To prevent these failures, steam is used to flush out the system in decoking cycles. Unfortunately, decoking itself causes wear and tear on the process equipment. The ethane feedstock remains stable in temperature during standard procedures, but the steam injection for decoking quickly increases both the velocity and heat within the system. If steam is added too rapidly and there is condensate in the line, vapour can explode in the lines, causing damage to the pipes and the water hammer effect on sensitive equipment. It is easy to see how ethylene production is a delicate balancing act between these cycles.

Leading the way in Austria

Innovations in automation technology allow for more process control during steam cracking. Coriolis flow meters can measure mass directly in the line, providing data intelligence to maximise yield efficiencies. This specialised equipment is less impacted by the changing fluid compositions in these hydrocarbon feedstocks. They are very accurate, have high turndown ratios, and straightforward designs that make for easy installation.

Modern equipment can also be used to automate the decoking process. Traditional plant designs still rely on manual decoking, requiring an operator to slowly and carefully open the steam valve over the course of 30-45 minutes to minimise the impact of condensate flashing in the line. Automating these challenging procedures increases the safety, reliability, and longevity of the equipment.

A plant in Austria spared no expense in making these upgrades to their systems. With the help of some of the best in automation technology, their operator had an optimised cracker with more throughput and higher yields while maintaining the highest levels of safety for personnel.

Pipes to blame

A plant in Texas implemented a smaller system upgrade, focusing on adding Coriolis meters, but without keeping the best practices of a fully automated system in mind. It did not take long for things to go wrong with the ethane cracking furnace.

At first, the operator assumed the newly installed meters were to blame, but advanced diagnostic capabilities on their Coriolis meters told a different story. Software checks the health of the meter itself, assuring operators that the flow meter is performing within normal parameters, and its measurement output is reliable. In this case, the meters were fully functional.

Learning lessons from the recent installation at the Austrian plant, the team could trace the Texas plant's steam lines and discover the issue. To reduce the flow rate and keep the steam at a higher pressure, the facility had added a restriction orifice to the steam lines, yet neglected to drill a small hole in the bottom of the line to drain condensate, resulting in loud knocking and shaking in the pipes due to the exploding steam. This was also causing water hammer damage to equipment.

The incident provided the opportunity to develop best practices to implement these newer automation capabilities in ethane cracking furnaces across the industry. Now, no matter the type of technology upgrade, operators can follow the appropriate steps to ensure good piping practices and monitor any potential process upsets with advanced flow meter technology.

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Analysis solves vibration problems

This story starts with a familiar scenario for a fluidised catalytic cracking (FCC) unit; a 30 year old waste heat boiler (WHB) had become a maintenance headache. For the first 20 years, the boiler combusted CO and operated largely reliably. Then when the burners were pulled (and it changed from a CO boiler to the current WHB), there was some vibration – enough to cause eventual cracking at the boiler front wall corners, both in the end connections of the horizontal stiffening members ('buckstays') and in the furnace enclosure itself. While the flue gas leaks were an increasing nuisance, all-in-all the operating experience was not a bad one, and in 2015 replacement-in-kind with improved buckstays was the path forward.

During the first start-up, the new boiler vibrated so violently that only a fraction of the normal gas flow could be achieved. The lower front wall was still the trouble spot, though the vibration magnitudes were way beyond the nuisance vibration seen previously. Even operating at partial load, the internal refractory around the inlet duct was quickly compromised and gas leaks made the lower front wall inaccessible. End connections were again found to be fractured.

So what went wrong? As far as anyone could tell, the boiler really was an in-kind replacement, and there were no gross design or fabrication errors found. The only external change was lowering of the restriction orifice chamber (ROC) upstream to give it more distance from the slide valve above it. Could that be enough of a difference to cause the new vibration? A model of the inlet piping and WHB is shown for reference in **Figure 1.**

Becht was brought in to do to a root cause investigation and fix the vibration issues – starting with field

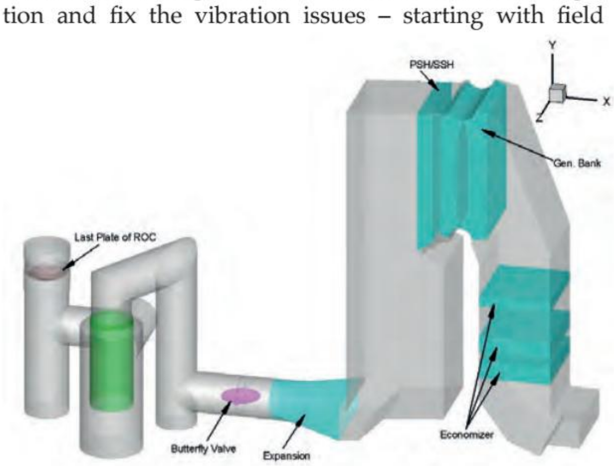

Figure 1 FCC unit waste heat boiler and inlet piping layout