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Kingdom of Saudi Arabia

Digital Insights:

Marjan implements modern flaring technologies into Tanajib Oil plant

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ABSTRACT

Marjan Increment Program is one of Saudi Aramco's mega programs, aimed at significantly enhancing the Kingdom's crude oil production capacity. Targeting an production capacity increase of 300 thousand barrels per day (MBD), the program supports national energy security and contributes in meeting global energy demand.

As part of this large-scale program, Marjan Onshore Oil Facilities team was tasked with expanding and upgrading Tanajib oil plant originally constructed in the mid-1980s. While the plant had proven reliable over decades of continuous operation, it was equipped with a conventional flaring system designed for a capacity of 500 MBD. With the planned expansion, the existing flaring infrastructure required a complete overhaul—prompting the installation of a new, advanced smokeless flare system.

INTEGRATION OF A SMOKELESS FLARE SYSTEM

A key component of the upgrade project was the replacement of the legacy flaring system with a smokeless flare system. This upgrade required complex, multidisciplinary engineering, involving process design, piping, structural modifications, and both static and rotating equipment. One of the most significant challenges was integrating the modern flare technology into a facility that has operated continuously for over 40 years. All work was executed with minimal disruption to ongoing operations, while strictly maintaining safety measures and complying with environmental regulations.

The newly implemented flare system is designed to serve as a critical safety and environmental safeguard. It is engineered to handle hydrocarbon and toxic gas releases from process units by safely combusting these gases without producing visible smoke, which is enabled through the utilization of a flare gas recovery system. In oil and gas facilities, flaring serves two (2) vital purposes: protecting personnel and equipment from overpressure and managing unplanned emissions in an environmentally responsible manner.

All major process units are connected to the flare system via pressure relief and control valves, ensuring rapid and safe disposal of excess pressure or hazardous gases.

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DESIGN OF THE UPGRADED FLARING NETWORK

To accommodate varying gas compositions, flow rates, and pressure levels, the upgraded flare system was segmented into three (3) subsystems: High-Pressure (HP) Flare System, Low-Pressure (HP) Flare System, and a Common Flare System

Each system is equipped with dedicated knockout drums to remove entrained liquids prior to combustion, ensuring safe and clean flaring while protecting downstream equipment.

HIGH-PRESSURE FLARE SYSTEM

Designed to manage gas releases at or above 50 psig, the HP Flare System integrates both new and existing equipment into a unified header system. It includes a high-capacity flare stack, a knockout drum, pumps, and fast-acting valves. A notable safety feature is the use of buckling pin pressure relief devices, calibrated to activate at 8.8 psig. When system pressure exceeds this threshold, the pin buckles, immediately redirecting gases to the flare stack for combustion.

Capable of processing up to 290 million standard cubic feet per day (MMSCFD) of gas, the HP system ensures smokeless operation through advanced combustion efficiency and flame control technologies.

LOW-PRESSURE FLARE SYSTEM

The LP Flare System handles gas discharges below the 50 psig. Similar to the HP system, it includes a dedicated flare header, knockout drum, flare stack, and buckling pin valves. With a capacity up to96 MMSCFD, the new LP system replaced the existing LP network and is designed to manage a wide range of gas compositions without visible flaring, thereby minimizing environmental impact.

A key design decision was to separate the HP and LP systems to avoid backpressure, which could impair the performance of sensitive process equipment. This approach also optimized both construction and operational costs while improving overall system reliability.

COMMON FLARE SYSTEM

To provide redundancy and operational flexibility, a Common Flare System was incorporated into the design. It features its own header, stack, and knockout drum and is utilized during operational upsets, emergencies, or maintenance periods when either the HP or LP systems are offline. This ensures continuous flaring capacity and adds a layer of assurance during peak load scenarios, enhancing the plant's overall resiliency and safety.

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FLARE GAS RECOVERY SYSTEM

To further improve environmental performance and reduce hydrocarbon loss, the Flare Gas Recovery System (FGRS) captures gases that would otherwise be flared and reintroduces them into the upstream process for reuse. Under normal operations, gases from the HP and LP flare headers are routed to their respective knockout drums, where liquids are automatically discharged to Low-Pressure Degassing Tanks (LPDT) via level control valves.

The dry gases are then compressed using atmospheric pressure compressors—existing units for the LP system and newly installed ones for the HP system. This configuration ensures compatibility with varying pressure levels and mitigates the risk of liquid carryover, which can lead to compressor trips and system shutdowns.

By reintegrating recovered gases into the plant's processing cycle, the FGRS significantly reduces routine flaring, lowers emissions, and enhances overall energy efficiency. This system also contributes to economic savings by preserving valuable hydrocarbons that would otherwise be lost.

CONCLUSION

The successful implementation of the smokeless flare and flare gas recovery systems at the Tanajib oil plant marks a major milestone for the Marjan Increment Program. This comprehensive upgrade resolves multiple long-standing challenges related to safety, environmental compliance, and equipment reliability. It enhances the plant's capacity to manage emergency discharges, process upsets, and routine gas venting—without compromising safety or environmental standards.

This modernization effort is a critical step in aligning legacy infrastructure with modern operational goals and sustainability commitments. By integrating advanced flare control, smokeless combustion technologies, and gas recovery technologies, the upgraded system ensures compliance with current and future regulatory requirements. It also supports Saudi Aramco's broader vision of achieving carbon neutrality by 2050.

Ultimately, this project serves as a model for cutting-edge solutions into existing oil and gas facilities across the Kingdom, setting a benchmark for future upgrades within the industry.