Final Public Outcomes Report

October 2024

Project Title: All-metal positive displacement pump expansion
Agreement Number: F0162768

Project Leader: Stephanie Rose
Lead Institution: Rotoliptic Technologies Incorporated

Project Budget: $3,008,654
ERA Funding: $1,500,000

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

1.0 Title Page:

ERA Project ID	F0162768
Project Title	All-Metal Positive Displacement Pump Expansion
Name And Information Of Recipient Contact	Harriet Beaumont, Stephanie Rose
Name Of ERA Project Advisor	Bruce Duong
Project Start Date	22-September 2023
Project Completion Date	30-September 2024 (Planned) 31-October 2024 (Actual)
FOR Submission Date	December 1, 2024
Technology Readiness Level (TRL) At Project Initiation	5
Technology Readiness Level (TRL) At Project Completion	9
Project Location(S)	*Alberta and British Columbia.* RTI Office/Shops in Squamish, BC: 39012 Discovery Way 201, V8B 0E5 39319 Queensway, Unit 8, V8B 0R5 1201 Commercial Way, 309 & 310, V8B 0V1

1. TOTAL PROJECT COSTS (i.e. total eligible + ineligible costs)	$3,008,652
2. TOTAL PROJECT ELIGIBLE COSTS	$3,008,652
3. ERA CONTRIBUTION	$1,500,000
4. Total actual ERA funds received	$1,500,000

1 Project Description:

This project focused on the development and commercialization of Rotoliptic's R200 pump, a high-performance all-metal progressing cavity pump designed for extreme pressure and multi-phase conditions, such as those found in Alberta's SAGD and heavy oil fields. Building on the success of the smaller R65 pump with a scaled geometry, the R200 was engineered and improved on throughout the project, resulting in a higher stage counts to handle 20% higher pressures and lift capacities of up to 1300m.

Key outcomes include successful field trials, demonstrating energy efficiency improvements, reduced CO_2 emissions, and reliable performance in high-viscosity applications. Despite challenges unrelated to the Rotoliptic pump design, such as tubing failures and foreign objects obstructing the pump, the results showed adaptability, durability, and scalability. These results position the R200 for broader market adoption, providing a robust solution for artificial lift in demanding environments.

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5 Executive Summary

The ERA-funded project "All-metal Positive Displacement Pump Expansion" successfully advanced the Rotoliptic R200 pump from a TRL of 5 at the beginning of the project to a TRL of 9 at the project completion, due to achieving key milestones in technology development and field demonstration validation. The R200 pump was designed pre-project, with simulations and in-house testing completed with success. The pump was then tested in two real field demonstrations in Alberta's steam-assisted gravity drainage (SAGD) fields, to validate its performance in challenging downhole conditions.

The engineering design work was completed prior to the start of the project, building upon the success of the smaller R65 model. The scaled R200 was designed to meet higher flow rate demands of operators in the Alberta oilsands, and also offered higher energy efficiency per unit flow. Over the course of the project, the pump was tested in two SAGD field demonstrations in Alberta with two different operators. Despite challenges faced by the operators unrelated to the pump's design, such as tubing and auxiliary part failures, the trials demonstrated significant energy efficiency improvements and reductions in GHG emissions compared to the operators' history with other all-metal progressing cavity pumps. The data achieved in the collective 300+ days of field demonstrations validated Rotoliptic's laboratory results showing the pumps' ability to perform reliably under demanding conditions, and provided operators with 15-30% reductions in energy consumption.

Another aspect of the project was a focus on Materials Durability & Enhancement, which allowed Rotoliptic to test a number of advanced material coatings and metallurgic treatments. Sub-scale destructive testing was completed on a number of unique material combinations, with comparisons done with the original generation of rotor and stator materials by Rotoliptic's Materials Engineers and lab technicians. The purpose of this testing was to further improve upon the wear resistance of the pumps and extend their operational life. In addition to further advanced material coatings and treatments trialled at subscale, longer pump lengths were able to be tested due to a successful trial of a new electrolyte used in the stator machining process. This new electrolyte significantly improved the consistency and precision of the stator machining process whilst reducing the amount of non-linear tapering. As a result, longer stator lengths were able to be achieved, accommodating higher stage counts and delivering greater pressure-handling capacity. These advancements in the pump length were tested to achieve a more significant impact on the durability of the pump than the new material combinations, and was then selected as the new process for full-scale pump manufacturing of both the R200 and R65.

6 Project Description

6.1 Introduction

The Rotoliptic pumps, both the R65 and R200, were designed as technologies to meet demanding operational needs of oil producers, whilst reducing the energy required during these operations. The Rotoliptic geometry has previously been commercially validated through multiple successful field demonstrations from 2019-2023 using the R65 design (65m3/d/100RPM). This project utilized the success of the R65 and scaled it to a larger displacement pump, the R200 (200m3/d/100RPM), and tested this pump configuration in Alberta's oilsands.

The Rotoliptic pumps offer a robust and energy-efficient solution designed for high-pressure, high-temperature, multiphase environments, with an innovative design that eliminates the reliance on elastomers and provides higher efficiency with a simple, two-part, all-metal pump. During this project, material durability enhancements were also explored, including testing advanced coatings and manufacturing processes to ultimately allow for the production of a longer stator, increasing stage counts and lift capabilities. This project demonstrated the scalability and adaptability of the R200, while achieving energy savings during the pumps' operation.

6.2 Background of the Project

The R65 and R200 are the two all-metal pumps that Rotoliptic have created, which vary by diameter and subsequent fluid production. The R65 has been demonstrated successfully through lab testing and two successful field demonstrations, and the R200 has recently been tested at full-scale in-house; Rotoliptic are ready and planning to deploy the R200 in two first-of-their-kind field demonstrations in the Alberta oil sands to prove its effectiveness and begin commercial sales. Rotoliptic have proposed a project partnership with two Albertan operators for this project, who currently use all-metal PCPs in a number of their wells in the Alberta Oil Sands and are looking to replace these with higher efficiency alternatives. The two field demonstrations in this project will have direct reductions in the GHG emissions of these operations in Alberta when compared to the baseline scenario in which the demonstration sites continue to use incumbent all-metal PCPs due to the RTI pumps' higher operating efficiency and lower required quantity of steel. Following a successful validation of the R200 pump through these field trials, RTI anticipates subsequent emissions reductions due to market adoption of the technology because of its higher efficiency and fewer workovers needed, as well as longer lifetime and lower steel quantity than an all-metal PCP.

Whilst the field demonstrations of the R200 are ongoing, Rotoliptic are continuing with metallurgical and manufacturing testing with the completion of a Materials and Durability Enhancement program to ensure that all RTI pumps will maintain high performance in harsh environments while ensuring the pumps can be manufactured at reasonable cost and throughput levels for commercial volumes**.**

6.3 • Project objectives

The scope of the project that Rotoliptic are proposing includes the two main objectives:

1. Field demonstrations of the R200 pump configuration in Alberta,
2. Materials and Durability Enhancement of the Rotoliptic pumps.

For the first of the project objectives, the proprietary pump technology is planned to be tested under operating conditions found in steam-assisted gravity drainage (SAGD) and other production methodologies such as cyclic steam stimulation (CSS), CO_2 flooding, and steam flashing. Rotoliptic are planning to complete two field demonstrations in Alberta of the R200, of which the following deliverables will signify a successful field demonstration:

- Initial consultation with partner, wellsite identification, contracting agreements and purchase orders signed,
- Procuring materials, manufacturing (including additional parts and specifications from the partner), shipping to wellsite and their receival and inspection of the pump,
- Pump installation, initial spinning (with Rotoliptic's applications experts on-site),
- Pump running in the well for a pre-defined period (at minimum 180 days) or for as long as possible until failure, and data monitoring, collection, and analysis,
- Pump removal (if required in project period), post-run testing and analysis.

The deliverables for the second of the project objectives, the ongoing materials and durability enhancement are outlined in the following testing plan for each new material combination:

- Material combination identified through research/consultant recommendation,
- Hypothesis and test plan written,
- Sub-scale prototype manufactured and shipped to Squamish testing facility,
- Testing of prototype under varying conditions:
  - Operating speeds from 150-400 RPM,
  - Operating pressures of ~25 psi per stage of pump,
  - Viscosities of < 5 cP,
- If testing deemed successful:
  - Begin full-scale prototype development, manufacturing, testing,
  - Test report write-up and comparison to baseline full-scale with original material combination,
  - Further trials, including field demonstrations.
- If testing unsuccessful:
  - Report on materials used and reasoning for failure,
  - Further research and aim to re-use materials purchased if possible.

By the end of the Project, successful demonstration of the RTI technology will be characterized by achieving the following:

- Beginning of Life (BOL) Pump Efficiency: >40% (better than all-metal PCP),
- Degradation rate of >6mo before needing to exceed 400RPM to maintain production (better than AM-PCP),
- Beta in field operation: >180 days or otherwise specified, or 1-2 yrs commercially.

The primary goal of the project 'All-metal Positive Displacement Pump Expansion' is to advance and validate the efficiency, durability, and environmental benefits of the Rotoliptic pump technologies, through a combination of rigorous testing and strategic field demonstrations in the Alberta oil sands. The milestone timelines within this project have been planned with specific objectives in mind, which include:

(a) Field Demonstration of the R200 Pump Configuration:

- Successfully deploy and evaluate the R200 pump in two first-of-their-kind field trials in Alberta, demonstrating the pump's operational efficiency and reliability under the demanding conditions found in the Oil Sands.
- Measure and compare the performance of the R200 through the achievement of predefined metrics, including pump efficiency, degradation rate, and operational lifespan in field conditions.

(b) Materials Durability & Enhancement:

- Conduct comprehensive metallurgical and manufacturing testing to enhance the materials used and the subsequent durability of the Rotoliptic pumps, ensuring that they can withstand the harsh operating environments found downhole, whilst being produces at a cost and throughput viable for commercial volumes.
- Identify and test new material combinations through a structured testing plan, leading to the development of prototypes for full-scale testing and further trials.

Explain any changes that have occurred to the original goals and objectives of the project.

N/A – no changes to original goals and objectives

Describe any changes to the overall approach for execution of the project.

N/A – no changes to approach

Performance Metrics Summary in Alberta SAGD well (assuming no gas production)

Success Metric	Commercial Target	Project Target	Achievements to Date	Justification/ Significance of Metric
Beginning of Life (BOL) Pump Efficiency	>40% in well, Better than all-metal PCP	>40% in well	Achieved in previous R65 field trials, R200 predicted at minimum same but likely higher BOL efficiency	Enables RTI's value proposition to be proven, which helps prove the GHG and CAC benefits of the pump
Slower Degradation Rate	>6mo before needing to exceed 400rpm to maintain production, Better than all-metal PCP	>6mo before needing to exceed 400rpm to maintain production	Achieved in previous R65 field trials	Enables RTI's value proposition to be proven that materials durability is enhanced.
Beta in Field Operation	1-2yrs	>180 days (or otherwise specified)	Achieved in previous R65 field trials	Enables RTI's value proposition to be proven that anticipated lifetime is longer and pump needs to be replaced less frequency than incumbent pumps.

Commentary on overall Performance Metrics at project completion:

The R200 pumps met the beginning of life pump efficiency metric, and were unable to validate the degradation rate and runlife metrics during the field demonstrations due to these being prematurely ended after tubing failures. More details on exact efficiencies and runtime further in the report.

• Performance/success metrics identified in the Contribution Agreement

Milestone 1:

	Target Achievements	Measures of Success	Status at Project Completion
A	Preparation of pumps for field demonstration	All necessary parts and supporting infrastructure manufactured/purchased, initial discussions with partners.	Complete
B	First deployment site identified and confirmed	Wellsite identification, contracts/purchase orders signed	Complete
C	Second deployment site identified and confirmed	Wellsite identification, contracts/purchase orders signed	Complete
D	First deployment commissioned	Including shipping, and RTI Applications Experts on-site with RTI pump deployed and initially producing	Complete
E	Second deployment commissioned	Including shipping, and RTI Applications Experts on-site with RTI pump deployed and initially producing	Complete
F	Materials research and benchmarking	Benchmarking and first new material combinations manufactured, shipped, and tested	Complete
G	Submission of Technology Transfer Plan	Submission of a Technology Transfer Plan to ERA's satisfaction in conjunction with the M1 progress report	Complete
H	Submission of Measurement, Monitoring, Verification Plan	Submission of a Measurement, Monitoring, Verification Plan to ERA's satisfaction in conjunction with the M1 progress report	Complete

Milestone 2:

	Target Achievements	Measures of Success	Status at Project Completion
A	First field trial successfully completed	Pump metrics met and run time of 180 days met/exceeded	Field testing results validated pump metrics as originally proposed.
B	Second field trial successfully completed	Pump metrics met and run time of 180 days met/exceeded	Field testing results validated pump metrics as originally proposed. Additional RTI pumps are being installed at the same time as ERA project completion.
C	Materials testing ongoing	Further materials testing completed with new material combinations on subscale prototypes	Complete

Milestone 3:

	Target Achievements	Measures of Success	Status at Project Completion
A	First field trial successfully completed	Pump metrics met and run time of 180 days met/exceeded	Field testing results validated pump metrics as originally proposed.
B	Second field trial successfully completed	Pump metrics met and run time of 180 days met/exceeded	Field testing results validated pump metrics as originally proposed. Additional RTI pumps are being installed at the same time as ERA project completion.
C	Materials testing ongoing	Further materials testing completed with new material combinations on subscale prototypes	Complete

7 Project Work Scope

Milestone 1: R200 Field demonstrations commenced, and Materials Durability & Enhancement Program kicked-off

The objectives of this first Milestone include commencing the R200 field demonstration and beginning the planning for the Materials & Durability Enhancement aspect of the project, as well as sub-scale benchmarking tests and the acquisition and testing of the first material combinations.

The critical tasks involved in the completion of Milestone 1 are:

- **Preparation of Pumps for Field Demonstrations** – this includes the manufacturing and procurement of all necessary parts and supporting infrastructure for the R200 deployments.
- **Site Identification and Confirmation –** the deployment sites were identified and confirmed, with contracts and purchase orders signed, ensuring readiness of the deployments.
- **Commissioning of Deployments – t**he deployment sites were successfully commissioned, with the R200 pumps received on site ahead of the date of the workover. Rotoliptic's Applications Engineers were present on-site to oversee the initial setup and production commencement, marking a significant achievement in operationalizing the project's core technology.
- **Materials Research, Planning, and Benchmarking –** initiated materials research and planning, as well as benchmarking tests on Gen I R200 subscale pieces and the manufacturing and testing of the first new material combination.

Milestone 2: R200 Field demonstrations completed, and Materials Durability & Enhancement Program continued with full-scale testing planned for one material combination

The objective for this Milestone mainly surrounded the successful completion of the field demonstrations, with any necessary troubleshooting and understanding of the pumps' reason for removal from downhole. The Materials Durability & Enhancement aspect of this project was also continued from the end of Milestone 1, with thermal testing and further material combinations trialed.

The objectives surrounding the completion of this milestone are:

- **Completion of Field Demonstrations** – this includes ending the trial at a point agreed upon with the two operators, the decommission of the pumps and the shipping back to Squamish.
- **Progress on the Materials Durability & Enhancement Program** – this includes additional subscale testing, reassessment of test schedule, and plan for full-scale testing.

Milestone 3: Manufacturing, testing, and deployment of longer R200 pumps in Alberta

The objective for this Milestone mainly surrounded finishing the Materials Durability & Enhancement Program by determining the latest pump configuration for deployment, and to get these deployed in Alberta. The plan for this Milestone was to then manufacture and have them deployed, to compare the data with the first deployments from this project and complete the 180-day target runtime.

The objectives surrounding the completion of this milestone are:

- **Extension of Field Demonstrations** – this includes the manufacturing, testing, shipping, installation, and monitoring of the two additional R200 pumps
- **Progress on the Materials Durability & Enhancement Program** – this includes concluding the subscale material testing program and proceeding with the full-scale manufacturing of longer R200 pumps.

Deployment I

The first deployment of the Rotoliptic R200 pump was overseen by Rotoliptic's Applications Engineering team. This deployment marked a significant step in Milestone I, focusing on replacing the all-metal PCP that was in the well prior and evaluating the R200's performance with regards to operational efficiency and contribution to emission reduction.

The switch to the Rotoliptic pump had the aim of improving upon the PCP's sub-optimal performance that was marked by significant torque fluctuations and low volumetric efficiency. The R200 immediately showed some improvements in VE, despite initial oil production not reaching the target level at first.

Throughout the 3 months that this deployment has been active, detailed performance analyses have been completed by Rotoliptic. Pump speed adjustments were made in attempts to enhance oil production to this target value, which led to variable power consumption rates and consequently fluctuating CO2eq. emissions. However, the data proved an overall reduction in the emissions of the operation following the Rotoliptic installation, but this was not quite as high as predicted at the FPP stage.

Deployment II

The second deployment of this project also focused on the replacement of an all-metal PCP with a Rotoliptic pump and was overseen on site by Rotoliptic's Applications Engineering team. There were some initial delays in the installation and spinning of the pump, however the pump began spinning on November 30th, with the initial observations through December showing promising performance.

Tests were completed in January to understand the impact of speed adjustments on fluid rates, with the pump eventually maintaining an average daily flow it was agreed by the Rotoliptic Applications Engineering team that the R200 shows higher efficiency savings at faster speeds. Despite this, the R200 still showed a reduction in power consumption for the operation compared to the previous PCP, indicating an improvement on the operation's emissions moving forwards. The cumulative emissions reduction was still significant, but lower than projected, with expectations set for a more consistent reduction in emissions in the following Milestones.

The pilot partner expressed their satisfaction with the Rotoliptic pump and its performance, and the data and experience gained during this period was deemed invaluable for future operations.

Materials Durability & Enhancement Program

The materials science aspect of the project kicked off with concentration on the development of an improved Gen II R200 material that provides increased resistance to fines, while ensuring water longevity. Simultaneously, efforts are underway to identify a Gen III R65 material aimed at boosting performance in flow, corrosion resistance, and fines durability.

Wear Trends

With regards to wear trends, RTI's past bench test data for wear from fines on the R200 has demonstrated a trend in wear that decelerates over a period of cycles, whereby the wear begins increasing rapidly and slows down over time until a point that the rotor's contact points are worn sufficiently such that there is no further wear and the pump continues to operate within its lifetime but with a lower efficiency than the beginning of life (BOL) efficiency. The RTI pumps have, however, successfully demonstrated a higher retained efficiency than equivalent all-metal PCPs and therefore it's anticipated that the relationship between the wear and the number of cycles is sub-linear and decelerates over time.

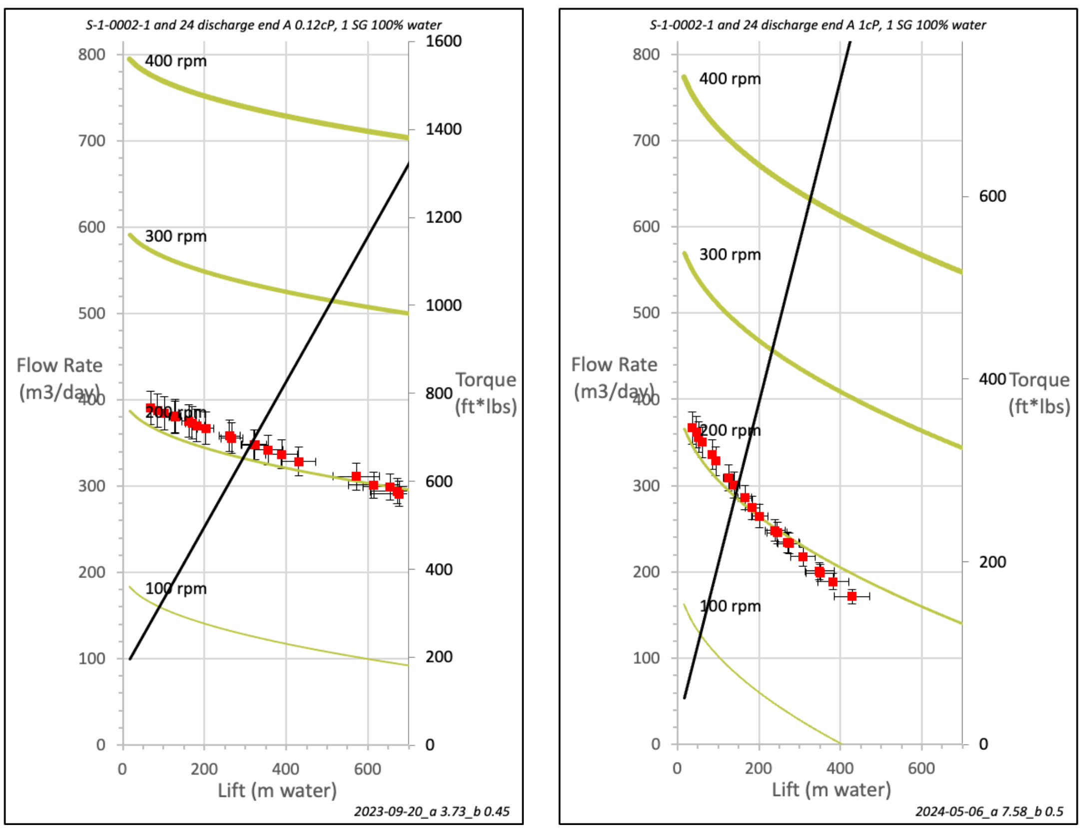

Figure 1: Flow test pre- (left) and post-deployment (right)

New RTI Pump Lengths

The original R200-800 and the new R200-1000 can be compared by their spec sheet graphs:

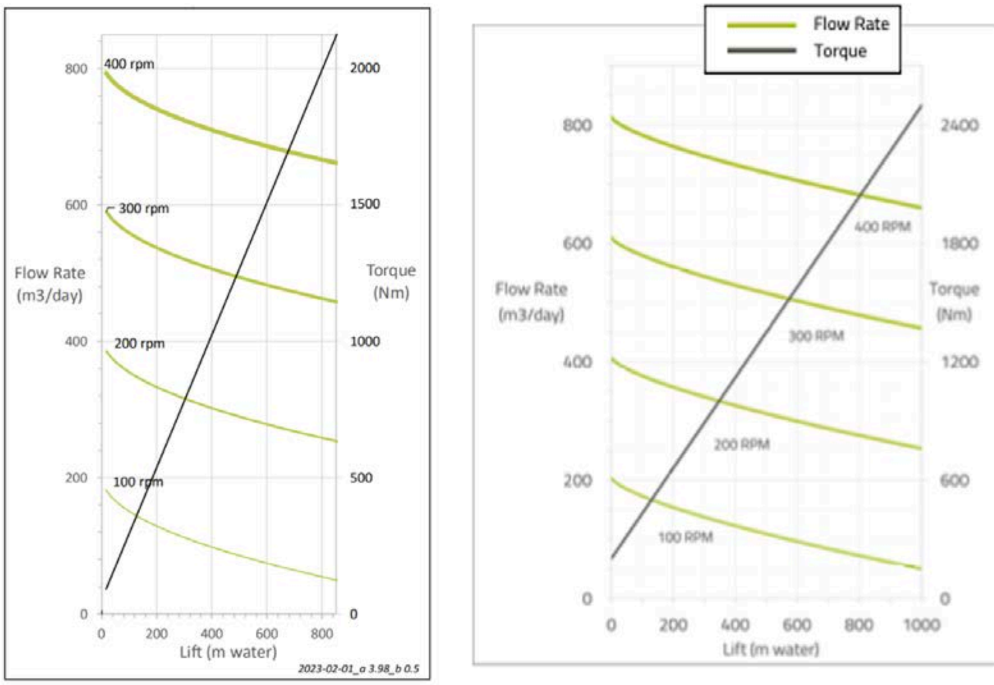

Figure 2: Flow rate and torque for original R200-850 (left) and the new, longer R200-1000 (right)

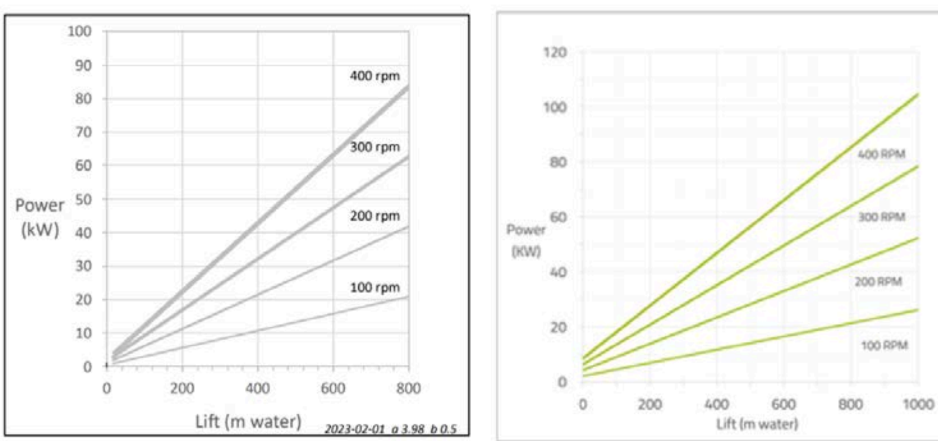

Figure 3: Power consumption for original R200-850 (left) and the new, longer R200-1000 (right)

Due to the R200-1000's additional stages, it achieves a higher flow rate for a given speed and lift. For example, at 400RPM and 800m lift, the flow rates are:

- R200-850: ~800m^3/d
- R200-1000: ~850-900m^3/d.

Although the longer pump's ability to consume less energy for a given operation has not yet been tested, it is understood that the additional stages of the longer pump mean that the mechanical wear is distributed across a greater surface area, enhancing durability and extending run life. The longer pump also gives a greater applicability to wells with greater depth or higher pressure requirements.

• Discussion on any changes in the Project during the lifecycle of the ERA funded Project scope

The initial plan for the two field demonstrations was to reach 180 days runtime, unless there was a failure within the system. Unfortunately, both of the deployments resulted in a slightly lower runtime The method of failure for these were determined by the operators to be related to a crossover part and a tubing failure, respectively. These parts were not supplied by Rotoliptic and are not part of the pump assembly, however we are looking to troubleshoot and understand whether these failures are common with surface driven PDPs.

Technology risks

Challenges regarding the early termination of the trial have been outlined in the previous section. These will not affect the budget or time constraints, but have required more investigation from RTI and external consultants in order to move forwards with commercial relationships

8 Commercialization

Following this project, the Rotoliptic R200 pump has been taken from a prototype to a fully validated commercial pump for use in Alberta and worldwide. Following the field demonstrations as part of this project, additional pumps have been ordered and will be deployed with Alberta based partners. The longer stator lengths that were tested as part of this project are directly applicable to the R65 pumps too, and these are now part of Rotoliptic's commercial offering.

Throughout the project, the technology advancements made were in-line with the objectives of the Materials Durability & Enhancement program. The pumps' geometries and sealing properties allow for a 22-30% reduction in energy consumption compared to other all-metal progressing cavity pumps during operation, and the longer pumps could increase the lifetime of the pumps by an additional 20%, reducing the number of workovers and interventions required in a well's life.

The R200 advanced from a TRL 5 to a TRL 9 during this project, reflecting successful engineering, field testing, and validation milestones, and allowing the R200 pumps to be ready for commercial sale.

This project provided invaluable insights into both technical and operational aspects of the R200's deployment, and enabled us to have in depth understanding of the decisions made by production engineers in the SAGD process. One of the primary challenges encountered was the frequent and catastrophic occurrence of tubing wear and clearing the tubing of any obstructions. These hiccups in the deployments also reinforced the importance of these pre-installation checks with the operators, who were also frustrated at the avoidable delays and hurdles. Whilst these assembly and well-related issues are outside of Rotoliptic's control, they underscore the importance of collaborative engagement with operators to optimize deployment outcomes.

Rotoliptic have begun recruiting for additional members to become part of the growing sales team. Internal shuffling and recruiting has resulted in two dedicated sales personnel including a Sales & Technology Associate and a Sales & Operations Coordinator (a new staff member starting in mid-June).

9 Environmental Benefits

9.1 Emissions Reduction impact

Table 6 shows the variance between the predicted and actual reductions in CO2e., where the average R200 energy consumption for the project was 0.505kWh/bbl and the average PCP energy consumption was 0.64, which is a reduction of 21% from the PCP baseline. This is a lower reduction than the anticipated 46% reduction that was hypothesized at the beginning of the project, likely due to the fluctuations in the running of the pump.

The baseline scenario (PCP) and the R200 energy consumption figures used at the beginning of the project to estimate the emission reduction were chosen from the published pump curves under the same conditions. This idealized scenario was used as these two deployments were the first of the R200, but now we have a better understanding of how downhole conditions can influence pump performance. The deployment 1 results align more closely with the initial expectations, achieving a 30% reduction in energy consumption when compared to the incumbent PCP. This was attributed to the pump being operated more in line with its optimal speed and conditions, demonstrating the potential efficiency gains of the R200 in these conditions. The difference between this and the lower energy reduction of 15% in deployment 2 highlights the critical role of running conditions on the pumps' performance; the two pumps were the same length and materials, so this large variance is down to the site-specific conditions.

From the MMV, using energy consumptions of R200 = 0.36kWh/bbl, PCP = 0.67kWh/bbl:

Table 1: Project emission reduction, pre-project

Year	In Alberta					
	Baseline Emissions @Year (tCO2e)	Project Emissions @Year (tCO2e)	Prorated Annual Production (if applicable)*	Actual Production (if applicable)	Unit of Production	Emissions Reduction @Year (tCO2e)
2023	121	65	0.4	2	No. of Pumps	56
2024	88	47	0.4	2	No. of Pumps	40

Updated to include the project energy consumptions of R200=0.505kWh/bbl, PCP = 0.64kWh/bbl:

Table 2: Project emission reduction, post-project

Year			In Alberta			
	Baseline Emissions @Year (tCO2e)	Project Emissions @Year (tCO2e)	Prorated Annual Production (if applicable)*	Actual Production (if applicable)	Unit of Production	Emissions Reduction @Year (tCO2e)
2023	116	91	0.4	2	No. of Pumps	24
2024	84	66	0.4	2	No. of Pumps	18

Using the energy consumption figures from this project, the R200 can achieve a 21% reduction in energy consumption on average in Alberta. This figure is expected to increase with the new releases of the longer R200 pumps, but these have not yet been validated downhole. The total reductions over the project period align with Alberta's goal of transitioning to low-carbon technologies in the oil sands, and the future adoption forecasts show significant potential impact, with anticipated annual GHG reductions of over 10 kilotonnes CO2e in Alberta by 2050, and over 0.5 megatonnes CO2e. annually worldwide. This adoption supports Alberta's leadership in reducing GHG emissions and building a low-carbon economy by providing a more energy-efficient but also cost-effective and simple swap to the current artificial lift methods.

Describe how the project will result in, enable, or lead to GHG emissions reductions in Alberta.

During this project, the all-metal Rotoliptic pump will replace its equivalent all-metal PCP counterpart in two sites in Alberta, both supplied by grid electricity. The implementation of this new technology is projected to lead to significant reductions in energy usage and subsequent GHG emissions through increased efficiency. The project will result in a direct reduction in emissions through the replacement of these two all-metal PCPs in the Alberta oil fields over the 6-month duration of the deployments. We have also proposed a reduction in the number of maintenance events and workovers and the gas that is flared during this time, as well as increased longevity of the Rotoliptic pump and a less frequent need for replacement.

Discuss any changes or updates to the anticipated greenhouse gas reductions/benefits for the project (including immediate reductions from project implementation and expected future benefits through market adoption). Describe why these changes have occurred and the driving forces behind the change.

The quantitative performance parameters of the RTI vs. the PCP were not quite met by the results from the two deployments. Rotoliptic expect that this is due to the operators experimenting with the new pump technology to see how it performs at various speeds.

Table 3: Quantitative performance metrics

Parameter	RTI	PCP	Reduction (%)
Proposed Energy Consumption (kWh/bbl)	0.36	0.67	46%
Deployment 1 Average Energy Consumption (kWh/bbl)	0.38	0.54	30%
Deployment 2 Average Energy Consumption (kWh/bbl)	0.63	0.74	15%

We anticipate that values close to the FPP proposed energy consumption figures will be reached during the project period, and that this requires some time for the pumps to reach a consistent flow rate without the operators fluctuating the speed and torque.

9.2 Other Environmental impacts

The hypothesis of fewer workovers and interventions when using the R200 compared to a PCP was unfortunately unable to be proven during the field demonstrations This hypothesis is still maintained, and we will continue to gather data to either validate it or not through our future deployments. Fewer workovers and interventions would result in fewer GHG and CACs vented.

There would be no changes to land use/soil/water resulting from the completed project.

10 Economic and Social Impacts

The enhanced energy efficiency of the R200 pumps compared to incumbent PCPs makes Alberta's oil sector extremely competitive in the global production market. The project supported the growth of knowledge within the artificial lift sector, which contributed to both Rotoliptic's team and our partners within the province. While the project primarily focused on technical development and commercialization, it also indirectly supported skilled employment in Alberta through collaborations with local vendors, subcontractors, and testing facilities. At this time, there were no known direct impacts regarding local communities, underserved communities, or indigenous groups, nor specific equity, diversity, or inclusion outcomes within this project.

11 Scientific Achievements

Multiple patents were pending throughout the duration of the project, with one new US patent and one new GB patent approved during the project period. These do not have direct work from the project included in them, but the completed field demonstrations added to the credibility of our future applications. There were several conference presentations during the project, related to the SAGD demonstrations, including Rotoliptic being a main technical speaker at the Artificial Lift Canada conference in Calgary in July. Two other technical manuscripts were selected for SPE conferences based on the field demonstration results, but these will not be presented until 2025.

12 Overall Conclusions

This project was successful to the future of Alberta and abroad due to the R200 now being a commercially viable and available product for many types of application. The reduction in energy consumption compared to the baseline was between 15-30% in these challenging well conditions, and this corresponds to a direct reduction in GHG emissions through energy reductions. Although the GHG emissions reductions were lower than originally predicted due to site-specific conditions and variations in the pump operation, the project validated the pump's potential under optimized conditions. The learnings from this project will continue to guide improvements in our knowledge, as well as our partners' knowledge, to maximize environmental and economic outcomes.

13 Next Steps

Rotoliptic's efforts will mainly lie in the process of securing additional and successful distribution partnerships, and in growing our relationships with current Alberta partners and customers. In addition to this relationship development, Rotoliptic will prioritize scaling production capabilities, broadening customer outreach, and attending key industry conferences to showcase the proven benefits of the R200.

Potential partnerships with technology integrators and global adopters are actively being explored to facilitate R&D work behind several of Rotoliptic's patented ideas. These range from simple variations to pump diameter, encouraged by one of the pilot partners, to more complex designs that include a downhole coupled motor or stator housing to allow both the rotor and stator to rotate. This project has enabled Rotoliptic to commercially produce the R200 that provides revenue and investment back into R&D, so that our pump offering is continually improving.

14 Communications plan

The primary audience of Rotoliptic's communications and presentations are production engineers at operators (Alberta and globally) that want to improve their production efficiency in a way that consumes the least energy and with pumps that last longer. These have been engaged through targeted communications (e.g. case studies, website postings, LinkedIn, in-person meetings and direct knowledge sharing, and published manuscripts/conference proceedings. Rotoliptic will continue to share information about the field demonstrations (within data sharing limits set by our two partners), and post these on public domain.

15 Literature reviewed.

N/A