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1. INTRODUCTION

The fabrication of critical process equipment - and equipment for urea plants falls in that category - has always demanded specific expertise and skills from the part of the vessel fabricator. This because of the process conditions in urea plants, with high operating pressures in combination with corrosive process fluids.

In order to be able to successfully complete projects for such an environment, a number of requirements must be fulfilled, both from the customer and the vessel maker. This applies even more to the repair or modifications of such equipment considering the conditions in the field, in particular the time constraint for most of such works. This paper describes the fabrication sequence of HP urea equipment and specifically refers to the critical steps. It also highlights the special features of repairing or replacing liners as well as retubing in situ.
Most important for the successful executing of a project, may it be a reactor or heat exchanger, is a good solid specification. All requirements, either statutory or coming from the process licensor or the client must be stated upfront. It is the fabricators duty to understand the specifications and to comply with them. Or to clearly take exceptions. If specifications are incomplete or contain conflicting information, it is the suppliers responsibility to have corrections made.

The customer on the other hand must not include all the possible specifications and requirements, but concentrate on the essential areas.

Planning is an important instrument for a successful and timely execution of a project. The planning process must start even before a job commences and must include all the disciplines necessary for the manufacturing of this kind of equipment, namely engineering, purchasing, welding technology, quality assurance and fabrication.
The planning must reflect realistic time lines for the individual activities, particularly delivery dates for materials. It should also have buffers to cover possible and likely delays during the job and ultimately helps to avoid „negative floats". It is our experience that a very detailed planning is necessary to be able to monitor and control the progress of a job.

We think that a system with a project manager or project coordinator is a must for this type of products. Regular updates of the planning is a requirement, also expediting of subcontracted materials and services.

Proper engineering and design is the key for a good project. Again a clear specification is a prerequisite for all the following activities like design calculations, parts lists, drawings and material requisitions. Sufficient time should be allowed for drawing review and incorporating of changes.

The inspection and testing plan is an important tool to define and visualize the hold points during the manufacturing. Agreed acceptance criteria must be part of such an inspection plan, particularly for corrosion resistant parts.

Having in place all what was said above, the manufacturing for example of a heat exchanger can commence. The first action is the qualification of tubesheet overlay welding, strip and manual, and subsequently the tube-to-tubesheet welding and liner connection welds. It is important to know, that for these qualifications only materials used in the actual fabrication must be taken. This determines that welding material - strip and rod - must be procured on a priority basis. A delayed start may already have an impact on the fabrication schedule. With the qualification in place, overlay welding may start and to be followed by the tubesheet drilling. Typically for HP heat exchangers this activity is on the critical path and progress must be closely monitored. In parallel welding of the LP-shell takes place, not to forget the expansion joint which can become a critical item itself. Ideally, the shell should be completed when the tubesheets are drilled and ready for welding onto the shell.

The fabrication of HP channels with welding-in of nozzles goes in parallel and insertion of liner or applying of a weld overlay is done.
After top tube sheet is welded, shell baffles need to be installed and tubes inserted. Having done that, bottom tubesheet is welded to the shell as well. Tubes will be positioned thereafter and tube-to-tubesheet welding can start.
Having successfully completed this step including the testing of welds by Ultrasonic, the exchanger can be completed by welding on both channels, stress relieve the closing seams and complete the lining inside the channels as well as the internals. Final testing and preparation for shipment follows thereafter. Typically the process described above stretches over a period of approx. 12 months.

2. IN-SITU REPAIR AND MODIFICATION ON MATERIALS IN CONTACT WITH PROCESS FLUID

The reasons for the necessity of doing repairs in-situ could be many. Either the equipment is reaching the end of its live, or offset conditions result in accelerated corrosion, or other reasons. Repairs may be needed to be done on liners or weld overlay, on tube to tubesheet welds or in other areas such as gasket facing rings. Let us have a look on these different areas:

Lining

If local repairs of lining must be made, these are mostly at the welds or heat effected zone near the welds. It is very rare, that repairs on plates need to be done, but this also may occur. The area to be repaired must be identified using the ammonia test by introducing ammonia behind the liner and check the liner with reagent spray or ammonia sensitive paper. After having completed the repair, the procedure must be repeated in order to ensure that the repair is acceptable.

After years of operation due to general corrosion attack, the liner may show thinning to an extent that an operation of the equipment is not safe, this applies particularly for reactors. In such cases an alternative to the purchase of a new piece of equipment is to make a partial or complete relining. Depending on the economic situation, sufficient time may be available to perform complete relining. This also depends on the size of the reactor and - not surprising - the size of the manhole. All materials must be brought into the reactor through the manhole. Depending on the remaining thickness of the existing liner the old liner may either be left in place or removed.

In case of a prestressed liner this is not advisable. For both options the first step is to install a new leak detection system with grooves alongside the new liner welds. In case of multilayer reactor shells, leak detection tubes must be inserted into the newly drilled leak detection holes. This procedure is applied also for the liner segments to be installed in the hemispherical heads.

In order to save on time, the new liner plates must be of maximal possible size to minimize the number of welds. All liner welds are subjected to PT-testing (root and cover passes). After completion of the relining - partial or complete - reactor will be subjected to a hydrostatic test with the PT-test and ammonia leak test to follow thereafter. Same or similar procedure is applied for the relining of heat exchanger channels.

Retubing

Retubing may become a need if the wall thicknesses of heat exchanger tubes have reached a critical point or are showing defects. In such cases a complete retubing in-situ with replacing all the tubes is not a economical solution since this takes too long time and has only little cost advantage in comparison with buying a new one. Partial retubing with replacing of tubes through the manhole, however, is a viable option. It appears that the cutting of tubes next to the bottom or top tube sheet is of bigger interest. This can become necessary, if tubes are showing defects due to Cl^--stress cracking and cause leaks. This can occur in the top or bottom end of the exchanger. In both cases, we have successfully shortened the shell along with the bundle and re-welded the tubes. Such an operation can be performed in an acceptable time frame results in a reliable piece of equipment.