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Performance Enhancing Benefits of Applying Redundancy and On-line Serviceability to Key Equipment at SaskPower's BD3 Capture Plant

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Abstract

As the world's first fully integrated, industrial, post combustion CO_2 capture facility on a coal fired power station, SaskPower's Integrated Carbon Capture Storage Project on Boundary Dam's Unit 3 pioneered the way for full scale carbon capture facilities around the world. The capture facility at SaskPower's Boundary Dam Unit 3 (BD3), commenced operations in October of 2014 and continues to operate today. As is commonly experienced with "first of kind" projects, the capture facility at BD3 experienced unforeseen operational challenges which hindered its overall performance and significantly reduced its reliability. Unfortunately, such challenges, although characteristic in nature for innovate projects, were scrutinized and emphasized which has served to deter the much-needed global deployment of CCS. Solutions to these challenges are crucial not only for improving the reliability of the individual facility but for establishing and strengthening global perception and confidence in CCS as a CO_2 mitigation solution.

Evaluating the historical operational data of the capture facility at BD3 in the first years of operation prompted initiatives to improve the capture facility's reliability. This paper details the engineering efforts and operational impact of upgrades that were applied to the facility in order to improve its reliability. This formal process evaluated all of the first contingency process equipment in the facility to assess operational history, process impact, potential upgrades, and the cost and benefits of the potential upgrades, in order to assemble the scope of work for the upgrade work. As an example, the lean rich heat exchangers, a set of six large plate and frame heat exchangers arranged in a three parallel by two series configuration was identified as a source of performance limitations. Difficulties with declining coefficient of heat transfer and limitations on flowrate as the heat exchangers fouled were cited as contributing to the overall reduction in capture rate experienced by the facility, and necessitated outages for remediation. Various options were considered for improving the performance of this key equipment and are discussed in detail. Options included: scheduling reoccurring maintenance for cleaning and service of the heat exchangers, increasing the number of plates of the heat exchangers, adding isolations for on-line maintenance with partial capacity loss, and installing a redundant heat exchanger set to allow on-line maintenance with no capacity loss. The challenge with installing these modifications factored significantly in the economics and heavily influenced the modifications chosen. If implemented more cost effectively as part of the original design, more robust approaches would likely be chosen.

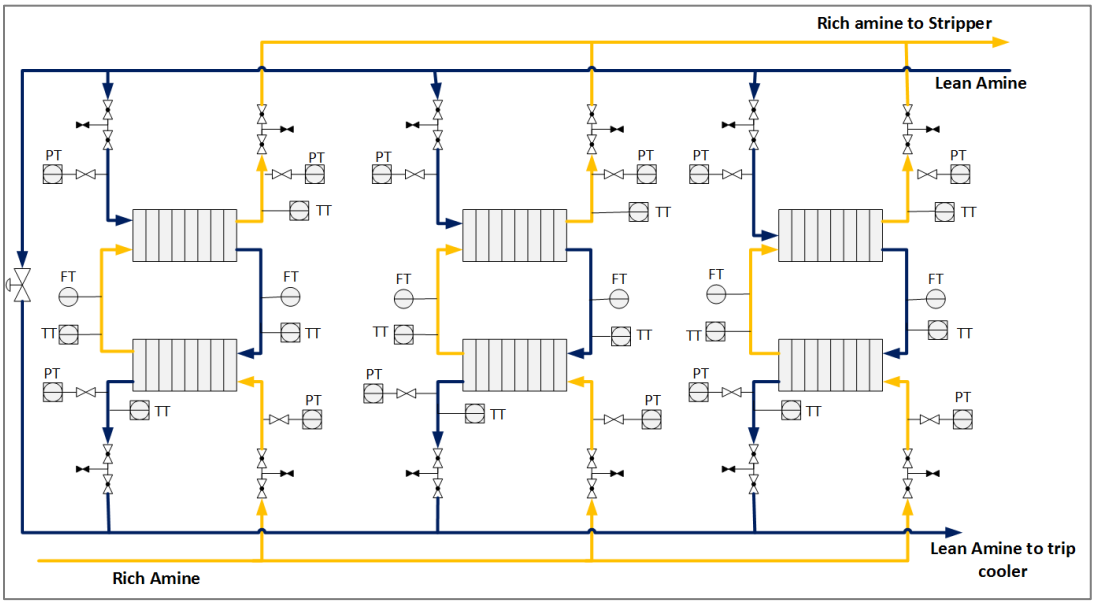

Figure 1. Schematic of the lean rich heat exchanger showing redundancy and isolations that were added

As expected, correcting the difficulties associated with the lean rich heat exchangers, and the other upgrades that were implmented improved the performance and reliability of the capture facility. Comparisons of capture facility performance prior to and following the modifications confirmed this as availability improved to 94% in 2018. Furthermore, data evaluation indicated that redundancy and on-line serviceability should be considered design standards in future amine-based post combustion CO2 capture facilities. In fact, economics favour the installation of such redundancy during construction as it is significantly cheaper when compared to retrofit installations. Increased deployment of CCS is essential for CCS technology evolution and refinement and will be dependent on improving the performance of existing CCS facilities.

Keywords: Carbon Capture and Storage, Post Combustion CCS, Boundary Dam Unit 3, Process Redundancy, Perfomance Reliability, Coal fired power station.