Cart before the horse

Gas-gas exchangers upstream of the interpass and final absorption towers in double contact, double absorption metallurgical and spent acid regeneration plants are prone to sulfate blockage in the SO₂ and SO₃ sides. The attendant loss in heat transfer efficiency increases the gas temperature into the absorber towers, thereby increasing mist formation as well as increasing the load to the acid coolers. In addition, it also decreases the temperature into the catalyst bed downstream. The increase in pressure drop due to the sulfate blockage not only causes a reduction in production capacity, but also can breach the divider plate between catalyst beds. The breach will cause SO₃ to bypass the absorbing tower. All these will result in an increase in stack SO₂ and acid mist emissions.

The sulfate blockage is normally the symptom of poor equipment design, improper operation and/or non-maintenance of the pieces of equipment upstream. Fig. 1 shows sulfate blockage in the shell side of a cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. Fig. 2 shows sulfate blockage in the tube side of a cold reheat exchanger. The inner 10 rows of tubes are entirely blocked for SO₃ gas passage.

To solve the blockage problem, some plants choose to correct the symptom rather than address the root cause. The exchanger is replaced with some modifications when all the sulfate removal techniques in their arsenal have been exhausted. Reversing the SO₂ flow from the traditional downward flow inside tubes and changing the material of construction to stainless steel are some of the techniques used. All these have proved to be inadequate and after less than three years in operation, the plant is back to square one. Cases in point are shown in Fig. 3 where SO₂ gas was switched with the traditional upward flow in the shell side to downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.

Fig. 6 shows a photo of the cold reheat exchanger with stainless steel tubes. The SO₂ gas passages are almost entirely blocked. The SO₃ gas flow was reversed from the traditional downward flow inside the tubes, and in Fig. 4 where SO₂ gas flow was reversed from the traditional downward flow inside the tubes to upward flow inside the tubes. All these modifications were in vain.

Fig. 5 shows a photo of the divider plate between beds three and four. A portion of the circumferential weld on the sidewall cracked due to the high-pressure drop in the cold reheat exchanger.

Lesson learned

Do not put the cart before the horse! Correct the root cause of the problem first before replacing the exchanger. Replacement designs should be given due diligence by an independent consultant who has knowledge and experience in the operation and maintenance of the equipment.
consult with a piping stress engineer for the proper type and application of expansion joints prior to installation.

In a hurry to startup

Maintenance turnarounds in acid plants can be very stressful. There are pressures coming from everywhere: pressure to finish the work on time, pressure to keep the cost on budget, pressure to get back on line as quickly as possible. So when an opportunity to save time comes around, management often jumps on it. Such is the case for a spent acid regeneration plant. Operations decided to get a jump on starting up the plant while work progressed in the acid circulation of the brick-lined final absorber tower. This particular acid plant is a 3+1 double-contact, double-absorption unit with the catalyst beds in stand-alone vessels. The 4th catalyst bed is equipped with its own preheating system. Preheating started with no acid circulation in the final tower. Towards the end of the preheating cycle, an alarm went off in the stack monitoring system and a visible plume was noticed coming out of the stack. During preheating, the SO$_3$ that was trapped in the catalyst during the cool down process prior to the turnaround was released when the catalyst started to liquefy. Without acid circulating in the final absorbing tower, the SO$_3$ just went through the packed section unabsorbed by the acid that was held up in the packing. In addition to creating stack emissions, putting hot gas in a brick-lined acid tower without the cooling effect of acid circulation is very risky. There is very high probability of collapsing the packing support and damaging the brick lining and packing at the bottom section when acid circulation is turned on due to thermal shock.

Lesson learned

During preheating of the converter beds, ensure that the absorber towers have acid circulation in them to absorb SO$_3$ that may be released when the catalyst starts to liquefy. Also, this will eliminate the possibility of damaging or collapsing the packing support.

Disclaimer: OP & Associates Ltd.–H$_2$SO$_4$ Consultants is not responsible for, and expressly disclaims all liability for, damages of any kind arising out of use, reference to, or reliance on any information contained herein. Readers should take specific advice before applying any information contained in this publication.

For more information, contact Orlando Perez at 360-746-8028 or orlando.perez@h2so4consultants.com, or visit www.h2so4consultants.com.

WINTERVILLE, N.C.—Roberts, a fully integrated engineering, fabrication, construction and plant maintenance company, continues to impress customers in the sulfuric acid industry with its quick response and quality workmanship. Recent projects have allowed several of Roberts clients to expand product offerings, improve plant processes and extend the life of their equipment.

Mosaic, featured in this edition, relied on Roberts’ extensive experience in the industry to provide the necessary work for several projects. The first was a new MECS Heat Recovery System™ (HRS). Mosaic also tapped Roberts to provide site prep, concrete and pilings for their Micro Essentials™ project, one of the largest projects Mosaic has undertaken.

Roberts’ quick turnaround at Rentech Nitrogen, disconnecting an old acid converter and installing a new, larger converter and associated ducting in their sulfuric acid plant, will allow the company many years of continued operation. Improved heat recovery and less downtime from a system that operates at peak performance are just some of the benefits of this project.

The sulfuric acid industry continues to rely on Roberts for its multitude of capabilities and vast knowledge. As a long-time service provider, Roberts has proven time and time again to be reliable, efficient and responsive. This leads customers to return for a variety of projects, including new project design, project management, plant maintenance services and repairs, as well as shutdowns, turnarounds and fast track emergency response.

For more information, please visit www.robertscompany.com.

A recent job for Rentech Nitrogen provided improved heat recovery and less downtime.