Prolonging the Economic Lifetime of GTCs and FTCs

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Abstract

After decades of operations of environmental systems such as GTCs and FTCs, operating conditions may have changed such that severe pressure is exerted on the remaining economic lifetime. Capacity drift of the constituting components is an additional factor that may weaken the prospects for the systems. As a consequence, investment requirement may become acute or operational limits may be imposed on the associated production plants (smelter and anode baking furnace, respectively). This article describes approaches towards improving performance and stretching the economic lifetime of such systems at optimized capital expenditure. It describes a structured approach to debottlenecking, accommodating all objectives in terms of cost, capacity and energy and emission limitations. The result is an optimum with respect to CAPEX and OPEX, whereby solutions are evaluated based on investment per unit of capacity. In addition, the article presents a project that was executed at Aluminerie de Bécancour with the described objective of prolonging the economic lifetime of the FTC at minimum investment. Process conditions (increased fume volumes, altered pitch burning conditions, pet coke impurities, etc.) had changed significantly since the commissioning of the system in 1985 and during this project, the conditioning tower was replaced with a new and improved design.

Keywords: Environmental systems; GTC capacity; FTC capacity; GTC lifetime; FTC lifetime; debottlenecking.

1. Introduction

Usually, the conclusion that a GTC or FTC is reaching the end of its economic lifetime can be deducted from operational indicators showing that the system is on the limits of its capacity. More likely, this conclusion will be made apparent by a growing list of shortfalls in production as well as rising maintenance costs. For example in the case of an FTC, typical signs are:

- Tar blockages of spray lances and in ducts or even bags,
- Frequent deluge of the ducting,
- Excessive filter bag wear,
- Control valves fully open (loss of control).

Escalation will obviously compromise the associated primary production process (smelting and anode baking respectively), which is unacceptable. Replacement or overhaul of the underperforming system comes at a substantial and possibly prohibitive CAPEX penalty and debottlenecking or partially upgrading the system is usually more attractive. For optimized performance and capital allocation, there is a structured, step–wise strategy towards this debottlenecking process.

2. Equipment Capacity vs. System Capacity

For obvious commercial reasons, during a system's design phase, engineers do their utmost to calculate equipment size to suit nameplate capacity. Subsequently, during the procurement phase for reasons such as standardization, guarantees and the like, larger equipment is selected. With any industrial system, there is operational margin which is unevenly distributed over the system. Figure 1 illustrates how for such a system, in new and "as built" condition, system design capacity and capacities for individual pieces of equipment are related. The margin in capacity distributed across the system is the system's creep potential.

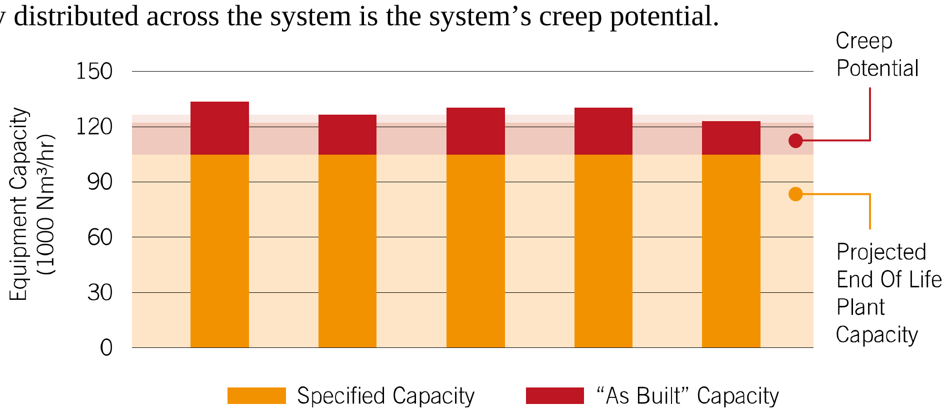

Figure 1. System capacity (new plant, Note: Y–axis is generic).

During the system's operational life, capacity creep is commonly implemented as a strategy to increase the system's capacity without investment. Capacity creep is the process of adjusting operations in minor steps to find the limit imposed by the capacity of the piece of equipment with the least margin or headroom in terms of capacity. Once operating on this limit, capacity creep may continue if further improvements can be unlocked at minor cost. For further plant capacity increase, more substantial investment may be required to remove the bottleneck. Once such a step change is made, cost to capacity ratios dictate that the capacity creep process continues in order to arrive at the next optimum for plant capacity at any given bandwidth of cumulative expenditure. Figure 2 illustrates how capacity creep and step changes take place against their respective cost: optimum operating cost structures for production are always at those operating points directly before a step change is required.

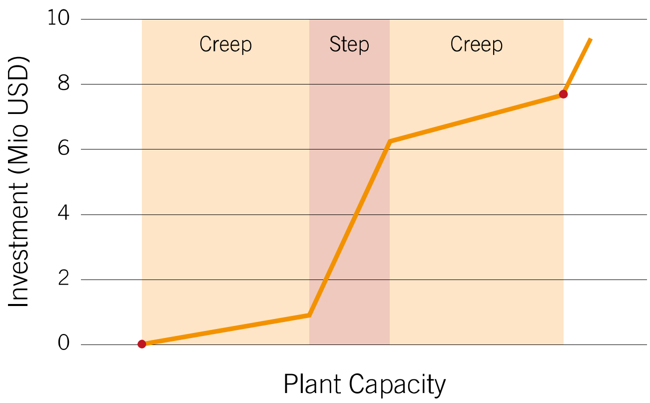

Figure 2. Capacity vs investment: Creep phases and step change (Note: Y–axis is generic).

As the system approaches the end of its technical lifetime, capacities of individual pieces of equipment (regardless of whether a capacity creep strategy has been implemented) will have drifted away from their nameplate capacities in many cases and a similar analysis of individual equipment capacities versus desired and actual system capacity can be made.

Once the system was stabilized, the unused spray lances were removed from the process to prevent carbon and soot accumulation in and around the nozzle. The temperature control loop was monitored and tuned as the operators and technical staff became familiar with the operation.

After commissioning, there was barely a hiccup in the bake furnace operation and fugitive emissions were held to a minimum to the satisfaction of all parties involved. After more than 15 000 working hours there was no reported injury.

Figure 9. New conditioning tower alongside existing tower.

The conscientious approach to the project kept the costs in check by re–using existing equipment where possible and the site team was able to make progress with the installation throughout the Quebec winter to meet the March start–up date. Careful preparation and planning allowed for a smooth transition from the old cooling tower to the new Conditioning Tower measuring almost double in size. The performance stability of the new tower has been recognized by ABI and all parties are very satisfied with the installation.

5. Conclusion

A structured approach is presented for modernizing and debottlenecking industrial systems based on establishing current and future operating points, identifying operational bottlenecks and evaluating options for modernization and debottlenecking for individual pieces of equipment making up the system. The modernization and debottlenecking is looked at from different angles, including required capacity, technical possibilities, investment cost and feasibility of installation/construction to arrive at the most efficient expanded capacity of the system. This strategy by its nature and origin can also be applied to larger units such as primary smelters to arrive at the most economical solutions.

Turning theory into practice requires solid experience in brownfield modernization and optimization, since these working situations induce practical and operational conditions entirely different to situations such as expansion projects or operations where associated plant equipment is decommissioned for the tie–in of new equipment.