 60% of failures occur on start up and shut down
Tubesheet is the most vulnerable refractory system in the SRU

**WHY?**

Ceramic ferrules are brittle materials – the only way a ceramic material can respond to an applied stress is through micro-cracking.

Therefore, each “event” compromises material properties
Tubesheet is the most vulnerable refractory system in the SRU

**WHY?**

Tubesheet located at transition between the reaction furnace and WHB

Tubesheet linings vulnerable to damage resulting from upsets in both reaction furnace and waste heat boiler
Tubesheet is the most vulnerable refractory system in the SRU

It takes only one broken ferrule to cause an unplanned shutdown of an entire sulphur plant.
PRESENTATION OF SEVERAL CASE STUDIES
Conclusions

Best way to ensure the most robust tubesheet lining is to:

– Focus on good ferrule design and quality installation

– Understand impact operating conditions can have on installation integrity
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