PROJECT SUMMARY AND OUTCOMES

REDUCTION OF VENTED METHANE EMISSIONS THROUGH THE CROSSFIRE INSTRUMENT AIR COMPRESSOR

Reducing methane emissions from conventional pneumatic instruments operated on fuel gas supply through field implementation of CROSSFIRE technology at central Alberta wellsites.

Prepared by Spartan Controls as part of the Methane Consortia Program

Table of Contents

Project Summary

This project reduced vented methane emissions from conventional pneumatic instruments and chemical injection pumps operated on fuel gas supply through the installation of the CROSSFIRE instrument air compressor. The project team consisted of seven collaborators including Petroleum Technology Alliance Canada (PTAC), Alberta Environment and Parks (AEP), Carbon Connect International (CCI), Spartan Controls, LCO Technologies, Bonavista Energy and Techmation Electric and Controls.

LCO Technologies has been distributing and marketing oil and gas related instrumentation products for 15 years. The backbone to the business is supplying PANAM Engineers instrumentation however, over the past 7 years, LCO began developing their own product line called the CROSSFIRE which uses an highly efficient variable speed motor with a gear box to drive the instrument air compressor used in this project. Both have been successfully launched in Canada and the United States.

Spartan Controls Ltd. provides automation, valves, measurement, and process control solutions in Western Canada. Partnership with Emerson and other solution providers, enables connection of customers with world-class technology, technical expertise, and full lifecycle services. Spartan Controls is a Canadian, employee-owned company with project experience spanning multiple industries.

The primary goal of this project was deployment of the CROSSFIRE instrument air compressor as a direct means of reducing vented methane associated with conventional pneumatic instruments operated on fuel gas supply. The secondary objective was to integrate compressor performance data with a remote data acquisition system to optimize compressor performance while tracking operations parameters and CO2e reductions achieved. Tracking of operations parameters guided site visits by exception and not routine.

Support from collaborating parties on this project has provided a case study demonstrating measurable impact on reducing the carbon footprint of the oil and gas industry and a positive impact on the Canadian and local Alberta economy. Projects such as this help Alberta position itself as an industry leader for environmentally sustainable energy production. Receiving funding support for this solution has also been integral to further improvements in the capability and reliability of CROSSFIRE technology.

Figure 1: Installed CROSSFIRE air compressor

Technology Summary

The LCO Technologies CROSSFIRE instrument air compressor has been commercially available since 2018 and is a proven technology to both eliminate emissions and optimize performance of the control loop.

The low power CROSSFIRE instrument air compressor has the needed hazardous area certifications. Product training, manuals, and documentation are in place and both Spartan Controls and LCO Technologies to support implementation at a large scale. The CROSSFIRE smart controller comes integration ready, with MODBUS communications built in for seamless connection with a local RTU/SCADA system. It has remote data acquisition capabilities with a permanent record of total stroke counts, vented methane offset, system status and operating conditions. Data can be easily accessed locally or remotely to help quantify air volumes provided. The CROSSFIRE is a common platform system, meaning the motor, the controller, and common base (Figure 2) are the same for each configuration whether chemical pump or instrument air compressor. This provides the same look and feel for operators and fewer spare parts for producers.

Item	Part Description
1	Smart Controller
2	PANAM Check Valve
3	Gear Box and Motor
4	Heat Sink
5	Cylinder with Enclosed Piston
6	Fan
7	Tubing
8	Filter (LCOF-8477259)
9	Common Base

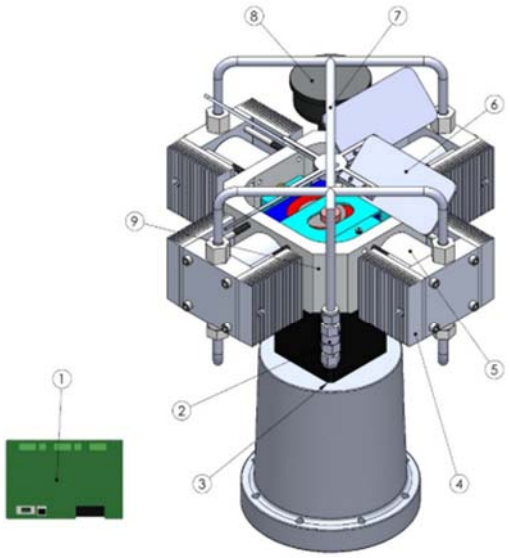

Figure 2: CROSSFIRE air compressor

Purchase and Installation Process

At existing upstream oil and gas sites, the decision to reduce or eliminate vented fuel gas is the challenge. Reduction with carbon offsets has traditionally been more cost-effective, but doesn't result in vent elimination. To eliminate venting, sites need to use the following approaches:

- Shut in
- Capture vent gas
- Electrify pneumatic assets
- Use instrument air (or other non GHG pneumatic media)

This project focused on vent elimination with the last approach. To determine which sites were the best candidates, the following criteria were considered:

- Fuel gas use (purchased, vented)
- Asset type venting
- Horizon for future production – Rate of decline
- Demand reduction needed
- Pump use – Electric or instrument air
- Supply pressure - 35psig or will ESDVs be included (need for higher supply pressure)
- Value of carbon offsets
- Power available at site
- SCADA infrastructure

This 24VDC air compressor was provided in two flavours that were best suited to the site(s) installed at. Where air compressor(s) are added at a given site with grid power, a form of remote power generation is not required. Replacing the existing fuel gas supply from the fuel gas scrubber with a compressed air supply from the LCO CROSSFIRE with the wired-in control board was fit-for purpose and more cost effective. When the unit is packaged in a stand-alone frame with batteries and a solar package, the unit price of the solution is higher, but the install costs are lower.

Based on a project scope of $400K, twelve LCO CROSSFIRE air compressors were installed.

Project Schedule

Baseline data for the sites of interest was first gathered to assess needed air demand and pertinent site-specific install details. Retrofits started in mid-Oct, 2020 and were completed in May, 2021 at pace of one to two per month as aligned best with regular site maintenance and other operations activities. Part of the commissioning effort included ensuring that no unnecessary leaks were present in the pneumatic system. Following commissioning, the operating trends were compared to initial sizing efforts and the findings were shared and included in this report.

Emission Profile

Summary of GHG Mitigated Due to the Project

A summary of the fuel gas volume displaced with instrument air is provided in Table 1.

Table 1: Air Volume Provided with Carbon (CO2e) Impact

Site	Anticipated Air Demand (Sm3/h)	Actual Air Demand (Sm3/h)	Actual Tonnes CO2e/year
1	0.30	0.34	50.5
2	0.16	0.11	16.8
3	0.50	0.48	71.5

4	0.35	0.51	75.7
5	0.31	0.37	54.7
6	0.15	0.11	16.8
7	0.38	0.40	58.9
8	0.37	0.40	58.9
9	0.49	0.31	46.3
10	0.26	0.17	25.2
11	0.37	0.51	75.7
12	0.43	0.57	84.1
	Average	**0.36**	**52.9**
	Total	**4.28**	**635**

Devices operated with instrument air included pneumatic instruments, actuators, and chemical injection pumps. The realized CO2e reduction was lower than allowed for in preliminary assertion because the installed CROSSFIRE air compressors didn't need to operate at higher duty cycle to meet the lower site pneumatic demands. On average the air flow rate provided was 0.36m3/h, which is only about one quarter of what a standard CROSSFIRE air compressor is capable of delivering. Average actuals were also within 0.02m3/h of what was anticipated after a Make and Model device assessment was carried out using the site detailed baseline inventory gathered.

The anticipated CO2e reduction that this project will mitigate is 5,080 tonnes over an 8 year period of time, which is equivalent to about 135 cars off the road. This was determined by review of the operating data and comparison to manufacturer testing. As shown in Figure 3, the red trend is the compressor accumulator pressure in psig, yellow is operating hours and green is RPM of the air compressor motor. A reset was done on purpose about one third the way into this data plot as shown on the operating hours trend. By knowing the discharge pressure, temperature and operating speed of the CROSSFIRE air compressor, the volume of fuel gas displaced in standard conditions was determined using the volume of air provided.

This unit operated in a stable manner after being tuned and was set to keep the supply pressure available in the accumulator between 32 and 35psig as needed to maintain 30psig supply to the pneumatic devices at this site. The pressure in the accumulator was trimmed from the more typical 35-50psig or 80-100psig pressure to reduce power requirements. Consequently, the accumulator was increased in size to ensure sufficient capacity available in the event many dynamic pneumatic actions all happened at the same time.

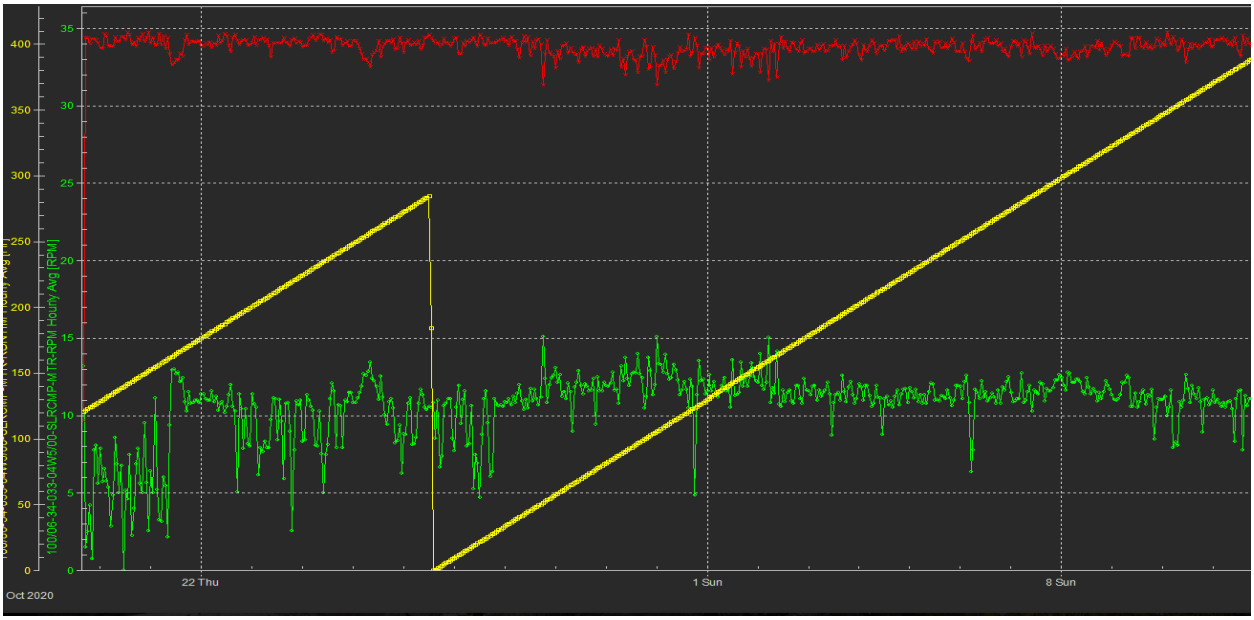

Figure 3: CROSSFIRE instrument air compressor operating trends

Abatement Cost

A reduction of 635 tonnes CO2e/yr. over 8 years results in abatement cost of $78 / tonne CO2e. When including fuel gas savings, the abatement cost is reduced to $74/ tonne CO2e. The lower volume reductions would not provide payback with the current book value of carbon of $40 per tonne CO2e/yr. It is anticipated that payback will be achieved as the value of CO2e/yr. increases to $50/tonne in 2022 and will continue to increase $15/tonne (2023 onwards) until reaching $170/tonne. This increase is anticipated through Federal regulations in Canada. Where the air volume supplied by the CROSSFIRE is its max capable, the abatement cost of this project would be less than $20/tonne.

Conclusion

Project Learnings

Obtaining a proper baseline information is paramount to implementing a CROSSFIRE air compressor. Understanding short and long term outcomes for a given site is also vital. It is also important to be mindful of site specific details and funding program specific criteria to ensure the best CO2e reduction, reliability and project cost outcomes can be achieved. In executing this project, there was consideration for potential negative consequences related to early action. Brownfield upstream oil and gas sites in Alberta are not regulated to be non-venting. In this case, implementing the project with support from the Methane Consortia Program was favourable regardless of future funding programs or offset credit opportunities.

The importance of collaboration cannot be understated. Clear alignment is integral to achieving improved outcomes. Orientation of solution providers with producers wanting to achieve improved outcomes,

instrument and electrical contractors carrying out maintenance and tuning activities, and funding providers is essential. Like other projects, it is really important to identify who is supporting and who will be leading at kickoff so all parties know their role from carrying out the evaluation, to completing field work and reporting outcomes or managing the paper trail.

Eliminating unnecessary leaks is also key. Where carbon offsets are generated this is a must do. In situations where carbon offsets aren't generated, it is also important as eliminating fugitives reduces the duty cycle of the air compressor, conserves power, and helps the CROSSFIRE air compressor asset run reliably for longer.

Technology Learnings

Choosing an air compressor at a site that doesn't need much power to operate is key to reducing total costs at upstream single well brownfield sites. The CROSSFIRE air compressor was selected because of its efficiency. Moreover, choosing an air compressor that can meet the site demand without being excessively oversized reduces total up front capital costs. With the reduced power draw of an air compressor, the costs associated with remote power generation are also mitigated.

Consideration for the size of the accumulator and the consequence of liquid in the accumulator is needed. While using a larger accumulator requires more space in an existing building, it also provides additional reserve pressure to stroke multiple pneumatic valves and pumps at the same time with acceptable level of pressure drop. Increasing the accumulator size increases cost. At the same time, it also reduces the power needed to operate the air compressor because the current draw is proportional to volume and pressure. That reduces remote power costs, which offsets the cost of a larger accumulator. Improved performance was achieved by Implementing the CROSSIFRE air compressor with desiccant drying infrastructure and an automated liquid drain. Pneumatic systems are more reliable when kept clean and dry.

Integrating the operating data into SCADA infrastructure on site has provided the remote insight data needed to monitor health of the pneumatic assets. Where air flow vent rates were trending higher than expected, there's opportunity to flag such as reason to ensure a new leak has not developed for example. By trending the current draw of the air compressor, the health of it can also be determined by comparing that to the power needed to operate at similar conditions in the past. This also provides the means to determine if the unit needs to be serviced.

In the course of deploying the LCO CROSSFIRE air compressor at these sites, the type of air compressor provided was also switched from a dry unit that required lubrication at more frequent intervals than the oil bath type that was later deployed. This improvement, in what is considered the standard product going forward, was a benefit to the producers and had minimal upfront cost impact on the solution. Improving by doing is an evergreen process. Further improvements and tweaks are anticipated with future use of this GHG mitigating technology.