New Technology: Saudi Aramco High Pressure Air Assist System (HPAAS) for Upgrading Existing Flares to Smokeless Combustion

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1 ABSTRACT

In order to meet increasingly strict environmental regulations and to promote cleaner energy at their facilities, many oil, gas, and petrochemical companies are seeking to upgrade existing flares to allow smokeless flaring of hydrocarbon gases. The main areas of application for these flare upgrades are located in Russia, Africa, Middle East, South America, and other countries with high oil production capabilities and programs. Many of these areas have utility flares located in facilities where a shortage of steam or water prevents conventional smokeless steam-injection systems from being added. Mr. Mazen Mashour of Saudi Arabian Oil Company has patented a new smokeless flaring technology using high-pressure air. This technology is called High Pressure Air Assist System (HPAAS) and has been successfully implemented on dozens of flare systems in Saudi Arabia. It uses supersonic air injection nozzles to inspirate smokeless air at a much higher efficiency than any previous smokeless high-pressure air-assisted flare technology. This has resulted in a system that can be easily retrofitted to existing flare systems in a quick and cost-effective manner. The technology will soon be used at facilities worldwide to create cleaner, more environmentally friendly flare systems. This paper describes the advantages of HPAAS over conventional systems, and also discusses the approach used in developing the technology.

2 BACKGROUND

Saudi Aramco is the largest oil company in the world and has hundreds of flare systems located at their various upstream and downstream facilities. The company's largest concentrations of flares are at the Gas Oil Separation Plants (GOSP) and the corresponding production fields near these locations. Most of the flares at these locations were installed during the past 50 years using utility flare non-smokeless technology and were designed using older API RP-521 guidelines that recommended maximum exit velocities of 0.20 or 0.50 Mach, which results in a large diameter flare tip, often 48"to 84" in diameter [1]. In addition, the available inlet pressures are very low and large diameter tips are required to meet the allowable pressure drop. The continuous operating conditions for these flares are often low flowrates composed of purge gas, control valve leakage, or tank vapors. This mixture of gas exits at a low velocity and smokes continuously, as shown in Figure 1 below.

Figure 1. Typical smoking utility flare

The utility flare tips used at these existing facilities have many drawbacks, including the following:

- Unfavorable Public Perception of Smoke
- Reduced Flare Tip Life from Flame Pulldown
- High Radiation Levels at Grade

2.1 Unfavorable Public Perception of Smoke

A thorough analysis of the chemistry of the combustion process, which is beyond the scope of this paper, would show that a smoking flare and a smokeless flare can both achieve essentially the same destruction efficiency. However, the public perceives a smoking flare to be one that is not burning all of the gas [2]. Public disapproval of smoking flares is quite common in highly populated areas; however, recent changes in the attitudes and policies of individuals and agencies worldwide have resulted in the need for fewer smoking flares even in remote locations. One of the goals of the Kyoto Protocol [3] is a reduction in worldwide flaring. For many of the Saudi Aramco facilities a reduction of flaring is not economically feasible—in these cases a reduction in the amount of smoking flare events is the next best solution.

2.2 Reduced Flare Tip Life from Flame Pulldown

Flame shape can be strongly affected by the wind. A strong wind blowing across a flare tip will cause a low-pressure zone on the downwind side of the flare tip. The flame will seek this low-pressure zone and “pull-down” to stabilize on this downwind side. Flares that operate at low pressure and low velocity (<100ft/s) have flames that are shaped by the buoyancy of the flare gas. However, the buoyancy forces of the exiting flare gas are often too small to overcome the shearing force of a crosswind; thus, the flame position will be dominated by the crosswind. Flares of this type will nearly always exhibit some flame pulldown during any wind over 5mph. When a flame stabilizes on the downwind side of a flare tip, it greatly reduces the life of the tip. The flare tip will experience uneven heating across its circumference, with a hot flame burning on one side and a cooling wind blowing on the other side. This differential heating causes stress in the flare tip shell. Also, as the wind shifts the low-pressure zone around the perimeter of the tip, the tip will heat up and cool down. This cyclic thermal loading causes additional fatigue damage and oxidation, which shortens the life of the flare tip. Figure 2 below shows a flare that has been damaged due to flame pulldown.

Figure 2. Utility flare showing damage from flame pulldown

This kind of poor performance can be avoided for a low-velocity flare tip by adding energy to the flare gas at the exit point, via a steam or air-assist system. Adding high-velocity steam or air to the flare pushes the gas upward, which helps it remain unaffected by a crosswind.

2.3 High Radiation Levels at Grade

Among the different flare designs, low-velocity utility flares exhibit the highest radiation levels at grade. This occurs for several reasons. First, a dark orange low-velocity flame is a more luminous flame, which will emit a higher percentage of radiant heat than a yellow or blue flame, consistent with steam-assisted, air-assisted, or high velocity flares. Second, a low velocity flame will tend to lean horizontally in a wind rather than standing erect. When the flame leans sideways, it is placed in closer proximity to people or equipment located at grade. Since radiation at grade is a function of distance between the radiant body and the point of interest, the radiation level at grade will increase as the flame leans.

3 PREVIOUS ENGINEERING SOLUTIONS AND THEIR DRAWBACKS

In recent years, Saudi Aramco started using smokeless flaring technology for all of their new flare installations to avoid the unfavorable performance described in the items above. In the late 1990's they also decided that a solution was needed for upgrading all of their existing utility flares in operation. Prior to developing any new technology, Saudi Aramco first performed an extensive evaluation of the existing flare technologies to determine if any of them would be feasible for their application.

3.1 Steam-Assisted Flare Tips

Steam-assist, through use of an upper steam ring, is often used to make low-pressure flares burn without smoke for very high flowrates and heavy hydrocarbon gases. A typical steam-assisted flare is shown in Figure 3 below:

Figure 3. Steam-assisted flare tip

Steam injected into the combustion zone pulls in a large amount of surrounding air with it, which creates turbulence and promotes smokeless burning. The main drawback of this type of flare system is that steam is not available in most gas or oil production facilities in the Middle East. Addition of a steam boiler and steam delivery system specifically for the flare system is not cost effective. Even in Saudi Aramco facilities with steam available, the cost to produce steam is extremely high, since sea water must first be desalinated through an expensive process.

3.2 Sonic Flare Tips

If a large amount of flare gas pressure is available (>15psig), then a flare tip can be designed to operate with a sonic exit velocity. Often these tips are designed with multiple flare gas exit ports. A typical sonic tip is shown in Figure 4 below.

Figure 4. Sonic flare tip

Splitting the flame into many smaller flames allows easier access for air mixing. The high exit velocity of the flare gas also pulls in a large amount of surrounding air. Both of these promote smokeless burning. A sonic flare can usually be applied to some of the relief sources for a gas or oil production facility, if the concept of a sonic, high pressure drop flare is considered from the initial FEED study for the plant and included in the design of the relief system. Most Saudi Aramco flares operate at older facilities that were designed considering very low pressure drops in the relief system, with very low available pressure at the flare—often less than 5psig. This low available pressure makes sonic flare tips a poor option for retrofits. Even if retrofit is possible, most plants have separate low-pressure relief gas sources that require a separate smokeless flare system utilizing some other method that is suitable for a low-pressure flare.

3.3 Low-Pressure Air-Assist

A common smokeless method for low-pressure flares is to use a low-pressure air-assist. For this design a high-volume, low-pressure blower located near grade supplies air to the top of the flare tip via an air duct. At the flare tip, this air is mixed with the flare gas at the combustion zone to produce smokeless burning. Since the blowers operate at a very low pressure, the air ducting must have a large enough diameter to prevent excessive pressure drop—most of the pressure drop should be taken at the flare tip. In addition, the volume of air required to achieve the proper combustion without smoke is very large, requiring a large diameter air duct. Thus, the air duct often has a much larger diameter than the gas riser, which can be seen in Figure 5 below.

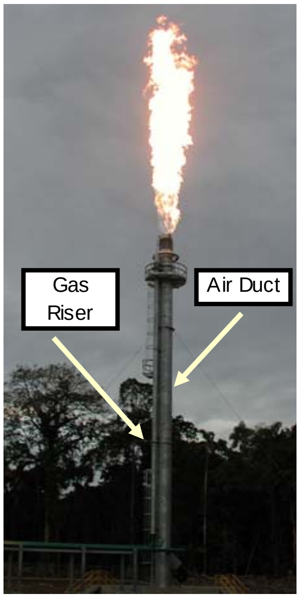

Figure 5. Low-pressure air-assisted flares

The blowers for this type of a flare system are typically vane-axial type . These flare systems are commonly used in the Middle East (including many of the newer Saudi Aramco facilities), because they allow smokeless operation for low-pressure and heavy molecular weight flare gases. The main drawback with this design is that the air injection method is somewhat inefficient. The air is injected into the gas stream vertically from within the air duct. Since it is not injected from an external ring, like a steam-assist, it does not pull in as much surrounding air with it; thus, approximately 30%-40% stoichiometric air is required to make most flare gases burn smokeless.

Low-pressure air assisted flares are generally used for new installations only. As can be seen in the previous figure, the air duct for these flare systems is often much larger than the gas riser. Addition of a large-diameter air duct to an existing flare system results in excessive structural loading to the existing flare structure and foundation. Major structural modifications are required to support this additional load. These modifications make this type of retrofit unreasonable from both cost and schedule standpoints.

4 HPAAS SOLUTION

After reviewing all of these previously described solutions, it was clear that none of them presented a reasonable and cost-effective solution for retrofitting Saudi Aramco's existing utility flares. Therefore, Saudi Aramco chose to develop a new type of smokeless flare design that could be retrofitted at their facilities.

Mazen Mashour, a young engineer with Saudi Aramco, took on the task of developing this design. Mr. Mashour determined that the best solution for Saudi Aramco's application was an air-assisted flare tip utilizing high-pressure air supplied from the plant air system or a dedicated air compressor at each jobsite. Mr. Mashour developed this specialized design over a period of several years, including production of many prototype flare tips that were installed at the various GOSP facilities for testing and optimization of the design. This new technology was named High Pressure Air Assist System (HPAAS) and was patented by Saudi Aramco with Mr. Mashour as the inventor [4]. A brief description of the HPAAS system is as follows:

4.1 Flare Tip

The HPAAS flare tip includes a barrel-type flare tip with a large windshield. In the space between the windshield and the flare tip barrel, a high-pressure air injection manifold is mounted. The air manifold includes supersonic nozzles that are directed upward toward the combustion zone at the flare tip exit. Figure 6 below shows the main components of a HPAAS flare tip.

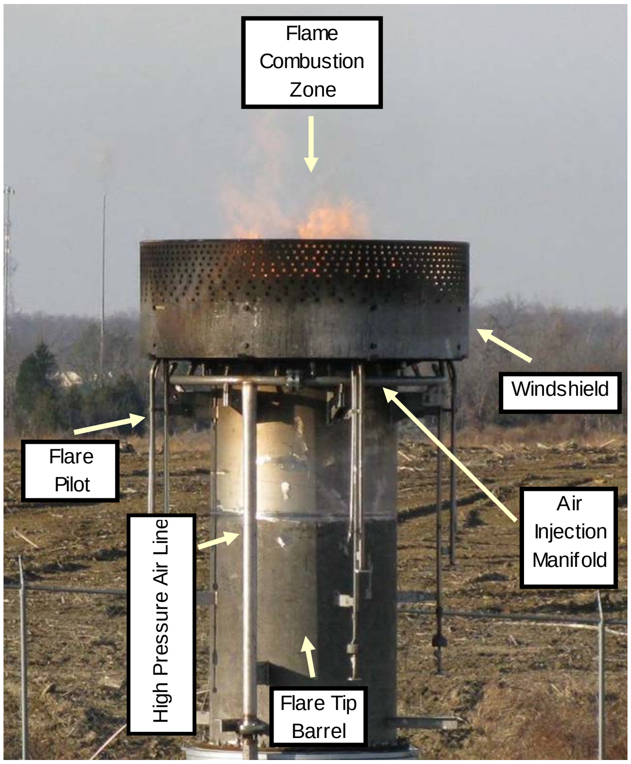

Figure 6. Main components of HPAAS flare tip

4.2 Air Injection

Compressed air is supplied to the high-pressure air line. This air can be supplied from the existing plant air supply or from a dedicated air compressor. This air feeds supersonic nozzles that are located on the air manifold inside the flare tip windshield. These air nozzles inject air upwards into the combustion zone. The air supplied by the nozzles provides only a small portion of the air required for smokeless combustion. Most of the smokeless assist air is pulled in from the surrounding environment by the high velocity of the air nozzles. The path of air within the windshield space, air jet pattern, air momentum, windshield design, and nozzle orientation are all key design features of the HPAAS tip. The air mixes with the combustion gas at the tip exit to produce smokeless flaring.

4.3 Advantages of HPAAS

The main advantages of the Saudi Aramco HPAAS design over existing designs are as follows:

- Easy retrofit to existing flares with minimal installation time
- Robust design
- Adaptable to range of conditions
- Minimized installation and capital cost
- Minimized utility costs for operation

Easy Retrofit. The flare system is one of the most important safety devices in a facility; therefore, at most facilities any time the flare is shut down, the entire facility needs to be shut down. Keeping a gas or oil producing / processing facility shut down is a very costly process. The required shutdown time for upgrading the flare systems should to be kept to a minimum. The HPAAS flare tip is easily bolted to the existing flare stack. The air supply line easily attaches to the flare stack with pipe support brackets. For most applications, this supply line is a 3” or 4” diameter pipe, which has a minor structural impact to the existing flare stack. Normal shutdown time for a full HPPAS flare upgrade is 3 days or less.

Robust Design. Most of Saudi Aramco’s utility flare tips are located in remote areas, where equipment is expected to operate for long periods of time without shutdown or maintenance. The smokeless flare solution for Saudi Aramco needs to follow this same philosophy and be provided with a very robust design. Typical injection systems for low-pressure or high-pressure air utilize air nozzles or air plenums that are located at the top of the flare tip near the tip exit. This location puts the nozzles or plenum directly in the high-heat combustion zone. In order to prevent damage of the nozzles or plenum, a continuous supply of cooling air must be provided, even when not required for smokeless flaring. If cooling air is lost for some period of time, the service life of the flare tip rapidly decreases. In some cases, an air-assisted flare tip can be completely destroyed within a matter of several days when cooling air is lost. The main air injection nozzles used in the HPAAS design are located several feet down from the top of the flare tip, outside of the high-heat zone. This design produces an extremely robust flare tip design that can even operate for long periods of time if the cooling air supply is lost. In order to place the nozzles away from the combustion zone, they must operate with a high enough pressure and velocity to maintain momentum near the tip exit. The best method to achieve this is a nozzle operating at supersonic velocity. Starting at supersonic velocity allows the air stream to still maintain significant velocity and momentum near the tip exit. This high velocity inspirates more ambient air into the combustion zone and provides better mixing of the air and flare gas for smokeless flaring.

Adaptable. The system needs to be adaptable to a range of conditions. The Saudi Aramco facilities operate with a variety of process conditions. Even within the same facility, the process conditions may change over time. Each HPAAS flare tip is provided with multiple connection ports for the supersonic nozzles. A variety of nozzles can be installed in these connection ports to provide different air flowrates, flow patterns, and exit velocities. This allows a significant number of modifications to a single flare tip in order to adjust to future changes in process conditions. This allows the same flare tip to still be used even when process conditions at a facility change significantly after many years of flare tip operation. Changes to the nozzle design can be made during turnarounds without removing the flare tip from the stack. The HPAAS design provides flexibility that is not available with any other kind of flare tip technology. Most other technologies would require a complete flare tip replacement, if these kinds of process changes occurred.

Minimized Installation and Capital Costs. Flare systems are generally considered a safety device and do not generate revenue for the owners. Most of the systems in operation at the

Saudi Aramco facilities provide adequate performance for relief capacity and hydrocarbon destruction efficiency, even though they produce unsightly smoke on a continuous basis. The primary purpose of any smokeless upgrade is to improve the image of these flare systems, which improves the public view of the corresponding facilities. This upgrade is mostly driven by a change in attitudes within the personnel at Saudi Aramco—it is not driven by an environmental decree by the Saudi Arabian government authorities. Therefore, the cost of the flare upgrade needs to be minimized. The cost for the equipment itself and for the installation of the equipment needs to be optimized to provide the most cost-effective arrangement. A robust flare tip design is used to provide a long service life, but the design is still a lower cost than many of the other available flare tip technologies. The air compressors are provided with features to make them suitable for the severe desert environment, but they are purchased from a compressor vendor as package units that are standardized to reduce cost. Very little field work is required for installation of the HPAAS flare tips. Flare tips and pilots bolt to the existing flare stack. Air compressors and buffer tanks arrive at the jobsite fully assembled and are bolted to foundations. Air supply lines arrive in pre-fabricated spools that minimize the amount of field welds. As mentioned previously, the average turnaround time for complete installation of a HPAAS package is 3 days or less.

Minimized Utility Costs. Capital costs and installation costs are important, but the operating cost can be equally or more important, given the fact that flare systems operate continuously. The system needs to provide reliable operation with the minimum amount of utility consumption. The HPAAS flare systems used in Saudi Arabia utilize oil-free screw compressors that are driven by electric motors. The use of a buffer tank and control valve allows the air flowrate to the flare system to be optimized so that only the minimum amount of air for smokeless flaring is used. This arrangement allows the compressor to cycle on and off, which reduces the overall utility costs. Even in Saudi Aramco facilities with existing steam supplies, the cost for running a HPAAS flare system is still much lower than the cost for a steam-assisted flare. Steam-assisted systems have high operating costs due to the costly process of desalinating ocean water for the steam system, maintaining steam boilers, steam traps, condensate systems, and insulation. The HPAAS flare system avoids all of these high operating and maintenance costs by using a rugged, oil-free screw compressor package that is suitable for the desert environment.

5. SOUTHERN AREA SMOKELESS FLARE PROJECT

During the development of the HPAAS technology, Saudi Aramco installed and tested prototype HPAAS flare systems at various facilities; however, these systems were installed on a case-by-case basis at specific facilities. In 2007 Zeeco received a contract for the Southern Area Smokeless Upgrade Project. This project represented the first large-scale step by Saudi Aramco to upgrade their facilities with the HPAAS technology. The project consisted of upgrading twenty-nine (29) flare systems at Saudi Aramco's GOSP facilities in the Southern Area Fields. The flare systems at these facilities ranged in size from 30-feet overall height to 130-feet overall height and from 24" diameter to 48" diameter.

5.1 Scope of Equipment

Equipment provided for each flare system with the upgrade included the following:

- HPAAS Flare Tip
- High-Stability Flare Pilots and Flame Front Generator (FFG) Ignition System
- Retractable Thermocouple System
- Air Delivery System including:
    - Oil-Free Electric Powered Air Compressor
    - Air Buffer Tank
    - Air Control System
    - Air Delivery Piping

On this contract, Zeeco provided the HPAAS flare tips, pilots, FFG ignition systems, and retractable thermocouple system, while the Al-Rushaid Construction Company—a well respected Saudi company—provided the air delivery system and managed the installation work.

HPAAS Flare Tip. The new HPAAS flare tip for each facility was designed by Saudi Aramco based on their design template from previous applications. To ensure the proper design of the flare tips for each facility, Zeeco performed a design verification of the tip design using both CFD modeling and actual combustion testing. To minimize shipping costs and optimize the project schedule, the flare tips were manufactured locally in Saudi Arabia.

High Stability Pilots and FFG Ignition System. During replacement of the flare tips, a new set of high stability flare pilots was provided. These pilots were tested on a HPAAS flare tip at Zeeco's facility to ensure compatibility with the new design. This ensured reliable and continuous combustion of the waste gases. A new FFG ignition system was also provided at each jobsite to provide reliable monitoring and ignition of the flare pilots.

Retractable Thermocouple System. Thermocouples are used to monitor and confirm the presence of a pilot flame. Zeeco designed and supplied retractable-type thermocouples for the HPAAS flare tips. Flare pilot thermocouples are located near the flare tip exit, and the constant large changes in temperature reduce the service life of most thermocouples to only a couple of years. In order to avoid shutting down the flare system for replacement of the thermocouples, Zeeco's retractable thermocouple design allows each thermocouple to be completely removed and replaced while the flare system is in operation.

Air Delivery System. The air delivery system for each HPAAS flare tip included an oil-free screw compressor with an electric drive motor. Downstream of the air compressor, a buffer tank was provided. Controls and instruments were provided to allow proper control of the air flowrate from the buffer tank to the flare system for smokeless operation. Air delivery piping was provided from the buffer tank to the flare tip air manifold. The air flowrate was adjusted as a function of the gas flowrate to ensure the proper amount of smokeless air at all times. The air-compressors were provided with special design features making them suitable for the hot, sandy desert environment. The only utility required for running the compressors was electricity. The system was designed with a very high outlet pressure for the smokeless air. This allowed some extra cushion for pressure drop in the air supply line, which enabled the compressors to be located at a very long distance from the flares, at a location closer to the motor control center. This arrangement not only saved cost in the routing of electrical power for the compressor, but it also provided a better location for future maintenance, since the compressor was located closer to the plant maintenance facilities. A 3" pipe was routed from the compressor buffer tank to the flare system to provide smokeless air for the system.

5.2 Design Confirmation

CFD modeling and full-scale combustion testing were both used to help verify the design of the flare tips. Zeeco's Research and Development Facility provided an ideal location for testing of production flare tips using simulated fuels.

Supersonic Air Nozzle. After receiving preliminary nozzle sizing information from Saudi Aramco, Zeeco fabricated several test nozzles and began comparison testing. The main goal of this testing was to confirm that the nozzle design was suitable for this particular project. The main criteria considered in the nozzle testing included the following:

- Maximize nozzle thrust while minimizing flowrate
- Nozzle must be easily fabricated and reproducible
- Nozzle must be robust in design

Figure 7 below shows the results of the flow testing performed on several nozzle designs.

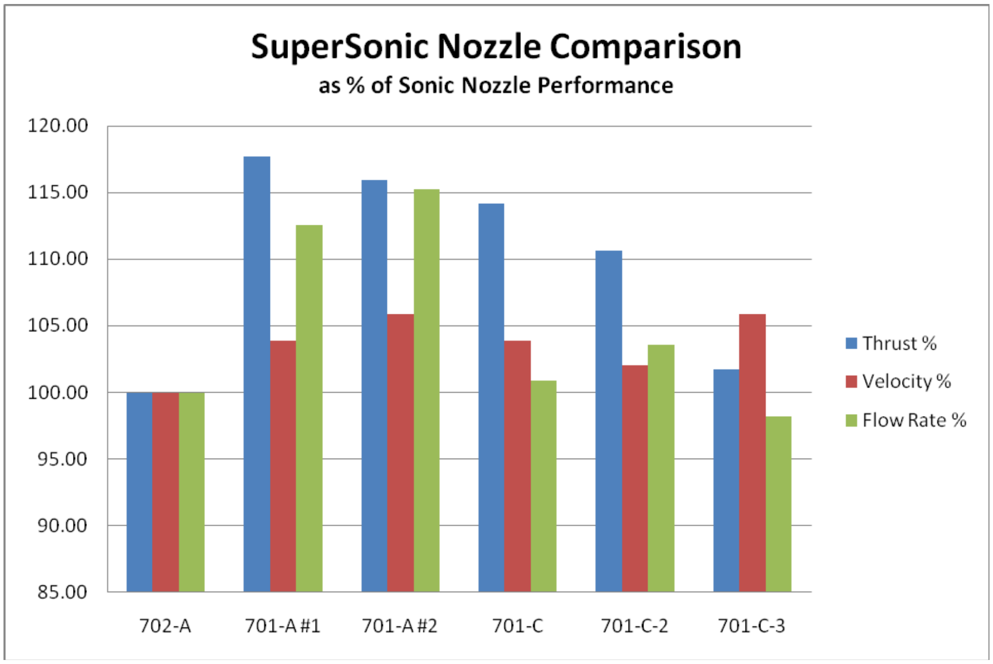

Figure 7. Supersonic nozzle comparison

A sonic nozzle (702-A in the above figure) was used as a baseline for comparison of the nozzles. In addition to the thrust, velocity, and flowrate values established in the initial testing, further testing was performed to compare the momentum of each nozzle as a function of distance. This item was important in the air nozzle comparison, since the nozzles were located away from the combustion zone and had to maintain adequate momentum at the combustion zone for air inspiration and mixing.

It was confirmed that nozzle design 701-C provided the best combination of the required criteria. As a final confirmation of the design, the nozzle was modeled using CFD software to confirm that the desired exit velocity and velocity profile were possible. This model is shown in Figure 8 below:

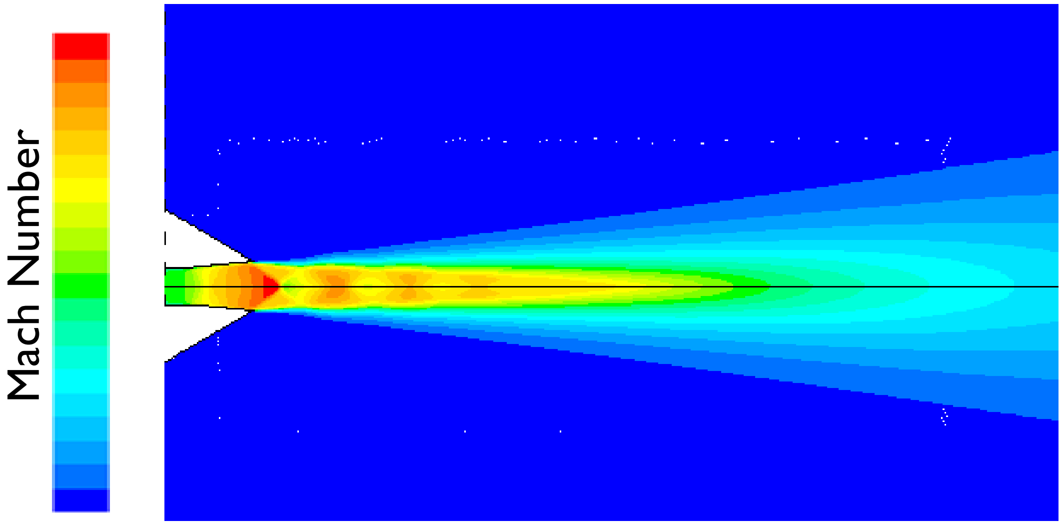

Figure 8. Supersonic nozzle CFD velocity profile

Air Nozzle Location and Orientation. The Saudi Aramco design template for the flare systems provided the key design parameters for locating and orienting all air nozzles; however, before production of the flare tips began, it was necessary for the design to be checked to ensure it provided all of the necessary functions and avoided certain undesired performance characteristics. The main desired functions for the flare tip design were as follows:

- Smokeless combustion for the required flare gas flowrate
- Stable combustion
- Minimize flame radiation
- Achieve required performance under varying gas flowrates and wind conditions

The main performance characteristics to be avoided included the following:

- Avoid burnback inside the flare tip barrel.
- Avoid flame pulldown on the side of the flare tip or windshield.
- Avoid smoking

The CFD model was used to verify the placement and orientation of all air nozzles and the windshield design. The nozzle location and layout needed to provide proper inspiration of surrounding air from the atmosphere and also provide mixing of this air with the flare gas to produce smokeless burning. The flow pattern of the air jets within the windshield area was also analyzed closely to ensure that it achieved the required performance. The CFD model was also utilized to eliminate possible low-pressure zones around the flare tip body that would produce flame pulldown during windy conditions—a situation which tends to shorten the life of the flare tip. Figure 9 below shows a velocity profile for one of the HPAAS flare tips.

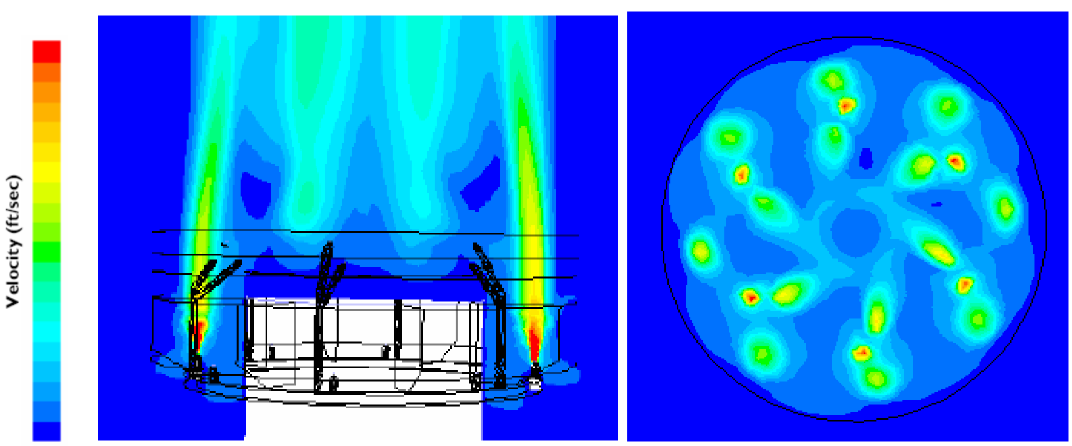

Figure 9. HPAAS flare tip CFD velocity profile

Full-Scale Combustion Testing. After reviewing the tip design in the CFD model, a full-scale production HPAAS flare tip was fabricated. The flare tip was installed in the Zeeco Research and Development Facility. Zeeco selected the worst possible gas cases for the flare tips (relative to smoke production) to use in the testing. Gases were blended in a large mixing tank to provide the proper simulated flare gas. A portable air compressor and air control system were installed to simulate the actual air delivery system.

Mazen Mashour, the Saudi Aramco inventor, was present during the testing to review and confirm that the system was meeting the required parameters for Aramco. Tests were performed over a period of several weeks to confirm the design of the flare system. During this time period, the tip was tested under a variety of conditions including the following:

- Changes in wind direction and wind speed
- Changes in gas flowrate and gas composition
- Changes in air flowrate

During all of these tests, minor adjustments were made to the mechanical arrangement of the flare tip to ensure that the tip provided the optimum performance. Figure 10 below shows the final HPAAS design with and without assist air. The HPAAS design completely eliminated all smoke. It also provided a cleaner, lower-radiation flame that did not pull down on the tip, even during strong winds.

Figure 10. Combustion Testing of HPAAS Flare at Zeeco

After successful completion of the design verification through CFD and full-scale combustion testing, Zeeco was given approval to move forward with fabrication of all HPASS flare tips for the Southern Area Smokeless Project.

6. CONCLUSION

At the time this paper was written, approximately fifteen (15) of the GOSP locations on the Southern Area Smokeless Upgrade Project had been successfully retrofitted with the HPAAS flare systems. According to the current schedule, the remaining GOSP's will be retrofitted before the end of 2009. All of the installed HPAAS tips have provided the same smokeless, low-radiation performance that was desired. The project has been a great success for all parties involved. Figure 11 below is a photo of one of the Saudi Aramco GOSP flares operating with the new HPAAS flare system.

Figure 11. HPAAS flare system installed in the Southern Area

6.1 Zeeco Al-Rushaid Middle East Joint Venture and HPAAS Licensee Agreement

Due to the significant success of the Southern Area Upgrade, Saudi Aramco started plans for upgrades at many of their other facilities in Saudi Arabia. In addition, Saudi Aramco felt that the HPAAS technology would be an ideal solution at many other facilities, including those outside of Saudi Arabia. In order to spread this technology worldwide, Saudi Aramco determined that it would be necessary to partner with an established flare company. In late 2008, Zeeco formed a joint venture partnership with the Al-Rushaid Group in Saudi Arabia. This partnership, known as Zeeco-Al-Rushaid Middle East Limited, will design, manufacture, and sell flare products through a newly established facility in Saudi Arabia. This facility will include an engineering and sales office, a flare system fabrication facility, and a state of the art research and development facility. This will be the first flare company based in Saudi Arabia, providing a key location for serving the Middle East Region. The facility groundbreaking occurred in early 2009. In early 2009, Zeeco-Al-Rushaid Middle East Limited also signed an exclusive licensee agreement with Saudi Aramco for the HPAAS technology. Zeeco-Al Rushaid will be the exclusive worldwide supplier of HPAAS flare systems.

6.2 Future Use of HPAAS Technology

The HPAAS technology is uniquely suited for use in certain key applications, where previous technologies have been unavailable. The best applications for HPAAS technologies are upgrades of existing flare systems, because the HPAAS system can be retrofitted to existing flare stacks very easily and quickly. Most applications only require the addition of a HPAAS flare tip and a 3" air supply line along the flare stack. HPAAS flare systems are generally most effective in facilities that do not have steam readily available (remote locations) or in locations where the cost to produce steam is very high. Common regions with this type of situation include the Middle East, Africa, Australia, South America, Russia, Canada, etc. The technology is also well suited for low-pressure flare tips on offshore platforms or FPSO's.

As discussed in this paper, the HPAAS technology offers many advantages over previous technologies. Zeeco expects that HPAAS flare systems will soon be operating in many different types of facilities worldwide.

7 References

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