Case study
Heat Exchanger Re-tubing Decision

Problem description: Should an aging heat exchanger be replaced, if so when, and with which new design option?

The heat exchanger examined in this study was demonstrating an increased frequency of tube failures (pinhole leaks) and lower performance due to the cumulative number of plugged tubes. So a replacement tube bundle was proposed.

The plant engineers also felt that changing from a Copper/Nickel alloy to Titanium material would yield greater reliability and longer bundle life.

This study was commissioned to ascertain the business case for re-tubing and to evaluate the life cycle cost/benefits of the alternative materials.

Results and benefits:

The study determined the optimal end-of-life strategy for the current tube bundle was to replace it with a like-for-like Cu/Ni design in 8 years’ time.

This showed a benefit of NPV £390k compared to renewal at the previously presumed timing (in shutdown in 2 years’ time). And this strategy was NPV £450k better value (lower life cycle costs and risks) than upgrading to titanium to achieve higher reliability and longer bundle life.

All study team members had been expecting that the increased reliability and life of the Titanium material would be worth its extra cost. But this was proven not to be the case. The team all accepted the outcome, based on whole life cycle cost/risk/performance and this mind-changing was seen as a major step forward in objective decision-making.

Heat exchangers are an integral part of processes plants: an oil refinery will typically have many exchangers of different designs, ages and criticalities. Heat exchangers are susceptible to fouling which reduces the efficiency of heat transfer, and results in either increased energy/operating costs or reduced output.

In addition they can suffer a number of different degradation mechanisms and failure modes including and tube blockages, corrosion, erosion and cracking, resulting in leaks in tubes or shell. Depending upon the service, these leaks can be minor nuisance (e.g. water leaks), or represent a major safety risk (pressurized gas).

Such heat exchangers are periodically opened and cleaned to recover their thermal efficiency, at which time any leaking tubes are usually plugged. However such intrusive maintenance can also introduce wear and damage, shortening the life of the tube bundle.

At some point, the bundle needs to be replaced, but there is always a temptation to defer the capital investment as long as possible, suffering the constraints of the thermal performance and increased risk of leaks.

In this case the plant engineers also felt that changing the tube bundle from a Copper/Nickel alloy to Titanium would yield greater reliability and longer bundle life. This study was therefore commissioned to ascertain the business case for re-tubing and to evaluate the cost/benefit of the proposed material upgrade.

The study we performed

The SALVO process provides the structured navigation and evaluation discipline to ensure all factors, stakeholders and scenarios were explored, quantified and evaluated on a consistent and auditable basis.

This process was supported by real-time cost/risk modelling and ‘what if?’ calculations using the DST Lifespan Evaluator™ tool.
The figure below shows the Life Cycle Costs and Risks (in NPV ‘business impact’) of the two options for replacement (Titanium and Cu/Ni). The optimal timing for replacement with higher cost Titanium tubes would be in 10 years time, whereas the cheaper Cu/Ni option is worth installing in just 8 years. Taking the subsequent (future) life cycles into account also, the total business impact favours the Cu/Ni option, with the earlier replacement point. NB but not as soon as all expected - the renewal had been proposed for the next shutdown opportunity in just 2 years time.

The SALVO rigour retains total transparency of all the risk, performance, Capex and Opex contributions, so that uncertainties, alternative scenarios and other ‘what if?’ options were explored in a matter of minutes.

This study involved a small team comprising operations, maintenance, engineering and commercial staff.

It needed just 2 hours to build the ‘base case’ scenario, model the risks, costs and operational options available, and identify the optimal strategy for like-for-like renewal. The team then developed the “replace with Titanium” scenario and explored the optimal timing and whole life cost/risk impact this option.

A formal decision-recording stage captured the optimal strategy, the audit trail for why this represents the best total value, the multi-disciplined team observations and endorsements, and the practical implementation actions.

To perform the complex reliability, risk and financial ‘what if?’ calculations, this study used decision-support software called DST Lifespan Evaluator™. This tool was developed as part of the international SALVO project (www.SALVOproject.org) to support the analysis of asset life cycle decisions at both design/selection/procurement stage and in end-of-life decision-making (e.g. refurbish/replace justifications and optimal renewal timing). Like other modules in the DST Asset Strategy Evaluator™ suite, the tool provides:

♦ A structured logic, with clear ‘storyboard’ checklist to ensure all factors are considered.
♦ Disciplined process to capture and quantify the knowledge of cross-disciplined teams, including their uncertainty.
♦ State-of-the-art analytical algorithms to evaluate the life cycle cost, risk and performance of decision options.
♦ Sophisticated, extremely rapid sensitivity-analysis to identify which assumptions have what effect upon the decision.
♦ Rapid creation and evaluation/comparison of multiple scenarios, enabling the study team to compare alternatives and explore ‘what if?’ ideas - instantly.

For further information about DST Inspection Evaluator, and the SALVO processes, please contact:

Decision Support Tools Ltd
Prince Henry House
Kingsclere Business Park
Hampshire
RG20 4SW
Tel: +44 (0)1635 299200

www.decisionsupporttools.com
www.SALVOproject.org
enquiries@decisionsupporttools.com

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