CYCLIC STEAM STIMULATION (CSS)

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OPERATIONAL FEASIBILITY EVALUATION AND READINESS FOR SUCCESSFUL EXECUTION IN HEAVY OIL FIELDS

R FIGUERA, JW MOLINA, J RODRIGUEZ, JD MOLINA, F MOLINA, J BODHANWALA
NAKASAWA MINING & ENERGY LTD / NAKASAWA INDIA PRIVATE LIMITED

ABSTRACT

The era of easily extracted oil has come to an end, and the pressing need to invest in enhanced oil recovery technologies has become inevitable in order to meet the ever-growing demand. With significant reserves of heavy crude oil found worldwide, Cyclic Steam Stimulation (CSS) emerges as one of the most suitable methods for achieving increased short-term production.

Therefore, this paper presents a comprehensive evaluation of the operational feasibility and readiness for executing CSS in Heavy Oil Fields. The objective of this study is to assess the organization's capabilities and determine the necessary considerations for a successful CSS project implementation. Through a detailed analysis of technical aspects, including mobility, supplier experience, delivery time, and design considerations, stakeholders can make informed decisions regarding resource allocation, budgeting, and timelines.

The evaluation highlights the importance of a reliable and efficient Steam Generator capable of producing high-quality steam for CSS operations. It emphasizes the significance of supplier experience in CSS operations and the adherence to industry standards. Furthermore, the evaluation emphasizes the adherence to timelines specified in bidding documents to avoid any loss of production.

By addressing these key aspects, this study aims to provide insights and recommendations that enhance the operational efficiency and feasibility of CSS projects in Heavy Oil Fields. This research contributes to informed decision-making and enables organizations to optimize resource utilization and achieve desired outcomes within designated timeframes.

Keywords: Cyclic Steam Stimulation (CSS), operational feasibility, Heavy Oil Fields, steam generator, supplier experience, project implementation.

INTRODUCTION

The CSS Operational Feasibility Evaluation provides a comprehensive assessment of the organization's readiness and capability to execute the steam service contract in Heavy Oil Fields. By conducting a thorough analysis of various technical aspects, stakeholders gain valuable insights into the project's practicality and can make informed decisions regarding resource allocation, budgeting, and timelines. This evaluation ensures that all necessary considerations are taken into account for a successful CSS project execution.

Most Heavy Oil Fields requires a reliable and efficient Steam Generator capable of producing steam with at least 90% quality, crucial to the success of the CSS operation. To ensure a successful development of a Steam Injection Project, it is essential that the supplier or contractor adheres to the premises specified by the client (bidding documents.

MAIN PREMISES:

1. **Mobility:** Maximizing efficiency in Steam Generation and Injection the evaluation begins by analyzing the mobility factor. The choice between a stationary or mobile steam generator is critical and depends on the duration and location of the steam injection cycle. For long-duration cycles at a single site, a stationary generator mounted on a skid is suitable. However, for short cycles at different wells, a mobile generator mounted on a trailer provides flexibility and ease of mobilization. By selecting the appropriate option, time and cost associated with relocation can be minimized, enhancing operational efficiency.

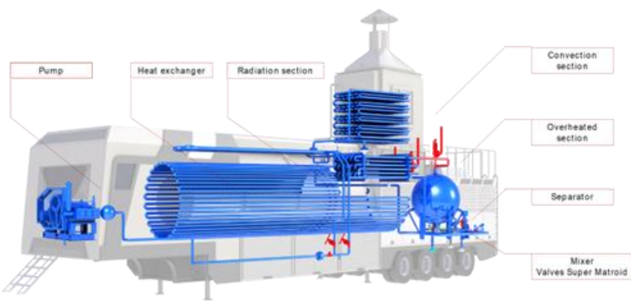

Figure 1. Portable Generator 25 MMBTU/HR-trailer-mounted.

2. **Supplier Experience:** Ensuring Expertise in CSS Operations The evaluation emphasizes the significance of supplier experience in CSS operations. The awarded contractor must demonstrate proven expertise in manufacturing high-pressure, high-temperature portable steam generators. Whether through in-house manufacturing or an experienced Original Equipment Manufacturer (OEM), compliance with ASME and IBR standards is essential. A track record of successful CSS operation project execution showcases deep understanding and proficiency beyond simple steam injection, contributing to the overall feasibility and success of the project.

3. **Delivery Time:** Meeting Timelines to Avoid Production Loss Adhering to the mobilization and delivery dates specified in the bidding documents is crucial to prevent any loss of production. The evaluation highlights the importance of timely execution to ensure a smooth transition and minimize disruptions in ongoing operations. By strictly following the proposed timeline, the CSS project can proceed efficiently, achieving desired outcomes within the designated timeframes.

4. **Technical aspects (Design):** Ensuring Safe and Efficient CSS Operation Technical aspects play a pivotal role in the operational feasibility of the CSS project. The evaluation focuses on key design considerations to ensure safe and efficient steam generation and injection:

   a. **Boiler capacity and pressure:** The evaluation examines the bidding document's specifications, taking into account the maximum operational requirements and design pressure considerations. Optimal design capacity and pressure, aligned with engineering practices and safety buffers, are crucial for smooth CSS operation. Meeting these requirements ensures reliable performance and avoids potential risks associated with exceeding operational limits. It is common engineering practice to operate a boiler with an operational safety buffer, limiting it to no more than 85% of the designed output capacity. The design pressure should be 10% higher than the working pressure.

   b. **Control System:** The control system architecture of the steam generator plays a crucial role in safe and efficient operation. A CSS process demand the inclusion of a comprehensive Programmable Logic Controller (PLC), panel view (HMI), and smart electronic transmitters controlled by custom programmed operating software specifically designed for CSS operation. The control program should be user-friendly, feature a self-diagnostic mode and keep a history of vital operating parameters; as well as having the ability to archive the data of the flowmeter measurements and generate daily reports for the client.

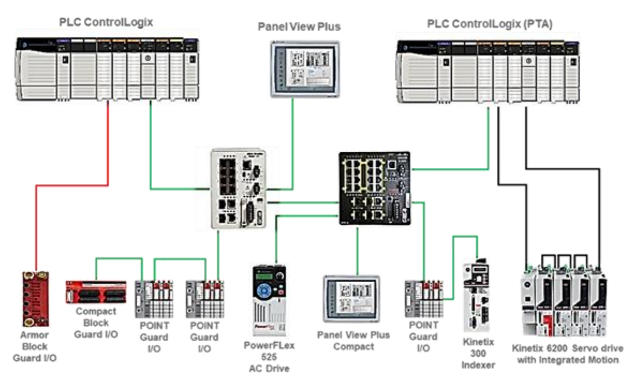

Figure 2. Control System / PLC System Architecture.

   c. **Required pipe thickness for calculations**: ASME and IBR codes require specific tolerances to determine the pipe/tube thickness based on the designed boiler pressure. These tolerances include a 3 mm corrosion allowance and a 12.5% commercial thickness tolerance factor. Applying these tolerances, the minimum required pipe thickness for different pipe sizes can be determined to comply with the code. For example, the minimum required pipe thickness for a 1 ½" tube is 6.37 mm, for a 2" tube is 7.17 mm, for a 2.5" tube is

8.01 mm, and for a 3" tube is 9.06 mm. In the case of a cylindrical wound coil, such as the radiant coil (combustion chamber), additional thickness thinning allowance may be necessary due to rolling.

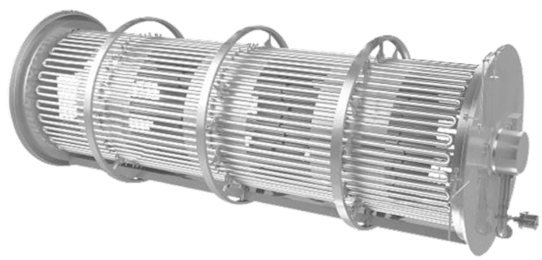

Figure 2. **Radiant section pipe.**

d. **Online remote Monitoring of the steam:** An online remote monitoring ensures continuous oversight and allows for quick response to any operational issues. Generally, the steam quality is measured by chemical titration method every hour by the operator to ensure it stays within prescribed limits. An advanced steam generator offers an additional feature program to continuously calculate and display the steam quality in a Panel view. This feature is crucial for taking timely action to correct the operating parameters of water, steam, and combustion in case the steam quality falls below the desired level.

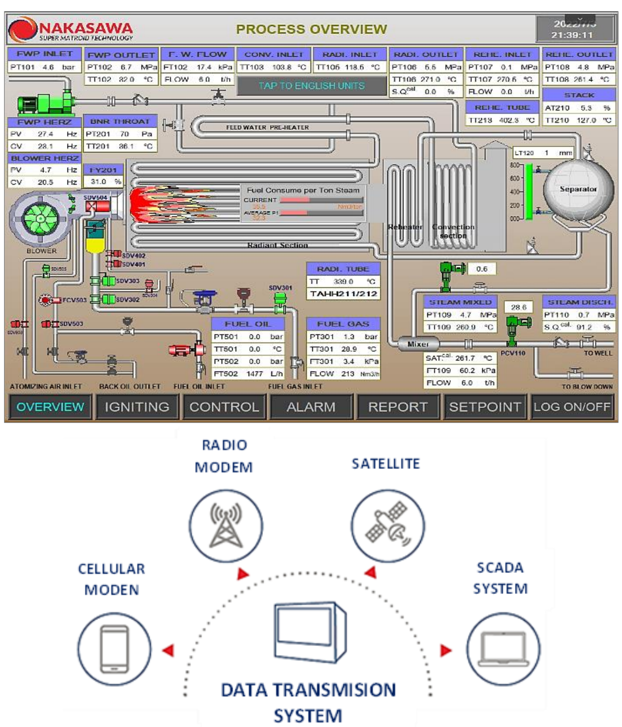

Figure 3. **Online remote Monitoring System.**

e. **Steam quality:** The evaluation highlights the client's requirement for a minimum steam quality of 90%. The selected vendor must explain and demonstrate their strategy for achieving such high-quality steam. Overfiring, which can lead to tube overheating and internal scaling hazards, should be avoided. Additionally, the installation of a steam separator at the outlet, which wastes water and heat, is discouraged due to increased operating costs and environmental impact.

Figure 4. **Integrated High Quality Steam Technology.**

f. **Security Controls:** Ensuring Safe and Environmentally Compliant Operations The evaluation emphasizes the importance of security controls in CSS operations. Suppliers must utilize NFPA-approved burner and fuel train safety controls to guarantee safe operation. Compliance with local environmental emissions regulations ensures the mitigation of exhaust gas emissions, promoting environmentally responsible practices.

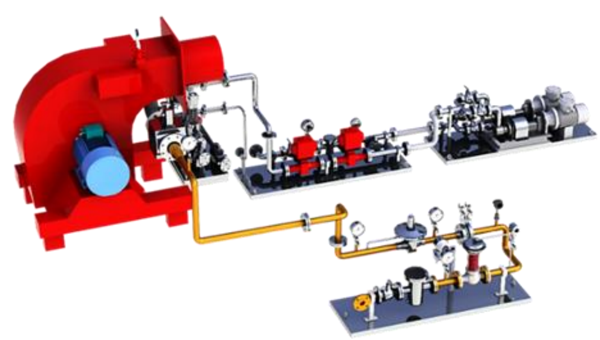

Figure 5. **Fuel injection system.**

g. **Added know-how value:** Leveraging Expertise for Optimal CSS Operation. The evaluation must recognize the value of the Contractor's Supervisors and Engineers in providing added know-how value to the client. Their assistance in calibrating steam delivery requirements, such as steam pressure and rate of steam flow gradient, enhances collaboration with oil company field engineers. This collaboration ensures the alignment of CSS operations with well completion and behavior, optimizing performance without incurring additional costs.

Conclusion:

The CSS Operational Feasibility Evaluation provides a comprehensive assessment of the organization's readiness and capability to execute a CSS service contract in any Heavy Oil Field. By evaluating mobility, supplier experience, delivery time, and technical aspects such as boiler capacity, pipe thickness, control system design, steam quality, security controls, and added know-how value, stakeholders gain valuable insights into the project's feasibility. Addressing these factors ensures a solid foundation for successful CSS project execution, maximizing operational efficiency and achieving desired outcomes.

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