DESIGN ASPECTS AND THEIR EFFECTS ON THE COMMISSIONING OF THE BULONG PRESSURE ACID LEACH AREA

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Rod Clary & W. E. Brooks

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1. INTRODUCTION

It is often quite difficult to ascertain just when a plant is in the commissioning stage. At Bulong, for example, it might be when the first ore is introduced into the feed tank, or the heater train or the autoclave, and so on. Or it could be when the CCD circuit was commissioned using pieces of equipment that were part of the acid leach plant and were convenient for use to move material into the CCD section. It might be when water was first introduced into the system to perform pressure testing.

This paper will attempt to address the fact that commissioning should begin much earlier, perhaps during the design stages when certain items may require special consideration during the commissioning phase.

However, when a project is fast tracked and the pressure is on to meet deadlines, the commissioning process often is the last thing on the minds of the designers and procurement people. This is not a criticism, it is a fact of life in all projects at one stage or another.

This paper will address five areas where some additional time taken during the design stage in the office would have saved time and a lot of headache in the field.

- Late vendor information on site
- Brick curing requirements in the heater and flash trains
- Autoclave liner cracking
- Commissioning on water as opposed to slurry
- Nuclear Detection Devices

2. LATE VENDOR INFORMATION ON SITE

Several vendor drawings and information necessary for proper equipment installation arrived on site after the equipment was delivered and in many cases installed. Specific items included the relief blast spool design & liner system, pump curves and gaskets.

2.1 BLAST SPOOL

With regards to the blast spool design and subsequent lining, two problems arose very late in detail engineering that potentially could have delayed start-up. Early in detail engineering it was decided to combine the safety relief valves of all pressure vessels on a common blast spool and all the high temperature heater vent control valves on a separate blast spool. The mechanical design of the vessel became the first issue since the blast spool had to be designed as a pressure vessel. The vendor had assumed that the head of the blast spool had to be a standard 2:1 ASME head. The standard design for this application is in fact a flat head to accommodate the heater vent control valves. The vent control valves are right angle let-down valves with ceramic seats which extend below the body of the valve. With the 2:1 head design the nozzle neck would have to be lined with ceramic to reduce wear rates.

The second problem that occurred was the lining design. The fact that titanium piping spools had to manufactured in a timely fashion necessitated that detailed isometrics had to be completed early. Therefore valve and piping orientations where fixed before final vessel drawings where received. This created two problems; 1) the vessel manufacturer had to design a vessel to conform to the isometrics which led to a late construction drawings being issued and 2) because the valves and piping were fixed, the brick lining in the blast spool was almost compromised due to interference between the vessel wall and the valve seats in the head of the vessel.

2.2 PUMP CURVES

Multistage pumps are used to generate the mechanical seal water pressure, high-pressure gland water and agitator seal water. During commissioning of the agitator seal system it was found that the pressure control valve maintaining the seal system was operating at 100% open and the system was pressurized to over 50% of design maximum pressure and severe cavitation was occurring at the control valve.

An investigation into the problem revealed that the control valve was properly sized according to the information that was supplied to the vendor. However, further investigation into the problem revealed that there was no pump curve supplied by the seal pump vendor. Once the official pump curve was received it was revealed that, at the lower operating pressures, the seal pump discharge flow rate was 3 times the maximum design. The solution to the problem was either slow the pump down, trim the impeller, resize the pump or resize the seal water line and control valve. In the end the latter was chosen as being the most effective in terms of cost and commissioning schedule. The control valve went from a reduce 1 ½" , to a full port 3" anti-cavitation trim control valve.

2.3 GASKET SUPPLY

Also, several problems were experienced in the area of gasket type and material for all of the pipe joints in use at the various temperatures and pressures. For example, the supply of specialty titanium wound gaskets soon became in demand as construction, hydro-testing and commissioning quickly exhausted spares. Problems where experienced in the delivery and manufacture of these gaskets. In some cases the inner titanium ring had to be sent to the manufacture for re-use as the manufacturers titanium supply was short. To alleviate the demand of these specialty gaskets and not delay commissioning, camprofile gaskets were used in place of specified spiral wound. When the supply of those became short, Gore-Tex gaskets were made and used with great success in order to finish hydro-testing and commissioning of the autoclave.

At first glance it would seem that using these different gaskets was harmless, however every time a gasket material or style was changed, gasket compression calculations had to be performed before use. This usually resulted in a delay of at least one-day every time a switch was made.

3. BRICK CURING REQUIREMENTS

The flash vessels and heater vessels are lined with varying thickness of acid resistant insulating brick. This brick system is standard and in used in many similar plants worldwide.

The brick is normally cured by recirculating acid solution from top to bottom and slowly heating this solution to temperature over a period of several hours or days. This is done one vessel at a time and is time consuming. In the case of Bulong, a supplier was found that did not require this acid cure. In the interest of saving time, this brick was ordered and installed. The commissioning plan, therefore, did not include this individual acid cure period but instead called for the whole plant to begin commissioning using ore slurry.

Late in the construction period, a message form the brick supplier indicated that we should not start the plant on ore but should use acid water in a special heat-up schedule. Whether or not this information was lost in the usual home office to site communication quagmire is unknown, and is unimportant. The fact remains that we were ready to start commissioning a plant designed for ore slurry and now were faced with attempting to start this same plant using water at less than optimum heating controls. Furthermore, the water was required to be acid water.

The heat-up procedure received indicated a five degree per hour increase until 100 degrees was obtained. Next, maintain 100 degrees for eight hours. Following this hold period, we were to heat again at 5 degrees per hour until we reached the operating temperature of each individual vessel. Of course each vessel had a different design operating temperature and trying to prevent overheating of the cooler units while bringing the hotter units to 240 degrees was a challenge, to say the least. We were to hold operating temperature for 48 hours and then cool down slowly and perform a complete inspection of all vessels. In order to perform this inspection, scaffolding is necessary in each vessel, a very time consuming and expensive effort.

This procedure also caused a great deal of problems with our planned hot-torque procedure for the over 10,000 bolts in the pressure leach area. The plan called for several days at an intermediate temperature to perform this task with a dedicated crew. Instead, we had to use several crews of men working around the clock to accomplish this very important task.

Several alternatives were considered but in the end we decided to use the procedure we had originally planned for ore since every alternative meant some form of expensive and time consuming pipe rework and installation.

Had we been aware of this requirement early in the design phase, a simple set of pipes, nozzles and a portable package boiler could have been installed for use in a vessel by vessel cure which could have taken place months before the plant was ready for ore. As it was, this cure requirement added a minimum of two weeks to an already tight commissioning schedule.

In future, a system should be designed to allow for brick cure techniques as an independent commissioning item.

4. AUTOCLAVE LINER

The autoclave at Bulong is completely lined with 8mm of Titanium grade 17. The liner was installed at the manufacturing site prior to shipment. Extensive quality control by the supplier was carried out during the welding of the liner at each joint. A representative from the engineer was present during most of this testing which consisted of a substantial amount of x-ray of the welds to ensure that they met Australian pressure vessel standards.

The vessel was shipped to site and installed. An inspection was made and the unit declared to be ready for service. No procedures for commissioning this unit were received on-site. Whether or not they were again lost in the communication quagmire is unimportant.

After the brick cure, the unit was prepared for final ore commissioning. Saline process water was introduced into the entire system and the commissioning process began by introducing steam at controlled rates to raise the temperature of the re-circulating water to a pre-set temperature prior to introducing ore. The water temperature had reached approximately 60 degrees when the vessel supplier contacted us at site. The supplier indicated that the commissioning procedure called for heating the vessel at a controlled rate using potable water to allow the unit to stretch and expose any possible cracks in the Titanium liner. They further indicated that any cracks that may be exposed would need to be repaired and the unit would require a second heat-up and cool down for final inspection and repair.

As was the case with the brick cure, the autoclave was not designed to allow for heating independent from the rest of the plant equipment. Furthermore, no provisions were in place for introducing potable water or for carrying out inspection and weld repairs.

It was necessary to suspend the planned ore commissioning and drain the autoclave. We then had to rig temporary piping to allow the autoclave to be isolated from the flash/heater train. This procedure, together with the double heat-up / cool down, and repair added weeks to the commissioning schedule.

The autoclave was in place and ready several months before the planned ore commissioning. Had the commissioning team been aware of this weld inspection requirement, a similar type of isolation system and package type boiler to that of a normal brick cure requirement could have been in place prior to water/ore commissioning. Inspection and repairs would then have been under a controlled and more relaxed setting long before ore introduction was scheduled.

5. PUMPING WATER VERSUS SLURRY

As mentioned, the original commissioning plan called for water to be introduced into the system and circulated in a closed loop around the pressure leach plant (from the feed tank →heater →autoclave→flash→discharge tank→ back to the feed tank) circuit for preliminary for water testing. Ore was to be introduced into the water loop at a controlled rate before any large increase in temperature and pressure was effected. All of the pumps used for moving slurry through the circuit were sized to deliver material at a specific gravity consistent with slurry at elevated temperature.

Since it became necessary to perform brick cure and autoclave commissioning using water only, the pumps were now faced with a much lower specific gravity solution and they began to cavitate severely as operating temperatures were approached. Even though the pumps had been commissioned previously in order to fill and calibrate the level detectors in the heater vessels, cavitation was not experienced at that time because the pumps were operated at their lowest speed and only for a short duration. To overcome the problem, the volume of material pumped was reduced. Initially this did not overcome the problem and it was then discovered that the variable speed controllers were set with a minimum speed 25% from the factory versus the 15% minimum stated by the manufacture. Pump capacities were not verified until slurry was introduction at a later date.

Not only did the water create cavitation problems with pumps but it also created problems with level control devices.

6. NUCLEAR DETECTION DEVICES

As already mentioned a problem was experienced during commissioning, with the nuclear detection devices. The sources were initially too small to shoot through the vessel and lining system and the detectors were not sensitive enough to accurately determine the level.

Even after the sources and detectors were upgraded, level control was still a problem due alignment of the sources and detectors. In the end, legal surveyors had to be brought in to accurately line up the detectors with the sources. This significantly delayed start-up by several weeks.

Had we followed a normal brick curing schedule as previously outlined, this problem would not have created a delay.

7. SUMMARY/CONCLUSIONS

Future projects should be designed in the early stages with a pre-determined commissioning plan in place that will allow easy isolation of plant components and provide the specialized services each of these areas may require.

This concept should include not only the areas discussed in this paper but also areas such as boilers, seal water systems, cooling water systems and a host of other ancillary equipment.

This can only be done by incorporating members of the commissioning team in the design stage and actually asking the question "what will I need, by when, to successfully commission this piece of equipment separately from the remaining plant equipment?"

The answer to this question may add some dollars up front to the overall cost but will easily save much more money and frustration at the end.