EMISSION ENHANCEMENT

Jim Deller, ClearSign Combustion, USA, and Andy Smith, ASHCOR, USA,
introduce an efficient combustion solution for oil and gas operators that can increase DRE while lowering NO_x.

Flaring is a widely used practice by operators in the US and throughout the world to dispose of natural gas or associated gas. Situations can arise where infrastructure is absent or insufficient to move this gas to market and flaring is used to safely dispose of the gas.

The use of enclosed combustors as a method of flaring has become a popular choice for operators needing greater control over emissions (unburned hydrocarbons, carbon monoxide [CO], nitrogen oxides [NO_x]), safety, and non-visible flames. Whether used as a primary means for associated gas removal or as a backup to gas capture systems, enclosed combustors face the same stringent emission regulations and permitting limitations as open flares.

ClearSign Combustion and ASHCOR have developed a partnership which introduces a unique second generation ClearSign Core burner design in an enclosed combustor (Figure 1). This achieves 99.99% destruction and removal efficiency (DRE), virtual elimination of volatile organic compounds (VOCs), and <5 ppm NO_x.

Enclosed combustors

Enclosed combustors isolate the combustion process from weather and better confine the exhaust plume, reducing the penetration of wind or other conditions

into the enclosure. However, enclosed combustors can potentially elevate NO_X emissions if the excess air ratio is not maintained or the enclosed combustor is not properly engineered. When a flame is enclosed, it is less able to radiate its heat to the atmosphere. If excess air ratios are insufficient, the temperature inside the stack will rise. Such high temperatures can create additional thermal NO_X, the primary mechanism contributing to overall NO_X emissions. NO_X is kinetically controlled, meaning it requires sufficient time and temperature to form.

ClearSign Core technology delays ignition by incorporating a high-temperature porous ceramic matrix positioned a few feet away from the fuel-air injection plane. Fuel and air are thoroughly mixed before reaching the matrix and entrain internal flue gases that dilute the mixture before being combusted. The mixture is then ignited by a continuous pilot and contained within a flame length that is typically less than 12 in. Since the high temperature porous ceramic has significantly better emissivity properties than a luminous flame, much more of the thermal energy is radiated into the combustion chamber than in a conventional burner. The thorough mixing of fuel and combustion air, combined with the entrained internal flue gases and enhanced radiation, result in a lower peak flame temperature; and through the combination of less time and lower peak temperature, less thermal NO_X is generated while also promoting complete combustion and destruction of VOCs. It is important to note that the chamber temperature of the enclosed flare is maintained or slightly elevated, thus promoting a higher DRE in the same combustor size as conventional burner technology.

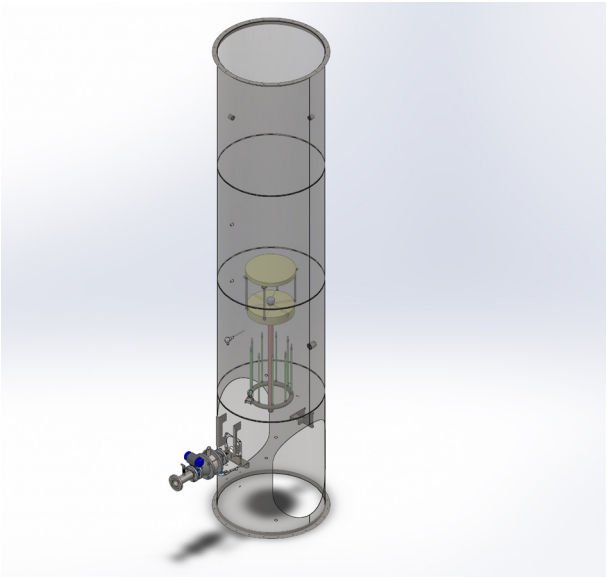

Figure 1. ASHCOR enclosed combustor featuring second generation ClearSign Core burner design.

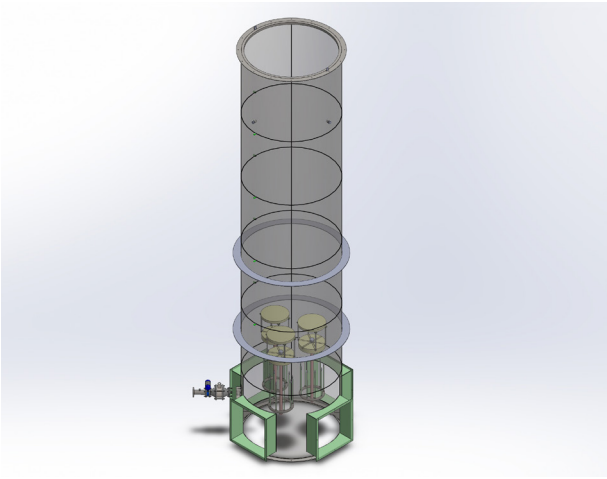

Figure 2. ASCHOR enclosed combustor featuring modular ClearSign Core burner design for site conditions of 32 million Btu/hr.

Unit overview

Enclosed combustion devices were once chosen based upon the most affordable option and only met minimum regulations set forth by the respective regulatory agencies. As years – even a decade – have passed since regulations were introduced in the US and Canada, revisions have been made, and control shifted to states and provinces with more stringent regulations and severe repercussions for violating regulations, including reduced production. Now more than ever, operators are evaluating the lifespan of their combustion technology along with its compliance with environmental requirements and the reputation and initiatives of their organisations.

The ClearSign Core Pod being used in ASHCOR enclosed combustors is a modularised variation (Figure 2) of the previous Duplex technology that integrates the mixing, ignition and stabilisation features into a compact burner package.

With a natural draft design, airflow does not require a blower as the heat from the combustion reactions will provide sufficient draft to induce airflow through the louvers of the combustor. The louvers may be manually set or automatically adjusted to a desired set point.

With overall emissions, site safety and operator budgets being top of mind, the ClearSign Core Pod's modular design allows for the retrofits of existing combustion systems, offering controllability of units previously deemed unsafe, unreliable or out of emissions compliance. Given a set of unit drawings and gas analysis, retrofits are feasible and usually only require small modifications to the internal fuel manifold. It offers large turndown ratios and is designed with multiple gas streams to accommodate various pressure streams and/or process streams.

As ignition occurs after good mixing and is stabilised on a bluff body, flame length becomes very short compared to the flame length of traditional burner technologies, reducing the most common issues facing enclosed combustion devices; smoke and flames exceeding the height of the stack. By moving the combustion process away from both the inlet and outlet of the enclosed flare, combustion noise is also greatly reduced.

Units utilise a pressure transmitter to detect fuel pressure along with a main gas solenoid valve that initiates startup when system pressure is available and closes when the system loses pressure, thereby eliminating potential for flashback. The burner technology is backed by an inline flame arrester for redundant safety and protection.

As all sectors of the oil and gas industry (upstream, midstream and downstream) face regulatory compliance, one problem facing many downstream operators is the sizing of their large, often emergency, flare systems. These traditional flare systems are designed to accommodate large flow rates that may only occur in an emergency situation when the facility needs to evacuate large volumes of gas. However, on a day-to-day basis, the large flare system is tasked with handling a very low volume of residual gas that may burn very inefficiently in the oversized flare system. Regulations are increasingly putting pressure on these low volume gas rates in an attempt to minimise any venting, reduce any unburned hydrocarbons, and at times inefficient combustion. ASHCOR's enclosed flare line, powered by ClearSign Core Pod, is capable of combusting the daily gas volumes in an extremely clean manner, all while keeping the emergency flare system in place to function as intentionally designed.

Demonstrated performance

Field results from previous projects utilising ClearSign Combustion technology have met all stringent California emissions requirements while combusting high Btu content wellhead gas in enclosed flares between 15 – 40 million Btu/hr. Emissions results were field measured at:

- NO_X: 1 – 6 ppm.
- CO: <4 ppm.
- VOC: <3 ppm.
- DRE: >99.99%.

Since the ClearSign Core Pod technology is a modular design, units can be offered in a variety of capacities ranging from 5 to 87 million Btu/hr (or 1.5 – 25.5 MW equivalent).

Conclusion

The technology discussed in this article offers the oil and gas industry the opportunity to combust at a 99.99% DRE and the ability to combust an order of magnitude more volume from the same combustor without modifying an air permit based upon annual VOC emissions limits. Additionally, this DRE performance is achieved with extremely low NO_X emissions that satisfy the most stringent requirements with no visible light pollution and reduced noise pollution.

As oil and gas operators in the US continue to navigate the New Source Performance Standards (NSPS), the introduction of enhanced combustion technology makes the emission debate less pertinent.

Note

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