RELINING RAILWAY TANKERS FOR SULPHURIC ACID TRANSPORT IN AUSTRALIA

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SUMMARY: This presentation provides an overview of the technical challenges that Wulguru Rail Maintenance (WRM) in Townsville had to overcome after award of a contract to reline railway tankers carrying sulfuric acid. Although the relining process is very common in the USA and had been done before in Australia, none of the parties with expertise were prepared to share it. Additionally, the coating manufacturer's Australian operation also had little to no experience with the specified lining system and could therefore also not provide substantial assistance. To make matters even more complicated, the owner and operator of the railway wagons has lost significant expertise with respect to the relining process around the time of award of the contract to WRM. And so started the journey to figure out exactly how to best install the single pack baked phenolic lining system on the internals of the railway tankers. From finding the right people to carry out surface preparation and coating application, designing and building the equipment to bake the lining between coats to meeting the client's quality management expectations, all within the tight budget constraints

Keywords: Rail transport, Sulphuric acid, Tank linings.

1. Introduction

In 2018, Wulguru Rail Maintenance (WRM) in Townsville (Queensland, Australia) was awarded the contract to reline 145 GATX-type railway tankers that are used for the transportation of 98.5% sulfuric acid. The railway tanker fleet consists of 11 strings of 13 wagons with 2 spare wagons. The Australian manufactured wagons are a modified version of the US designed GATX wagons and they have been scaled down to suit the narrower Queensland railway gauge of 1067mm compared to the 1,524mm gauge used in the USA and were first commissioned in 2001.

Each 21.6t tare weight wagon has an overall length of 12,900mm and consists of a single cylindrical tank mounted on two bogies with 2 wheel sets each.

As part of a wider maintenance regime, the internal tank lining is replaced every 7 years and this requires complete removal of the old lining and application of a new lining system.

Although the relining process is routinely carried out in multiple locations in the USA and had been done by another company in Australia previously, WRM learned quickly that none of the parties that had experience with the relining process, neither in Australia nor overseas, were prepared to share any detailed information

2. The Lining System

The internal lining system of the wagons has the dual function of providing corrosion protection to the steel substrate and protecting the cargo from contamination with corrosion product. The lining system consists of 3 coats of a single pack solvent borne phenolic at a total dry film thickness of 150 microns.

Heat curing is required after application of each coat and for this reason the coating system is often termed a "baked phenolic". This coating technology is relatively old (>50 years) and is an example of one of the earliest forms of true, thermosetting chemistry. In this case, it is the simple addition of heat energy alone, that results in a higher molecular weight, cross-linked structure that demonstrates higher physical and chemical form. Without going into specifics of individual proprietary formulations, the basic formulation makes use of the principle of heating hydroxymethyl phenols to around 120°C, which removes water molecules and forms a highly cross-linked 3 dimensional network of methylene and methyl ether bridges, without the use of a second step cross

linking agent. This process gives the coating properties such as excellent chemical resistance, hardness and thermal stability that are characteristic of polymerized thermo-setting phenolic resins.

3. The Challenge

In Australia, the use of baked phenolics as a tank lining is limited to only this one application in the GATX wagons maintained by WRM. Before 2018, the lining system was only applied by one other party: during construction and once after the first 7 years of service. Since that time, the owner and operator of the railway wagons had lost significant expertise and could only offer limited assistance with respect to the relining process that had been adopted by the previous relining contractor.

The relining process had never been documented in detail and expertise predominantly existed in the minds of the people that had been closely involved at the time. Additionally, the coating manufacturer's Australian operation also lacked expertise in the practical specifics of the lining system, simply because it is not used by anyone else in the country, and could therefore also not provide substantial assistance.

So now, WRM had to figure out exactly how to best install the specified lining system to the internals of the railway tankers to the satisfaction of their client.

4. People

Due to the uncommon nature of the lining system (in Australia), it was not realistic to expect that locally available spray painters were readily available that had experience with the single pack phenolic. In the region that WRM operates, spray painters tend to have a background in heavy industry such as mining and many of them also have experience in oil and gas in the Darwin, NT and northern WA areas. These are not typically industries where thin film systems with tight thickness tolerances are commonly used so it is not always easy to draw on that pool of candidates for the required skill sets. Furthermore, most of the industrial painters in these industries work rosters on fly-in, fly-out basis and are used to wages that could not be matched by smaller companies in regional areas.

Although the automotive finishing trade would have spray painters that are used to applying thin films, they usually lack experience in abrasive blast cleaning and work in confined spaces. WRM did however manage to attract applicators with broad experience from different industries and the skills that are needed to apply the lining successfully. In this process, inspiration was drawn from NACE RP0495 – guidelines for qualifying personnel as abrasive blasters and lining applicators in the rail industries. More importantly however, the operators that are currently responsible for the relining work are still there because they work well as a team, are willing to continue to learn and show pride in their workmanship.

Nevertheless, these people are used to variation in challenges and work in different locations whilst the wagon relining work can become repetitive. Although the current job offers the operators an opportunity to be home every night, it is important to rotate the different tasks, duties and responsibilities and for the company to provide training and career opportunities to retain the best staff. So far, two of the staff have participated in NACE Coating Inspector courses and been offered additional responsibilities in the wider organization.

5. Equipment

Buying blasting and painting equipment is reasonably straight forward and experienced staff tend to have their preferences and know what equipment is suitable for the task at hand. Configuring the blast room to accommodate the wagons and the allow for safe, easy access and cleaning took a bit of time, staff quickly developed an efficient process. This was also the case with the area where the lining needed to be applied. Aspects of the work such as access, lighting, ventilation and safe work in confined spaces were relatively straight forward and the staff used their experience in similar scenarios to adapt and successfully implement the procedures for lining application in the GATX wagons. In that same space in which the internal lining was to be applied however, the lining also had to be cured in a baking process. This consists of intermediate baking between coats and a final bake after application, inspection and repair of the final coat. Baking is a process that requires ramping up of the temperature inside the wagons at a defined trajectory, maintaining a set temperature for the prescribed period and allowing it to cool down in a controlled manner. This required sophisticated equipment and controls that was not readily available.

The company set out to develop an initial design and performance specification that was then further developed in partnership with a manufacturer of industrial heating equipment. Particularly the method of generating clean heat, lay-out of ducting that allowed for uniform airflow and placement of an array of thermocouples under the lagging on the outside of the wagon proved challenging and required significant fine-tuning to get to a stage that it could function correctly and reliably. The final design of the equipment and the way it is controlled is unique and believed to be the only one of its kind in the world.

After several occurrences of staining in the first coat, later found to have been caused by traces of residual acid and requiring complete removal of the stain affected coat, the company sought to prevent the staining from happening again. A review of the existing cleaning procedures did not indicate that there were opportunities to improve on the removal of acid residue and a different method neutralization using alkaline solutions was trialled. Since it was considered undesirable to add a separate process, that would extend the turn-around time of an already tight schedule, the substrate neutralization method was integrated with an existing step in the process between removal of the existing lining and final surface preparation prior to application of the new lining. Although the neutralization methodology required substantial dwell time of the alkaline solution, the successful integration with an existing process resulted in no additional time being added to the overall turn-around time. Since implementation of the new method, staining in the first coat has not re-occurred.

6. External Assistance

To satisfy the rigorous quality requirements that the client had imposed on the company, historic relationships were reinvigorated and an external consultant with expertise in tank linings and specialist skills in the development of bespoke QA/QC systems was engaged. This external consultant was familiar with the GATX wagon tank lining systems as they were engaged 17 years prior to audit the surface preparation and application process to identify risks and opportunities for improvement during construction of the Australian built GATX wagons. They could draw on this previous experience to advise the company on the lessons that were learned at that time. This meant that a phase of trial and error could be avoided and that risks and mistakes that were made during the original lining application in 2001 could be eliminated.

Assistance was initially provided during the start-up phase to help streamline the process and to help with the formulation of a methodology for localized curing of the coating where spot repairs were required and training of staff in QA/QC procedures before they were scheduled to get a formal NACE coating inspection qualification. The same consultant has since been engaged to fully document the re-lining procedure on behalf of the GATX wagon owners.

7. Systems

The client was quite adamant that all aspects of steel repairs, surface preparation and lining application be fully inspected, tested and documented throughout the entire process with the aim to provide detailed traceability that would assist in monitoring factors that would influence the performance of the tank lining system into the future. Based on NACE Standards that are specific to the lining of new in used railway tankers (e.g. SP0295) and the assistance of the external consultant, the company developed concepts of implementing an inspection, testing and documentation regime that would also satisfy the requirements of AS3894.10 through to 14. To achieve this, investments were made in the development in a detailed ITP as well as staff training and the appropriate inspection and testing equipment.

This resulted in a fine-tuned quality assurance system that reflects the current rigorous inspection and testing regime that offers optimum traceability of all aspects of the adopted relining procedure. This QA system is independently audited on an annual basis and has matured over time in accordance with the lessons learned during each individual relining event as part of the continuous improvement process that the company had strived for.

8. Documentation

Since the beginning, WRM's client, the owner and operator of the GATX wagons, acknowledged that it is a significant risk to the operation not to have the entire relining process fully documented. To mitigate this risk, the external consultant was also engaged to prepare a written relining procedure with the main aim to ensure optimization and consistency in the performance of the tank lining and significantly reduce reliance on undocumented knowledge and experience of individual operators, either within or outside the organization.

Documentation of the procedure furthermore functions as a central repository of knowledge and experience to benefit staff that is new to the client organization as well as the operation responsible for the relining work into the future.

With respect to quality systems, the fully documented relining procedure functions as a tool for internal or external auditors to assess the degree of compliance with agreed specifications and procedures and to identify opportunities for continuous improvement.

9. Lessons Learned

On the journey to try and achieve best practice in railway tanker relining, WRM learned some valuable lessons:

<u>Don't assume</u>

When taking on the contract, we originally assumed that we could purchase a curing station off the shelf, but quickly learned that there was no such item available on the market.

Don't procrastinate and tackle the difficult problems first

Due to our assumption that we could purchase a curing station off the shelf, we lost valuable time that could have served us better in designing and constructing our own custom curing station well before the contract commencement.

Reach out to industry experts

You don't have to go it alone or reinvent the wheel. Reach out to others within the industry as there will always be someone that can add some value to your project. Gather information from multiple sources and be prepared to decipher that information and connect the dots.

The importance of a change control process

When investigating the staining issue on the first coats we used a process of elimination.

We explored every possible cause until each one was eliminated.

We only ever changed one element of the process each time, to ensure that any change in results was directly linked to that change in process. Documenting those changes will definitely avoid costly re-work.

10. Acknowledgments

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11. References

No other literature has been referenced in this paper.

12. AUTHOR DETAILS

Gerard Small is the Operations Manager at Wulguru Rail Maintenance and he has held this role since the start of the company's attempt to secure the relining contract in 2017. He is responsible for the overall performance of the Rail Maintenance business including tendering, contract administration, profit and loss, safety and new business development.