EMISSIONS REDUCTION ALBERTA

Non-Confidential Final Outcomes Report

Reporting Period: September 1, 2020 to April 5, 2024

Project Title: Kinitics Valve Actuator for Gas Producers
Agreement Number: E0160849

Project Leader: Dean Pick
Lead Institution: Kinitics Automation Limited
ERA Project Advisor: Long Fu

Project Budget: $2,668,833
ERA Funding: $552,600

Project Start: September 1, 2020
Project Finish: April 5, 2024

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Project Schedule		*Cost Status*	
(1)	Project on schedule	(1) ✓	Cost on budget
(2)	Project delayed	(2)	Cost overrun
(3)	Project cancelled	(3)	Cost underrun
(4) ✓	Project complete		

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1 Executive Summary

Kinitics Automation (Kinitics) has successfully developed and commercialized its spring-loaded electric valve actuator, known as the KVA38, to address methane venting emissions originating from the Alberta energy industry. Over the course of the development project, the technology was elevated from TRL 6 to TRL 9. Key technical hurdles overcome include scaling up of stroke length and force, achievement of Class I Zone 1 hazardous location rating, expanded temperature range, addition of multiple power supply options, and creation of an integrated control module. To demonstrate and evaluate the actuator, six commercial samples were deployed to three facilities and one test lab.

Kinitics has communicated progress and technical advancement to the wider community in a variety of avenues. Seven technical articles specific to the KVA38 project were authored by Kinitics and published in technical journals, in addition to five conference presentations on the same topic.

Through field deployments and industry engagement, Kinitics has validated the KVA38's value proposition that was presented to ERA at project start. The KVA38 product line brings zero-emission process control technology to the Canadian energy sector in a spring-loaded low-maintenance package.

2 Project Description

With support from ERA, Kinitics has developed an electric valve actuator as a direct replacement for methane-venting pneumatic devices currently deployed at production well sites in Alberta. Methane-venting pneumatics deployed at production well sites are recognized as a major contributor to the Canadian gas industry's greenhouse gas emissions. Using electric valve actuators will eliminate the venting of methane at the sites, significantly reducing the emission of greenhouse gases. Kinitics' spring-loaded electric actuators, based on shape memory alloy technology, connect to AC or DC power sources, require minimal infrastructure and maintenance, and deliver exceptional valve control.

An alternative option the industry has to curtail methane venting is replacing the natural gas supply to the devices with instrument air. Given that many production sites are remotely located, instrument air and the associated infrastructure is currently not installed. Introducing instrument air systems to remote locations presents challenges as significant amounts of power are required to run compressors and a high level of maintenance is typically required to prevent unscheduled downtime. Since power grid connections and onsite staffing are not available at many remote site locations the challenge to convert to instrument air is significant.

Use of electrically powered actuators is generally preferred over instrument air in remote locations as the power demands and maintenance requirements are lower. These devices can typically be connected to the small power island systems that covert solar and wind energy into electricity. The electric supply from these sources is usually intermittent so battery banks are typically installed to improve power availability on remote sites. Even robust power island systems are subject to environmental factors that lead to intermittent power outages. This presents a problem when installing electric valve actuators currently available on the market. These electric globe valve actuators driven by electric motors that convert rotary motion at the motor to linear motion at the valve stem through a worm gear drive. When power is lost onsite these valve actuators tend to remain in their current position until power is restored. This feature can present significant process control problems as the devices can cause the unintended flow of media such as gas, oil, and water through various pipes in addition to creating pressure fluctuations outside the normal range. Existing electric actuators typically also require periodic maintenance, which becomes costly over the lifetime of the device.

The primary differentiating feature between Kinitics electric valve actuators and currently available solutions is the application of Kinitics Bundled Wire technology in place of the traditional drive motor.

This technology utilizes a spring that allows the actuator to close on loss of power, an important factor in process control at well sites. Additionally, they are mechanically simple, having only one moving part and no traditional motors. This simplicity in design eliminates the need for maintenance, saving significant cost by avoiding both service costs and shutdown time.

As part of the development program of the new actuator, Kinitics worked with industry partners to integrate valve actuators into process control systems at pilot sites in order to demonstrate the product as a viable alternative to pneumatic actuators and to raise awareness of the technology in the industry. Based on installations at in-kind industry supporters, the project is expected to reduce $CO2_e$ emissions each year over a traditional pneumatic installation.

Kinitics has begun the commercial rollout of its KVA actuator across Alberta natural gas facilities in advance of the project conclusion. New wells will be targeted for greenfield installation while legacy wells will be targeted for retrofits, and additional opportunities have been identified at on-grid facilities.

3 Project Outcomes and Learnings

The Valve Actuator development project successfully elevated the technology from TRL6 (Prototype Development & Testing) to TRL 9 (Commercial Implementation & Market Rollout). Key project achievements include:

- Widespread consultation with Canadian energy sector stakeholders to tailor the product
- Scale up of Kinitics linear technology
- Canada & USA Class I Zone 1 hazardous location certification
- Successful field deployments of prototype and commercial sample actuators to live operating customer sites

Kinitics maintains technical expertise in the design of shape memory alloy (SMA) based actuators, such as the KVA38 designed in this project. The Kinitics technical team has developed a fundamental understanding of SMA and the interplay between key design parameters (chemical composition, material structures, transition temperatures, wire diameters and related manufacturing processes), device performance and failure mechanisms. Kinitics has a broad blocking patents protecting the design of its product and maintains extensive trade secrets regarding methods for designing, assembling, and controlling SMA actuators.

In the design of the KVA38, Kinitics uses SMA materials in the company's patented Bundled Wire assembly. This assembly utilizes a compression spring to providing closing force on the connected valve. To open the valve the SMA generates pulling forces to overcome the spring load and position the valve according to the customer request. This arrangement makes the KVA38 suitable for the high-reliability, high-precision and high-force requirements of oil & gas valve applications. SMAs are active materials that convert thermal energy into mechanical energy.. In the KVA38, this results in pure linear motion in line with the valve stem axis, resulting in a high force, zero backlash, low maintenance actuator.

Kinitics worked closely with natural gas producers leading up to announcing availability of prototype actuators for field trials. Kinitics personnel were present during product install and commissioning to provide on-site support. Installation was generally well-received by technical contractors, however details regarding the load transfer of the prototypes KVA38's mechanical spring were taken into consideration for improvements in the subsequent commercial model. The KVA38 is positioned as a drop-in replacement for existing valve actuators and, as such, did not require significant changes to site operation in order to be placed into service.

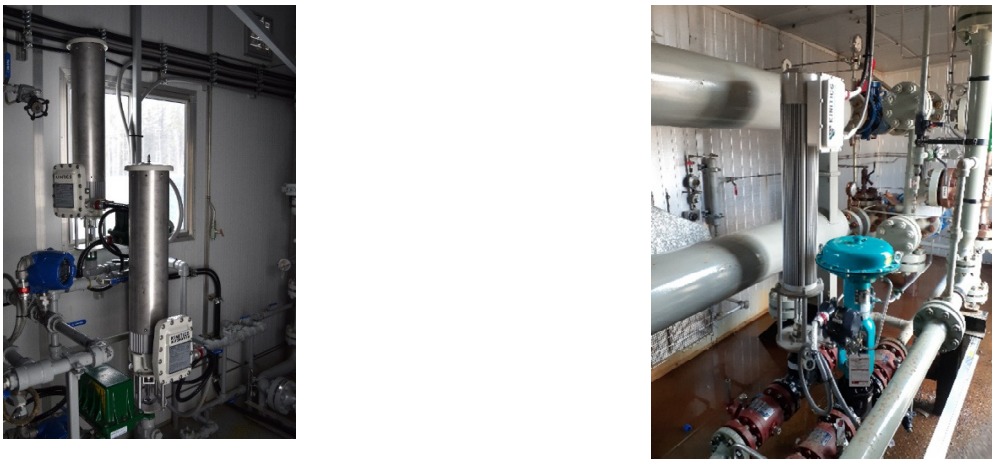

Figure 1 - Left: Dump valve actuators on a separator. Right: Kinitics prototype actuator on a gas lift valve

In addition to field tests, Kinitics proved the actuator technology in a series of lab tests both in-house and externally at the NGIF Emissions Testing Centre (ETC) located at the University of Calgary. An initial test program in spring 2022 was hampered by an experimental setup deficiency, which was corrected in a follow-up experiment in late summer 2022. The initial experiment successfully established the new actuator could suitably replace a similarly-sized pneumatic actuator.

Figure 2 - KVA38 prototype under test at the ETC lab

Significant challenges were encountered and overcome during the project. In particular, the COVID-19 pandemic greatly affected the early stages of development, where travel and communication with stakeholders were reduced from what the company had planned. Later on, the pandemic also affected material lead times and prices to extend far beyond what the original budget and timeline had predicted. Critical activities such as hazardous location certification were forced to expand in scope in order to be deemed suitable for the Canadian energy sector. The project was initially envisioned with Class I Div 2 classification, however during initial requirements elicitation it was quickly discovered that Class I Zone 1 would be required in order to operate in many intended use cases. A Div 2 rating limits the actuator to use in areas where hazards are “not likely to occur during normal operations, but may occur for short periods” such as near a gas well but in open air. Zone 1 areas contain hazards that are “likely to occur during normal operations”, for example in an unvented structure housing process equipment, and therefore require much stricter standards on equipment certified for use within. The majority of

Canadian gas producers surveyed during the requirements elicitation phase of the project identified Class I Zone 1 as a requirement in order to be considered for use on their separator level control and backpressure control valves, a primary intended use-case for the KVA38. The increase in rating resulted in product certification taking far longer than expected. Finally, Kinitics encountered extreme difficulty in procuring long-lead components required to manufacture the actuator. The delay in receiving components impacted key blockers to product launch such as hazardous location certification.

Since the start of the ERA project, the regulatory environment has also changed regarding the limits and reporting of methane gas emissions. Initial project projections were constructed using the latest data available in early 2020 matched with the current regulations in place. Since then, Alberta Directive 060 has evolved to ban methane-venting actuators on new site construction, and placed limits on vent rates of equipment at existing facilities. The project baseline has been adjusted accordingly leading to lower than initially projected emissions reductions. Additionally, Canadian and American federal regulations have been published recently that similarly ban the use of methane-venting equipment. These new developments have vastly increased the addressable market and accelerated the projected adoption rate of the KVA38.

4 Greenhouse Gas Benefits

The GHG benefits that were realized during the project and post-project roll-out were achieved by replacing methane venting pneumatic devices with zero-bleed devices. Pneumatic devices are point sources of GHG emissions. All GHG benefits quantified in this proposal are limited to Alberta. In 2020, pneumatic devices in Alberta were estimated to account for 475,000 tonnes of annual methane emissions. A significant portion of these emissions is attributable to the control valves and associated controllers that are used at natural gas well sites for separator level control and pressure control.

By replacing a methane venting pneumatic level controller or pressure control device with a Kinitics SMA electric valve actuator these methane emissions can be curtailed on a unit-by-unit basis. When electricity is provided from renewable resources, which is the case for off-grid power systems that rely on solar, wind, or hydro power, the CO_2e emissions from operating the Kinitics SMA electric valve actuator can be completely eliminated. The technology can be installed onto level control and pressure control valves at new facilities and retrofitted onto level control and pressure control valves at existing facilities. Industry engagement during the project has revealed many other use-cases for the Kinitics actuator, including gas lift and blanket gas applications. The methane venting quantification for these applications remains very similar to the pressure control scenario previously examined.

Following the commercialization plan Kinitics will supply its SMA electric valve actuator, the KVA38, product to support greenfield installations and the retrofit market. Additionally, following successful deployment at well sites, Kinitics will offer its valve actuator to replace similar pneumatic venting devices that are operating at gas batteries and various downstream facilities. While GHG benefits from converting these additional devices was not quantified it is reasonable to assume that additional GHG benefits can be realized by installing the Kinitics valve actuator at these other operating facilities.

Per the forecast commercial rollout forecast, the annual and cumulative GHG reductions in Alberta from commercial roll out of the technology is expected to peak by the year 2030. Kinitics previously estimated the retrofit market to be fully exploited by 2040, however recent changes to Alberta's regulations are expected to come into effect completely prohibiting the use of venting pneumatics by 2030. It is possible that due to the accelerated rate of retrofits required, deployments of Kinitics actuators may

exceed the previously forecasted amount. It remains to be seen by what date the presence of methane venting devices will be essentially eliminated from the Alberta landscape.

5 Economic and Environmental Impacts

In direct employment benefits, Kinitics has created an Alberta-based sales team, headed by a new Director of Sales position located in Edmonton. Additional sales associates have been positioned in Calgary. Kinitics anticipates the need to expand this Alberta sales force within the next 18 months, and will be adding field engineers as well.

Through the development project Kinitics has worked directly with four different contracted firms based in Alberta on the wellsite design and deployment of actuators, in addition to the gas producers themselves. Over the course of the project, Kinitics found the level of general knowledge and expertise for deploying electric actuator technology to be in its infancy within Alberta. Now, not only have these firms gained the knowledge needed to successfully integrate KVA38s into their systems, they have gained valuable experience that can be transferred to other electronic wellsite technologies as well.

The widespread rollout of the KVA38 will directly result in environmental benefits. The new valve actuator is being marketed as an ideal solution for gas producers searching for non-emitting alternatives in order to comply with Alberta Directive 060. When used in brownfield retrofits, each KVA38 is able to accumulate carbon benefits by overperforming against the legislated maximum emissions level. By directly replacing methane-venting technologies, Kinitics is equipping the energy sector with the technology they need to meet any future federal carbon-offset or pollution-pricing program goals, as well as achieve their own methane reduction commitments.

6 Overall Conclusions

Kinitics Automation has launched the KVA38 valve actuator to address the urgent need of the Albertan energy sector for non-venting solutions to valve actuation. The KVA38 acts as a fully electric direct replacement for methane-venting pneumatic devices deployed at production well sites and supporting facilities in Alberta. Kinitics has begun its roll-out of its electric valve actuator across Alberta natural gas facilities in advance of the project conclusion. New wells will be targeted for greenfield installation while legacy wells will be targeted for retrofits, and additional opportunities have been identified at on-grid facilities.

7 Scientific Achievements

Table 1 - List of articles and presentations created directly related to the KVA38 project

Title	Publication	Type	Date
A Solution to Control Valve Deadband Issues: Shape Memory Alloy Actuators	Valve World Americas	Technical Journal	April 18, 2024
Designing an SMA Actuator	SMST Entrepreneurial Workshop	Conference Presentation	March 15, 2023
NGIF Cleantech Ventures Panel	PROPEL Energy Tech Forum	Conference Presentation	June 14, 2022
Speaker Panel	Globe Forum 2022	Conference Presentation	March 30, 2022
A New Globe Valve Actuator Based on	Valve World Americas Expo	Conference	May 25, 2023

Shape Memory Alloy	& Conference 2023	Presentation	
Application of a Kinitics Valve Actuator for Methane Abatement	CRIN-PTAC Focused Conversations	Conference Presentation	May 15, 2023
Shape Memory Alloy Actuator Performance In An Industrial Control Valve	SMST NewsWire	Technical Journal	March 2023
A Look at Shape Memory Alloy Actuators	Valve World Americas	Technical Journal	April 18, 2024
Standardization of Shape Memory Alloys from Material to Actuator	Shape Memory and Superelasticity	Technical Journal	March 28, 2023
Kinitics' valve actuator brings potential for significant emissions reductions	Gas Pathways	Technical Article	July 6, 2023
Innovation at the Heart of Emissions Reduction. A Story of a Canadian Startup	Global Voice of Gas	Technical Journal	February 6, 2024
Kinitics ETC Phase 1 Test Report	CERIN	Technical Article	December 2022

8 Next Steps

Post-project the valve actuator product will be immediately available to roll out on a commercial basis. A robust sales and marketing plan for Alberta, developed during the project, will be executed to generate market awareness and sales leads. By leveraging relationships with supply chain partners established during the project Kinitics will be able to sell and supply units that will be installed at new and existing well sites. Kinitics is not aware of any significant post-project barriers that would prevent it from rolling out its commercial product in Alberta.

Kinitics is positioned to scale-up into the role of a traditional equipment manufacturer. The sales model for the Kinitics electric actuators is based on channel-sales, where complete actuators are built and tested in-house, and are sold through a third party to the end-user. This strategy keeps the company's IP in-house and allows Kinitics to control the quality of the finished product. The channel-sales partner may be a manufacturer's representative, a distributor, a value-added provider, and/or another entity selling Kinitics actuators as their own white-label product. The specific sales channels and strategic sales partner's aspect of the sales model will be established during the project.

A third party will be responsible for installing the valve actuators in the field. Kinitics will seek out and align itself with companies that have existing, extensive experience in the oil & gas industry, and this reduces risk associated with scaling this aspect of the company. After-sales support will be provided through a combination of detailed product documentation, system integration consultation, and field engineers.

9 Communications Plan

Kinitics has been proactive in knowledge-sharing new discoveries from this project. **Error! Reference source not found.**Table 1 includes a full list of all articles, studies, publications, and presentations made regarding the KVA38 project. An additional technical article authored in partnership with the NGIF ETC at the University of Calgary is expected to be published during the summer of 2024 and will be made publicly available online. Figure 3 illustrates several examples of KVA38 product literature that has been

produced. As part of Kinitics' product roll-out strategy, knowledgeable personnel will be contacting natural gas producers and support industry to provide education and product solutions through in person visits, phone, and e-mail.

Figure 3 - KVA38 commercial product brochure, methane fact sheet, and product data sheet

10 Acknowledgements

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