PROJECT SUMMARY AND OUTCOMES

REDUCTION OF VENTED METHANE EMISSIONS THROUGH THE CROSSFIRE CHEMICAL INJECTION PUMP

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

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Project Summary

This project reduced vented methane emissions from conventional pneumatic chemical injection pumps operated on fuel gas supply through the installation of the CROSSFIRE chemical injection pump. The project team consisted of twelve collaborators including Petroleum Technology Alliance Canada (PTAC), Alberta Environment and Parks (AEP), Carbon Connect International (CCI), Spartan Controls, LCO Technologies, Spartan Delta Corp., Vermilion Energy, Ember Resources, CFI Energy Services Corp., Quantum Controls (Newforce), TNT Electric and Controls Inc. and WoodHill Instrumentation.

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 8 years, LCO began developing their own product line called the CROSSFIRE which uses a highly efficient variable speed motor with a gear box to drive the chemical injection pump used in this project, which has 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 chemical pump as a direct means of reducing vented methane associated with conventional pneumatic pumps operated on fuel gas supply. The secondary objective was to integrate pump performance data with a remote data acquisition system to optimize chemical injection rates and reduce chemical use based on real time operating conditions.

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 chemical injection pump

Technology Summary

The LCO Technologies CROSSFIRE chemical injection pump has been commercially available since 2017 and is a proven technology to both eliminate emissions and optimize performance of the control loop.

The low power CROSSFIRE chemical injection pump has the needed hazardous area certifications. Product training, manuals, and documentation are in place and both Spartan Controls and LCO Technologies 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. Chemical injection rates can be automatically adjusted based on downhole operating conditions for chemical savings and optimal injection rates. It has remote data acquisition capabilities with a permanent record of total stroke counts, volume of chemical injected, system status and operating conditions. Data can be easily accessed locally or remotely to use in carbon offset programs. The CROSSFIRE can be configured with one to four standard 5100 series fluid end (as shown in Figure 2) and can therefore replace up to four pneumatic alternatives with one unit.

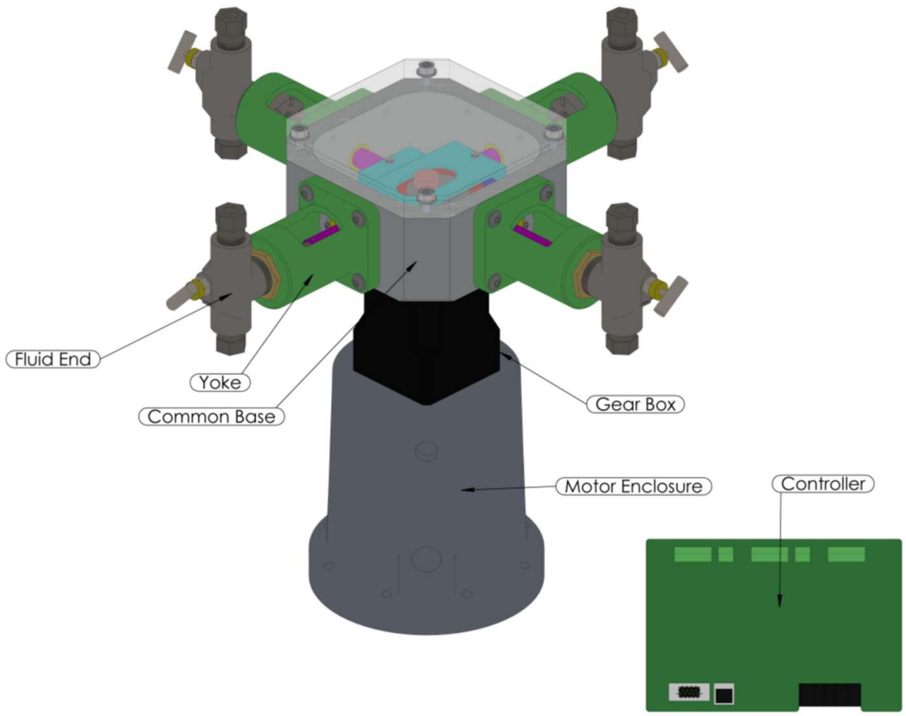


Figure 2: CROSSFIRE chemical injection pump

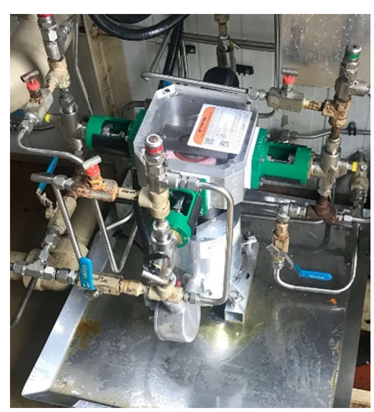
Purchase and Installation Process

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 third approach. To determine which sites were the best candidates, the following criteria were considered:

- Fuel gas use (purchased, vented)
- Pump type venting
- Horizon for future production – Rate of decline
- Pump use – Electric or Fuel Gas
- Chemical injection pressure
- Proximity of pneumatic pumps to each other
- Value of carbon offsets
- Power available at site
- SCADA infrastructure



This 24VDC chemical pump was provided in several flavours that were best suited to the site(s) installed at. Where the CROSSFIRE was added at a given site with grid power, a form of remote power generation is not required. Replacing the existing pneumatic chemical injection at sites that had grid power was most cost effective. Where the grid power or sufficient power available on site (thermo electric generators or other) wasn't available, the unit was integrated with additional solar generating remote power to operate autonomously. For the latter, the cost of the solution was higher, but the units worked just as well in either scenario.

Based on a project scope of $400K (+ GST), with $200K provided by PTAC and $200K provided by Carbon Connect International, 26 LCO CROSSFIRE chemical injection pumps were installed.

Project Schedule

Baseline data for the sites of interest was first gathered to assess pump requirements (plunger diameter, stroke length, RPM, injection volume, injection pressure), power available and pertinent site-specific install details. The first round of retrofits started in early May, 2021 and were completed by the end of May, 2021 at pace of one to four per week. Five more were retrofit in one week at the end of Sept, 2021. Part of the commissioning effort included ensuring that assets were properly grounded.

Emission Profile

Summary of GHG Mitigated Due to the Project

A summary of the fuel gas volume displaced with the electric CROSSFIRE pump is provided in Table 1. Values are estimated because of the seasonality of injection rates. i.e. methanol volume injected to prevent hydrate formation are often higher in the winter than in the summer

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

Site	Anticipated Tonnes CO2e/year
1	48.3
2	48.9
3	27.6
4	27.6
5	54.6
6	41.4
7	27.6
8	340.1
9	236.8
10	27.6
11	109.3
12	164.1
13	103.3
14	35.8
15	48.3
16	48.9

17	27.6
18	27.6
19	54.6
20	41.4
21	27.6
22	502.1
23	435.3
24	163.2
25	41.4
26	27.6
Average	105.3
Total	**2,738.6**

The realized CO2e reduction was in the anticipated reduction range. Early in the execution of the project, the ability to generate carbon offsets from electric pump retrofits was changed from having a 2.5 years window ending on Dec 31, 2022 to an 8 year window. In addition, the value of a carbon offsets is now anticipated to increase above $50/tonne, which meant that some of the retrofits were better suited economically through generation of carbon offsets.

The anticipated CO2e reduction that this project will mitigate is 17,500 tonnes over an 8 year period of time, which is equivalent to about 465 cars off the road.

Abatement Cost

A reduction of 2,739 tonnes CO2e/yr. over 8 years results in abatement cost of $24 / tonne CO2e. When including fuel gas savings, the abatement cost is reduced to $19/ tonne CO2e. The lower volume reductions would still provide payback with the current book value of carbon of $40 per tonne CO2e/yr. It is anticipated that payback will be quicker as the value of CO2e/yr. increases to $50/tonne in 2022 and will continue to increase $15/tonne (2023 onwards) until it is $170/tonne. This increase is anticipated through federal regulations in Canada.

Conclusion

Project Learnings

Obtaining proper baseline information is paramount to implementing a CROSSFIRE pump. For example, confirming that power was available in close proximity and that an RTU is available on site or across the road are key details to be aware of prior to retrofitting. There was much value going to site to scope what needed to be done first to ensure there was a clear plan for what to install and where. In addition, confirming the chemical type that needed to be injected, the packing type that works best, the volume that needed to be injected and the injection pressure was paramount to ensure the pump was fit-for-purpose. Not having a good understanding of seasonal variation would have been detrimental to implementing the correct pump geometry.

Understanding short and long term outcomes for a given site is also vital. For example, in Alberta if a site is presently operating close to vent limits, implementing electric chemical injection pumps helps ensure it remains below vent limits when pneumatics are included in total emitted volumes in 2023. That factor was part of the selection criteria for the chosen retrofit sites

It was 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 yet not regulated to be non-venting. In this case, implementing the project with 50% payment provided by PTAC and 50% payment provided by Carbon Connect International was very 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 every day at sites, and funding providers is essential. Like other projects, it was 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, obtaining payment or managing the paper trail.

Completing these 26 electric pump retrofits in two short periods of time made significant gains in the area of mitigating fuel gas vented volumes and reducing greenhouse gases, which lead to a very positive environmental outcome.

Technology Learnings

Choosing an electric pump that doesn't need much power to operate is key to reducing total costs at upstream single well brownfield sites. The CROSSFIRE chemical pump was selected because of its efficiency. Moreover, choosing an electric pump that was able to replace up to four pneumatic pumps reduced total up front capital costs while maximizing potential carbon credits from a single pump. With the reduced power draw of the CROSSFIRE, the costs associated with remote power generation were also mitigated.

Using plungers that were disconnect-able with a removable pin made it easy to stop injecting chemical from a given head as is often seen with methanol in the transition from winter to summer. Furthermore, using adjustable thrust rods made it much easier to fine-tune chemical injection volumes. In this way, when the motor speed was increased, the stroke length of a given thrust rod was shorted to maintain the same injection volume and vice versa. That adjustability proved to be very helpful and reduced the OpEx associated with would have been over-injected chemical.

Setting up the pumps to operate with at a low RPM, while remaining at or above 10RPM provided the most even chemical injection. When the pump was operated at a speed below 10RPM, chemical was injected for the first portion of a minute until that specified incremental volume was reached. The pump then stopped injecting until starting up as the start of the next minute to inject the next incremental volume needed. Because the motor is variable speed, there wasn't current inrush impact on battery life. However, there was preference by some producers to inject chemical continuously at speeds above 10RPM by downsizing the plunger diameter, often from 3/8In. to 1/4In. and short stroking if necessary despite the slightly higher current draw operating above single digit RPMs. Throughout the retrofits, the plunger diameter of the existing pneumatic pump in service was not needing to be matched to ensure the retrofit electric pump was fit-for-purpose.

Integrating the operating data into SCADA infrastructure on site provided remote insight data needed to monitor health of the pump. By trending the current draw of the CROSSFIRE, the health of it was also monitored through comparison of the current power draw to the power needed to operate at similar conditions in the past. This also provided the means to determine if the unit needed to be serviced, which aligned with the approach of asset management based on call out by exception rather than routine.