Case study

Rotary GGHs for Tail-End SCR applications on Sinter Strands

Design and supply of high performance rotary Gas Gas Heaters for operation on sinter strand tail-end SCR DeNOx plant.

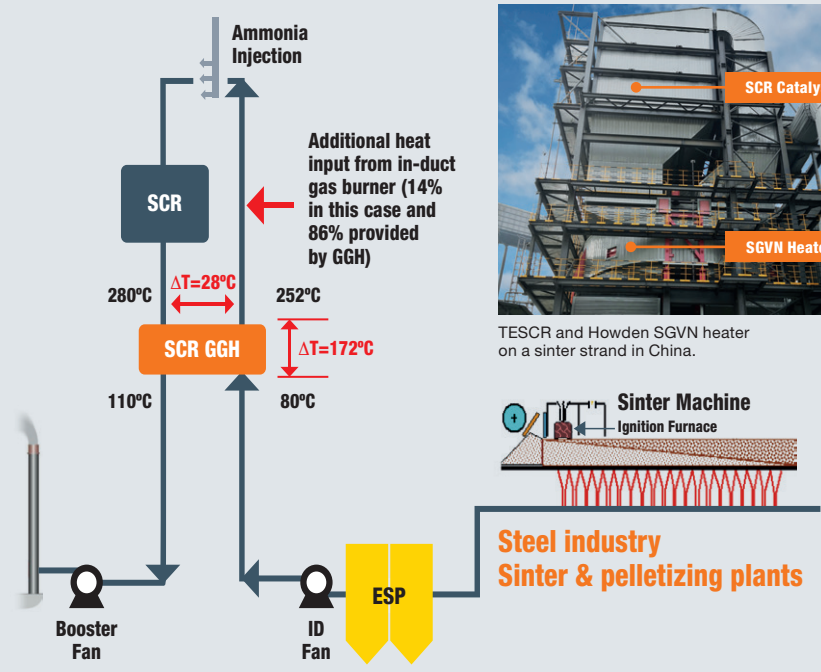
Modern industrial plants, such as sinter strands in the Iron and Steel industry, have to comply with increasingly strict gaseous pollutant emission standards requiring the retrofit of flue gas treatment equipment, such as tail-end selective catalytic reduction (TESCR) for the mitigation of NOx emissions. This case study summarises the principal challenges and design solutions developed and supplied by Howden over the last 10 years to well over 250 tail-end SCR Gas-Gas Heaters (GGHs) for such plant in China and the Far East.

The challenge

Tail-end selective catalytic NOx reduction (TESCR) provides the most cost-effective, high-performance NOx removal capability on sinter strands. In such applications, Howden's high-performance rotary gas-gas heaters (SGVN range) play a vital role in dramatically improving fuel efficiency while being much smaller and lighter than tubular heat exchangers. Figure 1 shows the location of a large SGVN heater in a typical TESCR plant.

The ongoing challenge has been to continually develop our rotary gas-gas heater technology to produce cost-effective solutions that achieve the required thermal performance while minimising the leakage of untreated flue gas to the stack.

The low log mean temperature difference across such heaters produces some of the largest and heaviest rotary heaters in the world, with rotor diameters up to 22m, total element depths up to 3.2m and rotating weights over 1300 tonnes. While these heaters would be approximately half the size and weight of equivalent tubular heat exchangers, such extremes in the physical size and operating conditions for rotary heaters has required us to continually extend and prove both our previous mechanical and thermal design limits.



TESCR and Howden SGVN heater on a sinter strand in China.

Figure 1: Typical installation of a TESCR plant and SCR GGH on a sinter strand.

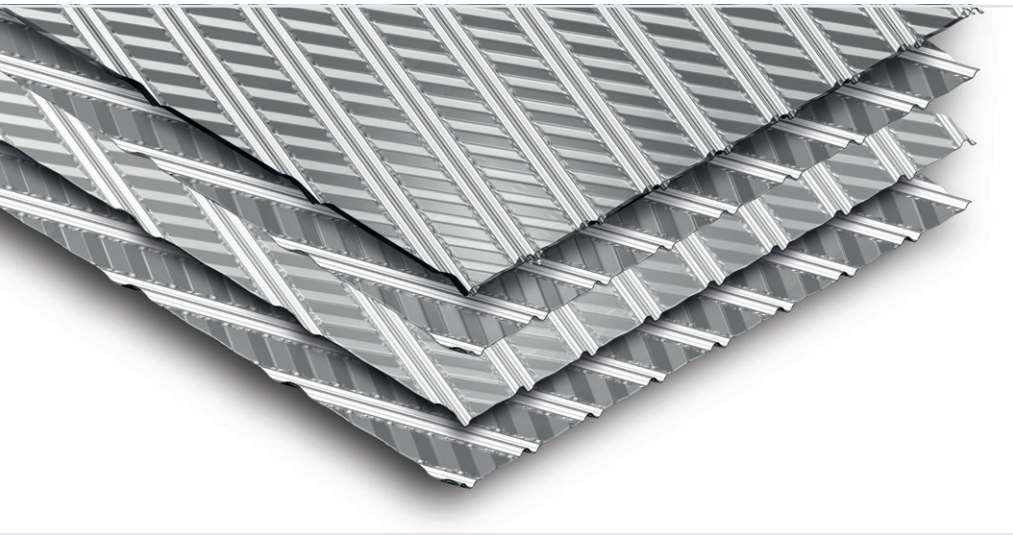


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Figure 4: NCU elements as adopted on many TESCR contracts.

Our solution

As is Howden's conventional design practice, whenever any equipment or component is deemed to exceed our proven and recorded design rules or falls beyond our operating experience, we complete a detailed mechanical analysis involving extensive finite element analysis (as shown in **Figure 2**) with associated weld fatigue assessments and analysis of the component stresses and thermal and mechanical deflections.

In addition to such mechanical analysis, as part of our ongoing effort to optimise the design of our rotary heat exchangers, for many years we have developed new ranges of heat transfer elements for various applications. While modern developments employ the use of CFD analysis, these developments continue to be firmly based on physical testing on our heat transfer rig located in Scotland (see **Figure 3**).

This rig was extensively used in the development of our latest NCU elements (as shown in **Figure 4**) that have been optimised for application in low fouling environments, as is predicted in TESCR applications on sinter plant.

NCU elements, which are an extension of our earlier range of Flat-Notched-Crossed elements, produce an optimum combination of thermal performance and pressure drop characteristics. The resultant significant reduction in element surface and weight produces smaller, lighter and more cost-effective heaters.

With regard to leakage control, Howden have adopted our well proven, non-actuated multiple sealing systems as installed and demonstrated on may air preheaters and FGD gas-gas heaters.

On the largest heater sizes, this can entail the use of up to 6 radial seals being continually maintained at any time under the outer sections of the radial sector plates (see **Figure 5**), with this multiple-labyrinth effect significantly reducing the leakage of untreated to treated gas. Using such sealing systems, the leakage levels can generally be held below 2–4%, which is generally adequate for most TESCR requirements.

However, whenever even lower leakage levels are required, we have adopted our equally well proven, fan-assisted leakage systems (as shown in **Figure 6**) which can reduce the leakage levels to less than 1%.

The outcome

Since Howden UK's original sale of two TESCR GGHs for a US power station in 2002, both the market and our product design have continued to develop. Indeed, since 2009 when Howden UK supplied their first TESCR GGH for installation on a sinter strand in South Korea, Howden have sold over 250 of such heaters throughout SE Asia and China.

Furthermore, since their first reference in 2015, Howden Hua have sold over 230 TESCR GGHs for installation on sinter strands in China. Over the same period, Howden have also sold many lower temperature GGHs for installation on wet FGD systems on sinter strands.

As international legislation increasingly requires all industrial processes to stringently control gaseous pollutants such as SOx, NOx and fine particulates (PM2.5) to lower levels than previously specified, the international market for TESCR systems for NOx removal is will inevitably continue to expand in the future.

The use of rotary SCR GGHs for heat recovery plays a vital part in maximising the thermal efficiency of these TESCR systems and minimising the necessary support fuel burn required.

As the clear global leader in this application of SCR GGH technology and with a long term presence in most of these industries with the supply of fans and compressors, Howden can be considered to be the supplier of choice for such equipment.

Each application is considered and designed according to its individual requirements with Howden being able to draw upon an increasingly unparalleled amount of process application experience.

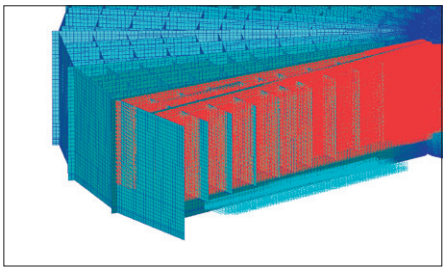

Figure 2: Rotor Fatigue Assessment of size 36 SGVN rotor for Dangjin, South Korea.

Figure 3: View of Howden's element heat transfer rig in Renfrew, Scotland.

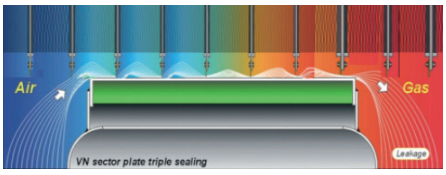

Figure 5: Fixed, multiple sealing as adopted on many TESCR contracts.

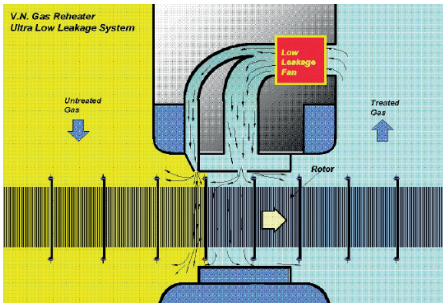

Figure 6: 'Active sealing' system using fan-assisted clean gas as a further leakage barrier