

Cut the costs of refinery heater revamps

The second half of the 20th century saw a massive expansion in the demand for refined oil products, resulting in dozens of grassroots refineries being constructed worldwide. Of the fired heaters needed for these plants, thousands were designed and supplied by Foster Wheeler. Many are still in operation but the current condition of some requires urgent attention. This article discusses the importance of being able to deliver a safe, cost-effective heater revamp, in the shortest possible shutdown.

The reasons for revamping heaters are many and varied:

- Extend their working life, with minimum investment
- Efficiency improvements, such as increasing the duty or efficiency by adding air preheat
- Reduce environmental impact to meet noise and flue gas emission regulations, (such as Nox/CO₂ reduction)
- Extend the periods between shutdowns by improving availability and reliability.

Common challenges:

The prolonged use of sulphurous fuels has often resulted in the corrosion of some components essential to the structural integrity of the heater. Where the sulphur compounds in the fuel have precipitated out behind damaged refractory layers, it is common for the refractory anchors to have been severely corroded. This allows the refractory to move away from the heater walls and the acidic deposits to attack the steel casing plate and main supporting columns. Frequently, this results in hot spots on the outer casing of the heater, which can be evidenced by peeling cas-

ing paint or alternately, can be detected early by using thermal imaging technology.

Other common problems encountered include:

- Dew point corrosion of cold end surfaces and tubesheets of air pre-heaters.
- Convection section extended surface tubes clogged by ash, refractories, catalyst fines, or unburned fuel, leading to thermal under-performance of the convection section and subsequent lower heater efficiency. Where air pre-heaters are installed, this can lead to an increase in combustion air temperature which, in turn, can produce long burner flames in the radiant section. Flame impingement on the radiant roof tubes and convection section tubes can, in time, cause premature failure of the cast tube supports, especially if the supports have also been exposed to fuel contaminants such as vanadium and sodium.
- Tube thinning and bowing.
- Damage from tramp air

through heater casing and header boxes.

Almost all heater component parts can and have been replaced



by Foster Wheeler on numerous revamps over the past forty years. Safe, practical and economic solutions have been delivered for replacement pressure parts, removal and reinstallation of corroded steelwork, disinvestment of refractories containing asbestos, replacement of combustion equipment and addition of air preheat systems.

Planning

When evaluating revamp projects to establish their viability, it is wise to recruit the services of a consultant company with a proven track record of actually delivering safe, successful and cost-effective revamps. Such a company will have experienced heater thermal and mechanical engineers, as well as project managers, estimators and planners to undertake a thorough study of the various possible options available for the plant owner to consider.

Intimate knowledge of heater design is essential, as many of the older heaters were constructed in-situ, and safe removal or modification of the corroded component parts is a skilled task. Many of these older heaters have asbestos materials in refractories and/or sealing tapes in joints, which have to be removed under strict safety procedures by specialist contractors. Factors such as plot space for lifting, piling for heavy lift equipment, logistics for modules, access and egress for plant and heavy equipment, laydown areas and site working areas all need to be considered during the initial planning and evaluation phase as they will affect cost, schedule and practicality of the various solutions.

Involving the stakeholders

Another essential ingredient for a successful revamp project is the early participation of all relevant personnel who will be involved in or impacted by the proposed work.



It is important to involve inspection and safety personnel as well as the usual engineering, operational, and maintenance groups. During the definition of the scope of work, and especially during the planning, peer group reviews help reveal any activities or requirements hitherto not considered in the plan. Seemingly unrelated shutdown activities from other departments can have a crucial impact on the overall plan during shutdown so it is vital to ensure all groups 'buy in' to the project as early as possible and fully define the scope of work. Late scope definition or significant changes can severely impact on the shutdown schedule.

Foster Wheeler's Fired Heater Division has eighty years experience in the heater business, world-wide, and has developed and delivered numerous novel techniques for revamping heaters.

These include jacking up 30-metre long convection tube banks to make way for soot blowers, to sliding 650-tonne modules into place on specially coated pads; from lifting redundant 320-tonne modules containing asbestos over live plant, to pulling fully modularised heaters into place on skates! The company has developed many special lifting and moving arrangements for heavy or unusual replacement modules and special techniques for

safely removing and replacing steel panels and refractories from outside of the heaters where access from inside is impractical.

Developing the options – cost phase 1

When estimating the overall costs and return on investment of the various options under consideration, several aspects should be considered. Lowest in real cost but often the most cost-effective overall, is the initial study and detailed engineering and planning. It is during this phase that comparisons between, say, in situ remedial work and modular replacement will need to be made: crucial decisions that will effect the overall cost of the job. Innovation is essential to effect solutions to problems that may seem initially impractical.

Consideration must be given to such matters as the strength and integrity of corroded structures and the possible ways to handle these safely, or how to establish the presence of any asbestos and the procedures for its safe removal within the minimum time available. It is often possible to reduce the costs and schedule for disinvestment of materials, such as asbestos, by containing the materials within suitably strengthened and sealed modules for later safe disposal away



from the immediate plot area.

In Foster Wheeler's experience, the relatively modest investment in thorough detailed engineering and planning made during this stage of the project is more than repaid during the shutdown and construction phase.

Materials, fabrication and logistics – cost phase 2

The next cost to consider is that

of replacement materials, offsite pre-shutdown fabrication, transportation and temporary equipment such as heavy lift equipment and manpower for the shutdown.

The specialist heater contractor who has designed the replacement equipment is best equipped to undertake procurement and supervision of pre-shutdown fabrication and materials to ensure these are available in advance of the shutdown.

To minimise the possibilities of overrun on the shutdown, the best defence is good planning. If the condition of vital components that might need replacement before the shut-down cannot be ascertained, or if they are at risk from damage during the disinvestment, (cast tube sheets for example), it is worth 'taking out insurance' by replacing them anyway or by having them to hand. This is especially wise for long lead items such as pressure parts and castings. If the heater is thirty years old these components have already paid for themselves anyway!

In this phase, close liaison between the various suppliers, fabricators and on-site shutdown contrac-

tors is essential; both those directly involved in the revamp and those working on other plant adjacent. Early selection of contractors and establishment of site rules and conditions is also critical to success. This is the responsibility of the project management team, whether it is the owner themselves or an experienced managing contractor like Foster Wheeler acting for and on behalf of the client.

Foster Wheeler's experience indicates that clients have often underestimated the time needed to successfully complete these first two phases of a revamp project. The best advice is 'to save costs, start earlier than you think you need to.'

The shutdown – cost phase 3

The final phase to consider is probably the most costly and often the one most easily underestimated; the shutdown.

This is especially important where activities such as removal of asbestos type materials is considered, as safety will in the event, take precedence over time, and any potential problem not carefully considered during phase 1 will invariably extend the shutdown with the possibility that the cost of the project will soar.

While the daily cost of lost production and demurrage on sales contracts varies with each refinery, in the event that the planned shutdown is extended for any reason, these costs can rapidly outweigh the original budgeted engineering and materials cost of the revamp.

Unplanned extended mobilisation of site contractors and hire of temporary equipment such as scaffolding and heavy lift equipment will again drive up the final cost of the project. The fired heater specialists should be on hand to supervise the overall site installation, or at least to act as advisors to provide speedy solutions to any unforeseen problems of the kind that often only manifest themselves during the actual shutdown.

Foster Wheeler's advice - think of everything but plan for the unexpected!

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Hydrocarbon Asia thanks Tony Tindal, Business Development Manager, Foster Wheeler Energy Limited (Fired Heater Division) for contributing this paper.