

TRANSFORM DOWNSTREAM PROCESSING WITH AN INTEGRATED SOLUTION:

Optimize Time, Space and Cost Using
MOTIV® Inline Buffer Formulation
with FlexiPro™ Chrom

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EXECUTIVE SUMMARY

Buffer preparation is a critical and resource-intensive component of biomanufacturing, traditionally managed through tank batch processes that demand a large footprint of valuable cleanroom space, in addition to extensive planning, cleaning validation, and manual labor. These methods introduce operational inefficiencies, ergonomic risks, downstream processing bottlenecks, and significant waste due to overproduction and expiry, while limiting flexibility for continuous manufacturing. Inline “just-in-time” buffer formulation, enabled by MOTIV® technology combined with the FlexiPro™ Chrom, offers a transformative alternative by delivering buffers on demand with real-time analytical verification. This approach eliminates tank cleaning (as well as the demand for large in situ vessels), reduces labor exposure, optimizes floor space, and enhances production agility for both batch and continuous operations at various scales.

In the theoretical study of purification across a capture step and a polishing step of insulin, it was established that the MOTIV Inline Buffer Formulation System from Asahi Kasei Bioprocess combined with the FlexiPro Chrom system from VERDOT offers an immediate benefit in the case of a new facility where the inline buffer formulation system is chosen from the outset. Furthermore, even when replacing fully depreciated equipment with new single-use systems, a rapid ROI is obtained —typically within one year— with the ability to reallocate resources to higher-value tasks. By delivering buffers on demand with real-time analytical verification, MOTIV technology developed by Asahi Kasei Bioprocess combined and synchronized with the

VERDOT FlexiPro Chrom offers a transformative and compelling alternative to traditional tank-based solutions by saving space, CAPEX and preparation time.

INTRODUCTION

Traditional buffer preparation and management accounts for roughly 20% of overall biomanufacturing costs and the use of large tank batch processes present significant operational challenges in modern biomanufacturing environments [1]. This approach requires complex planning and scheduling, as each of the dozens of required buffer formulations demand a dedicated tank, unique standard operating procedure (SOP) and batch records. The process incurs substantial costs associated with cleaning and validation of tanks prior to formulation, while also introducing ergonomic operational risks through manual handling of powders that can generate dust and respiratory irritants. Furthermore, the batch model is inherently inflexible, making it difficult to adapt to dynamic production needs or continuous manufacturing paradigms, where buffer volumes and timing must be predicted and closely monitored. These constraints often lead to inefficiencies, including idle equipment, production delays, sub-optimal downstream process performance, and increased labor burden, as well as additional production costs.

Beyond operational complexity, the batch buffer model contributes to significant waste and resource inefficiency. Prepared and released buffer batches are frequently discarded—partially or entirely—due to changes in production demand or expiry, creating a large environmental and financial burden. The requirement for extensive floor space to accommodate multiple tanks further limits facility capacity and scalability. As bioprocessing shifts toward more agile and continuous operations, these limitations underscore the need for a more adaptive, cost-effective, and ergonomic solution for buffer management.

Inline “just-in-time” buffer formulation addresses these challenges by delivering buffers on demand directly to the point of use. This approach eliminates the need for large tank infrastructure and cleaning validation, reduces manual handling risks, and unlocks valuable floor space. By leveraging onboard calibrated analytics, inline systems provide real-time verification and quality release, ensuring reliable and reproducible buffer quality for both batch and continuous processes. The agility of this model not only enhances operational efficiency but also accelerates return on investment (ROI), typically achieving positive cash flow within one year while enabling resource reallocation to higher-value tasks such as quality control and analytical operations. Ultimately, inline buffer formulation represents a transformative shift in buffer management, driving scalability, flexibility, and sustainability in biomanufacturing.

Another challenge in biopharma, particularly for contract development and manufacturing organizations (CDMOs), is the need to handle highly variable batch sizes. This requires equipment capable of adapting to a wide range of flow rates and processing volumes. To avoid significant CAPEX or the need for numerous

space-consuming units, it's preferable to use equipment that can cover a broad flow rate range—both for inline buffer formulation systems and for chromatography or tangential flow filtration (TFF) systems.

MOTIV® technology, developed by Asahi Kasei Bioprocess and integrated with the VERDOT® FlexiPro™ Chrom, provides buffers on demand with real-time analytical verification. This solution presents a compelling alternative to conventional buffer tank systems by reducing space requirements, CAPEX, and preparation time with the ability to accommodate a broad range of batch sizes.

Leveraging the in-house design and engineering expertise of both companies, the integrated solution can be customized and tailored according to unique process requirements.

About Asahi Kasei Bioprocess and MOTIV system

Asahi Kasei Bioprocess (AKB) is a global leader in advanced manufacturing equipment solutions for the biopharmaceutical industry. With decades of expertise in designing tools for chromatography, filtration, oligosynthesis and buffer formulation, AKB enables developers to achieve the highest standards of safety, efficiency, and scalability in drug production. AKB's Fluid Management business unit specializes in delivering integrated systems that streamline critical processes, ensuring consistent product quality and regulatory compliance.

At AKB, innovation is driven by a deep understanding of bioprocessing challenges. AKB designs solutions that minimize contamination risk, optimize operational flexibility, and support multi- or single-use manufacturing strategies. By combining robust engineering with cutting-edge materials science, Asahi Kasei Bioprocess helps clients accelerate time-to-market while maintaining uncompromising control over unit operations.

As part of the Asahi Kasei Group, AKB leverages a global network of resources and technical expertise to provide end-to-end support. With intense commitment to collaboration and continuous improvement AKB is a trusted partner for biopharmaceutical companies seeking reliable, future-ready fluid management solutions.

MOTIV® Technology and Systems

MOTIV Inline Buffer Formulation System (Figure 1) enables precise, on-demand preparation of dilute, pH-adjusted buffers from concentrated stocks, streamlining bioprocess workflows. Each stainless-steel system uses Pro-Yield™ blender technology to achieve high accuracy and fast response times while minimizing waste and improving efficiency. Available in standard 3-pump and 5-pump configurations—as well as completely custom—MOTIV is suitable for batch or continuous processing. For single-use (SU) applications, MOTIV SU offers the same precision and flexibility in a disposable format, reducing



Figure 1. MOTIV Single-Use Inline Buffer Formulation System

cleaning requirements and supporting rapid changeover. Both system types are designed for GMP environments, integrating seamlessly with existing operations and offering automated control via OCELOT® System Control, compact footprints, and compatibility with chromatography, TFF, and virus filtration processes.

About VERDOT and Downstream Processing

With more than 70 years providing solution-driven engineering expertise, VERDOT continues to pioneer innovations for biopharmaceutical downstream processing in GMP environments. Ranging from standard to highly customized formats, VERDOT designs chromatography columns as well as single-use and multi-use systems for chromatography and TFF.

With a focus on the purification, separation and concentration of biomolecules such as monoclonal antibodies, vaccines, viral vectors (e.g., adeno-associated virus and lentivirus), and mRNA-based therapeutics, VERDOT partners with industry leaders in biopharma, research and development, early-stage biotech, and CDMOs. Across the entire drug development workflow from initial exploration to commercial manufacturing, VERDOT offers tailored, high-quality purification technologies that support clients to advance clinical manufacturing and improve speed to market for groundbreaking therapies.

FlexiPro Chrom System

The FlexiPro Chrom (Figure 2) is a single-use system delivering a flow rate range of 10 mL/min to 560 L/hr that allows seamless scale-up from process development (10 mL/min) to GMP commercial (9.3 L/min) manufacturing. The multi-scale system uses interchangeable pump heads with paired SU flow kits providing optimal purification performance across all chromatography steps, from capture to polishing.

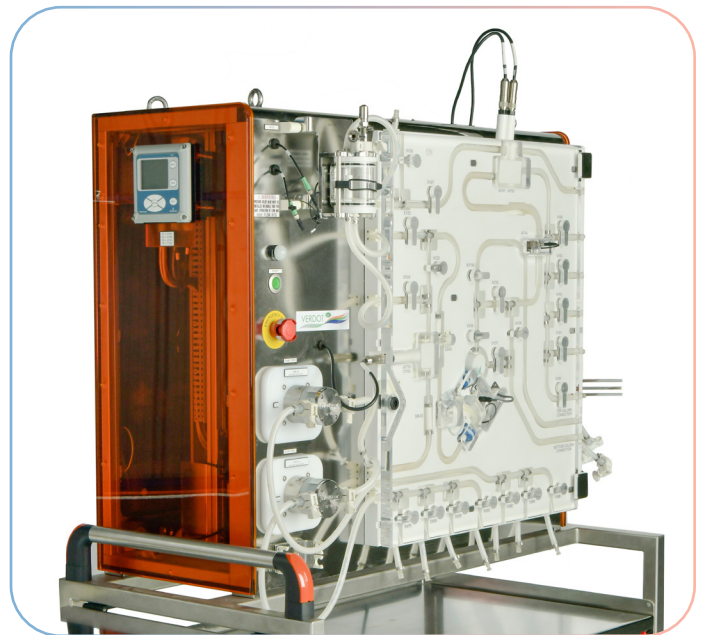


Figure 2. FlexiPro™ Chrom System

Designed to maximize operating flexibility, users can choose between four flow kit ranges that best meet their process requirements. Pump head change over and flow kit installation can easily be accomplished in less than 20 minutes. The one-piece pre-assembled flow kits are mounted on the front of the instrument and secured by a transparent door, allowing full visibility of the fluid path.

Other design features include concurrent control of flow and pressure to maximize efficiency, high precision instrumentation for very shallow and precise linear gradients, conductivity probe with a wide measurement range (0-500 mS/cm) for complex purification processes, and dual wavelength UV (e.g., 260 nm and 280 nm) with detection as low as 1 mAU.

Unified integration of FlexiPro Chrom and MOTIV Inline Buffer Formulation System

The integration of the MOTIV® Single-Use Inline Buffer Formulation System with the FlexiPro Chrom platform creates a fully coordinated solution in which buffer preparation and chromatography operate as a single, automated process.

In this one-to-one configuration, each FlexiPro system is directly paired through OPC-UA with a dedicated MOTIV system. The key feature of the integration is that a single method is programmed in the FlexiPro platform, which centrally governs both chromatography execution and buffer preparation. The FlexiPro system not only manages the chromatographic sequence (i.e., equilibration, loading, washing, elution, fraction collection, and regeneration) but also directly instructs the MOTIV system as to which buffer to prepare, in what volume, and at what time. This unified control eliminates the need for separate configuration and manual coordination between systems.

Through real-time communication, the FlexiPro system continuously transmits the exact buffer demand to MOTIV system, ensuring that only the required volume is prepared. This demand-driven approach removes the need for conventional safety margins (~10%), thus significantly reducing excess buffer production. Because the buffer preparation rate adapts precisely to the chromatography consumption rate, restart events and transient losses are minimized.

The synchronized integration is particularly advantageous for steps controlled by inline measurements such as conductivity, where the final volume cannot be predicted precisely. In these cases, the FlexiPro Chrom can use process data to stop buffer preparation proactively, thereby preventing overproduction.

Fully-automated execution further enhances efficiency. Once initiated, the combined system operates autonomously, reducing manual interventions, operator-dependent variability, and transition-related downtime. Operators are not required to remain present during buffer preparation or chromatography runs,

decreasing operational burden while improving consistency and robustness.

The integrated solution reduces waste, improves sustainability, strengthens process reliability, and increases operational efficiency in mature bioprocessing facilities by synchronizing buffer preparation with chromatographic demand under a single unified method.

CASE STUDY OVERVIEW

Insulin Production Process

Insulin is an ideal case study: its manufacturing process is relatively standardized, batch sizes are large—highlighting the importance of floor space optimization—and the molecule faces strong pricing pressure, making manufacturing cost control essential. While insulin is traditionally produced and purified using stainless-steel equipment, this study explored the benefits of transitioning to SU bags, in parallel with the implementation of an inline buffer formulation system.

Case 1: Insulin Capture Step Using Anion Exchange Chromatography

The chromatography column (1 m diameter, 20 cm bed height, for a total of 157 L column volume) is initially equilibrated for 3 column volumes (CV) to condition the resin prior to product loading. The insulin-containing feed solution is then applied to the equilibrated column. Following product loading, a wash step is performed using the equilibration buffer to remove loosely bound impurities. Insulin is subsequently eluted from the column, and the elution is collected into four fractions, with 270 L designated as the main product fraction. After product recovery, a three-step regeneration sequence is implemented to remove remaining bound species and restore resin performance. These regeneration steps are designed to strip strongly bound impurities, neutralize biological contaminants, and recondition the resin for subsequent use. A column cleaning step is then performed to remove residual contaminants and prepare the column for reuse. This is followed by a rinse with the equilibration buffer, restoring the column to its initial operating conditions and ensuring consistent performance in subsequent batches.

Case 2: Insulin Polishing Step Using Anion Exchange Chromatography

The column (1 m diameter, 25 cm bed height, for a total of 196 L column volume) is initially equilibrated to establish the ionic strength and pH conditions required for optimal insulin binding. This equilibration step ensures that the resin surface charge and conductivity are appropriately aligned with the product feed conditions. The insulin-containing feed solution is then applied to the equilibrated column. A wash step using the equilibration buffer is performed to remove weakly bound impurities.

Elution is then carried out using a two-fraction (A and B) gradient system, enabling controlled separation of species with closely related charge characteristics. As the ionic strength increases, insulin disassociates from the resin and elutes in defined fractions. This fractionation strategy supports optimization of both product purity and recovery.

Following product elution, the resin is regenerated to remove any strongly bound impurities remaining on the column. An alkaline cleaning cycle is subsequently performed to ensure microbial control and maintain resin performance by sanitizing the resin and removing residual biomolecules. Finally, the column is rinsed to remove traces of the cleaning agent and prepare the resin for storage or for the next operational cycle.

Application study

This process has a demand for 9 unique buffers across the capture and polishing steps (excluding the product load) as shown in Table 1 below.

Table 1. Buffers for the capture and polishing chromatography steps of insulin purification

Buffer	Total Prep Volume (L)	Flow Rate (L/h)	Steps
20 mM Tris-HCl, 10 mM NaCl, 10% IPA, pH 8.8, 1600 $\mu\text{S cm}^{-1}$	1570	600	Equilibration, Wash 1 Rinse
20 mM Tris-HCl, 40 mM NaCl, 10% IPA, pH 8.8, 2500 $\mu\text{S cm}^{-1}$	471	600	Elution
0.5 M NaCl	314	600	Regeneration 1
1 M NaOAc, pH 3	235.5	600	Regeneration 2
0.5 M NaOH, 2M NaCl	471	600	Regeneration 3
0.5 mM Tris-HCl, pH 8.8	150	600	Cleaning
20 mM Tris-HCl, pH 8.5	1570	600	Equilibration, Wash 1 Elution
20 mM Tris-HCl, 0.5 M NaCl, pH 8.5	785	600	Elution Regeneration
0.5 M NaOH	392.5	600	Cleaning

For this application study, the MOTIV® system is supplied with two bag weigh scales, each containing 6 x 50 L bags with individual weight measurement (Figure 3). These bags can be pooled together to create larger allocated lots for high buffer volumes, as is shown in the table above. The system maintains detection and control of the bags and scales throughout the process.

The MOTIV system begins filling each bag with the respective buffer prior to starting the capture or polishing chromatography step. The full 150 L of cleaning buffer required for the capture step is prepared at this point. The system monitors each bag for additional demand of buffer. In this case, the equilibration buffer is demanded first – the MOTIV recipe is written to satisfy the demand as needed and then can switch buffer recipes if the next process requires additional buffer demand.

If a bag reaches the specified maximum volume set point, then the MOTIV system pauses operation and waits for the level to drop before preparing additional buffer. The system continues to prepare buffer, even while being consumed, until the total preparation volume is reached, or until the FlexiPro system requests to stop production or requires transition to next buffer. Each time a new buffer is prepared, the system purges until the transfer line is flooded with in-spec buffer, so no waste product is delivered to the bag. At the end of a step, 5% of the total volume of buffer can be produced to avoid risk of shortage in the chromatography operation.

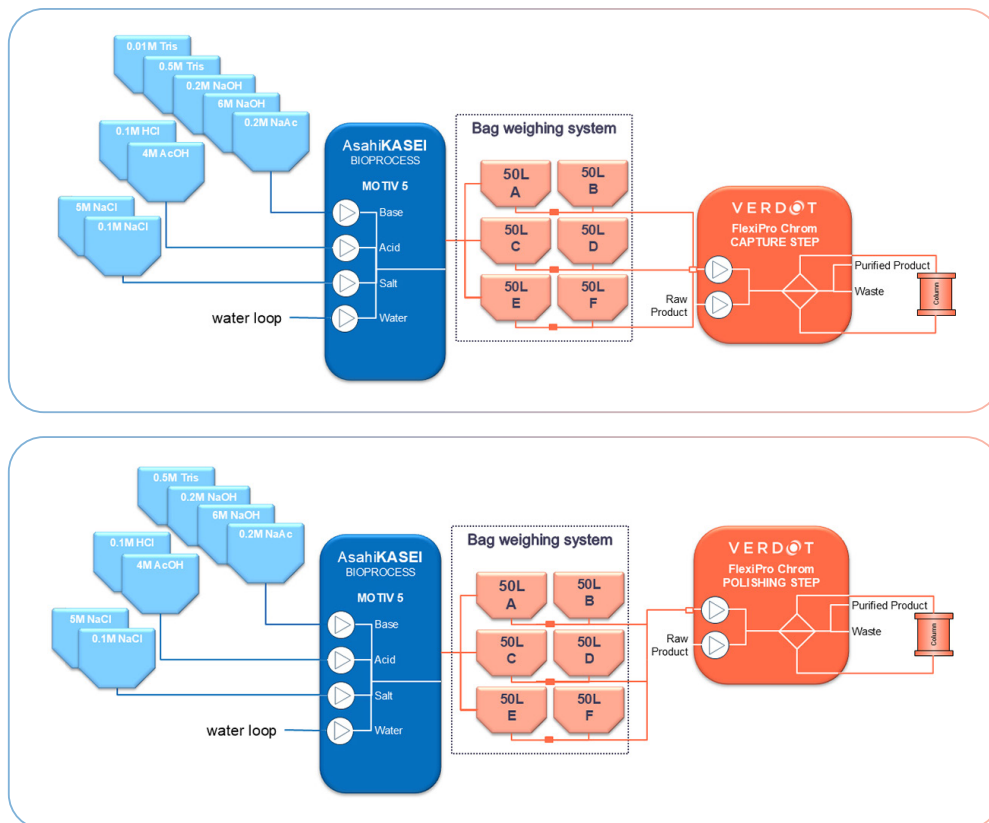


Figure 3. Operational Schematic of the Integrated MOTIV 5 and FlexiPro Chrom System for the Capture and Polishing Steps

ECONOMIC AND FINANCIAL ANALYSIS

Scope and Methodology

This economic analysis compares traditional batch buffer preparation using fixed tanks and inline “just-in-time” buffer formulation enabled by the MOTIV® Inline Buffer Formulation System integrated with the FlexiPro Chrom platform.

Preliminary assumptions

Base economic assumptions used in this analysis are provided in Table 2.

For cleaning, it is generally assumed that approximately 10% of the total tank volume is required as a cleaning solution to perform an effective clean-in-place (CIP) [2]. The CIP sequence used in this study is based on standard procedures applied to bioreactors and tanks used in biopharmaceutical applications [3].

Bag prices were estimated based on Biopharma World product pricing [4], and the cost of plastic waste generated was estimated based on a study conducted by Sartorius [5]. The SU bag waste treatment cost is assumed as \$0.7/kg and 1.5 hour is assumed for a single tank cleaning.

Table 2. Economic Assumptions for MOTIV Inline Formulation System vs Tank Farm Buffer Preparation

Parameter	Individual Operation	
	MOTIV Inline	Tank Farm
Operator Time in hours	2	16
Operator Cost per hour	\$50	\$50
Analytical Wait time in hours	3	4
Analytical Wait time cost per hour	\$5 000	
Number of batches per year	50	
Quality Check Time in hours	1	2
Quality Check Cost per hour	\$100	\$100
Cleaning time cost (assuming \$120/ hour)	\$120	\$120

CAPEX Comparison

CAPEX comparison demonstrates a substantial difference in capital requirements between traditional tank-based buffer preparation and inline buffer formulation.

Conventional tank-based preparation entails considerable infrastructure investment, even when supporting a single chromatography step. Capital costs are predominantly driven by the construction of a dedicated tank room, the installation of stainless-steel buffer tanks, extensive piping systems, and enhanced HVAC capacity to accommodate larger classified preparation and storage areas. Consequently, total CAPEX reaches \$4,830,000, making it significantly higher than the alternative solution.

In contrast, inline buffer formulation requires an initial investment primarily associated with the MOTIV® system and the construction of a dedicated formulation room, supported by more limited utility needs such as piping, HVAC, and electrical installations. Under this configuration, total CAPEX amounts to \$3,895,000.

Overall, inline buffer formulation reallocates capital away from large, fixed storage infrastructure toward a more compact, modular, and scalable configuration. Although facility construction remains the largest contributor in both cases (77% of total investment for the MOTIV system setup and 82.8% for the tank-based installation) the inline approach reduces overall capital intensity and enables a more flexible manufacturing footprint.

Table 3. CAPEX Breakdown for Individual Chromatography Operation (N/A: Not Applicable)

Fixed Cost	MOTIV System	Tank Farm
Equipment (MOTIV® / Tanks and installation)	\$775 000	\$480 000
Facility Construction	\$3 000 000	\$4 000 000
Piping	\$15 000	\$250 000
HVAC	\$10 000	\$100 000
Other (Electrical requirements...)	\$20 000	N/A
Bag Weight Rack	\$75 000	N/A
TOTAL	\$3 895 000	\$4 830 000

OPEX Comparison

OPEX analysis highlights a significant gap between traditional tank-based buffer preparation and MOTIV inline buffer formulation (Table 4).

The tank-based approach generates substantially higher recurring costs. Manual weighing, mixing, and sampling demand considerable operator labor, while batch-prepared buffers require additional quality control testing. This includes a typical 3-hour delay for pH, conductivity, and strength verification, leading to production downtime and associated opportunity costs. Most importantly, stainless-steel tanks require frequent cleaning and sanitization, which represent major OPEX drivers due to labor intensity, cleaning agents, water consumption, and equipment downtime. In this study, cleaning costs were estimated using CIP cost structures aligned with GMP bioreactor operations. As a result, the annual OPEX for the tank-farm configuration reaches \$1,808,059.

In contrast, MOTIV inline formulation significantly reduces recurring expenses. Operating costs are mainly associated with routine room validation, limited operator involvement, and, where applicable, single-use consumables. Automation eliminates manual mixing, sampling, and transfer steps, as well as the extended wait time required for quality control validation of each batch preparation. Although minor buffer losses during

Table 4. OPEX Breakdown for Individual Chromatography Operation

Annual OPEX										
Year	1	2	3	4	5	6	7	8	9	10
MOTIV® System										
Room Validation	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000
Buffer Prep Quality Checks	\$5 000	\$5 150	\$5 305	\$5 464	\$5 628	\$5 796	\$5 970	\$6 149	\$6 334	\$6 524
Buffer Prep Operator Time	\$5 000	\$5 150	\$5 305	\$5 464	\$5 628	\$5 796	\$5 970	\$6 149	\$6 334	\$6 524
Analytical Waiting Time	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000	\$750 000
Buffer Losses	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883	\$1 883
SU Bag Prices	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491	\$289 491
Waste Bag Treatment	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071	\$25 071
TOTAL	\$1 081 444	\$1 081 744	\$1 082 053	\$1 082 372	\$1 082 700	\$1 083 037	\$1 083 385	\$1 083 743	\$1 084 112	\$1 084 492
Tank Farms										
Room Validation	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000	\$5 000
Buffer Prep Quality Checks	\$10 000	\$10 300	\$10 609	\$10 927	\$11 255	\$11 593	\$11 941	\$12 299	\$12 668	\$13 048
Buffer Prep Operator Time	\$40 000	\$41 200	\$42 436	\$43 709	\$75 020	\$46 371	\$47 762	\$49 195	\$50 671	\$52 191
Analytical Waiting Time	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000
Tanks Cleaning	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115	\$736 115
Buffer Losses	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892	\$3 892
Other (labor, consumables, etc.)	\$5 000	\$5 250	\$5 516	\$5 788	\$6 078	\$6 381	\$6 700	\$7 036	\$7 387	\$7 757
TOTAL	\$1 800 008	\$1 801 658	\$1 803 357	\$1 805 108	\$1 806 911	\$1 808 768	\$1 810 681	\$1 812 651	\$1 814 680	\$1 816 770

the first 15 to 45 seconds of operation and single-use consumables are included in the model, these costs are offset—particularly in a brownfield scenario—by the elimination of tank cleaning and the reduced quality control burden. Under these assumptions, annual OPEX for MOTIV® amounts to \$1,082,908.

Overall, by reducing labor, minimizing cleaning requirements, and simplifying workflows, inline buffer formulation delivers markedly greater operational efficiency. The MOTIV system shifts recurring expenditures away from infrastructure-heavy maintenance toward a streamlined, high-efficiency operating model.

Brownfield Transition Assessment: Replacing an Amortized Tank Farm with an Integrated MOTIV Inline Formulation–FlexiPro Chrom Solution

Given that inline buffer formulation requires lower capital investment and reduces operating costs compared with a conventional tank-farm solution, it is the natural choice in a greenfield project.

The key question, however, concerns brownfield scenarios—where an existing, fully amortized tank installation is already in place. In such cases, is it economically justified to replace stainless-steel buffer tanks with an Inline Buffer Formulation system such as MOTIV system, fully integrated with a FlexiPro Chrom platform and buffer track?

This question reflects two fundamental trade-offs. On one side stands upstream batch preparation with a typical 10% buffer overage, versus real-time, on-demand buffer generation. While inline preparation involves short transient phases—approximately 90 seconds during restart, during which off-spec buffer is discarded, eliminating systematic overproduction. On the other side, stainless-steel tanks require regular cleaning and sanitization, whereas SU bags require periodic replacement and plastic waste management. The comparison therefore balances cleaning-intensive fixed infrastructure against disposable-based, just-in-time manufacturing.

To assess this scenario, financial performance was evaluated over a 10-year period using discounted cash flow analysis (Table 5). Although adopting MOTIV system in a brownfield setting requires incremental CAPEX—covering the system itself, the bag weight rack, and necessary electrical upgrades for a total of \$895,000—the overall economic outcome remains strongly favorable.

Despite this upfront investment, inline buffer formulation demonstrates a substantially lower total cost of ownership than the traditional tank-based approach, which continues to generate high operating costs driven by cleaning, labor-intensive handling, and large classified facility requirements.

The techno-economic assessment yields a net present value (NPV) of +\$2,735,886 over 10 years. The return

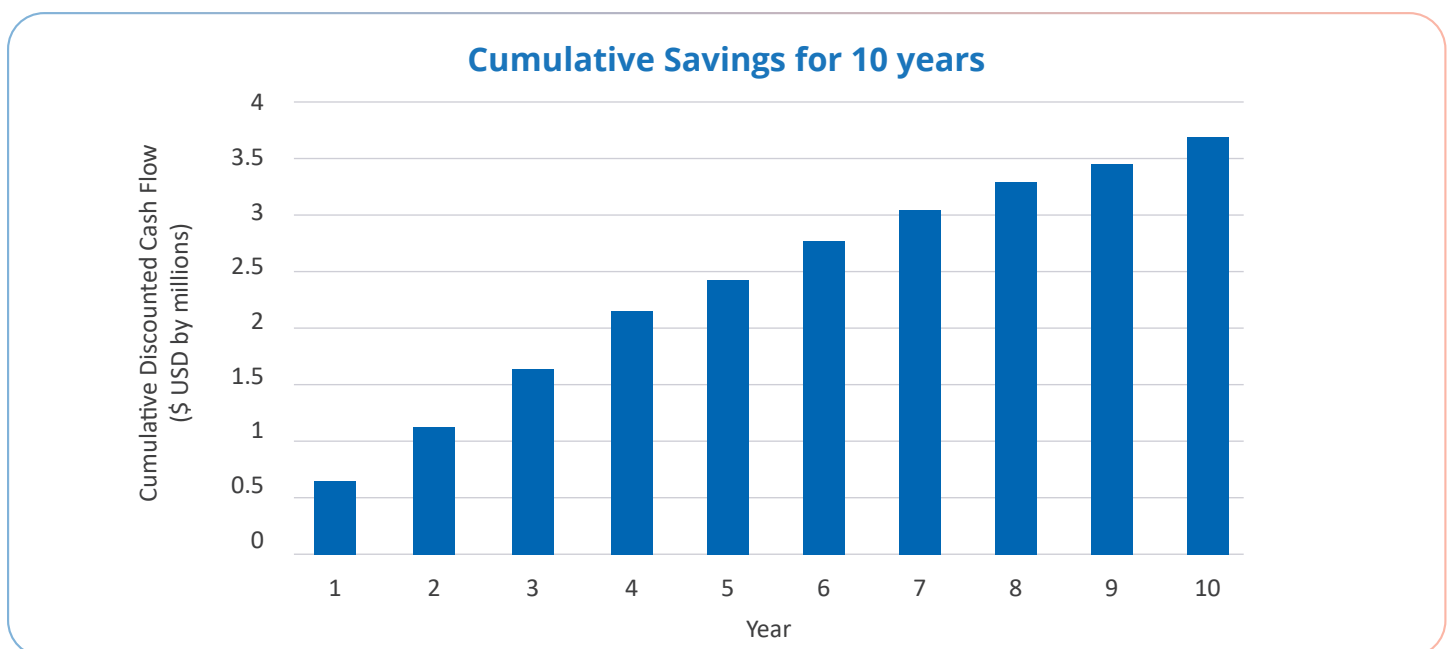
on investment (ROI) reaches 710%, meaning that every dollar invested in MOTIV® system generates \$7.10 in return—even when replacing an already amortized tank installation. The calculated payback period is only 1.62 years.

By year 10, cumulative discounted savings exceed \$3.6 million as shown in Figure 4, reflecting the immediate and sustained impact of OPEX reduction. Overall, even in a brownfield context, inline buffer formulation provides a stronger financial profile, combining rapid payback, high long-term value creation, and improved operational efficiency compared with the tank-farm approach for individual chromatography operations.

Table 5. Comparative Economic Assessment

Year	1	2	3	4	5	6	7	8	9	10
OPEX Difference per year	\$718 563	\$719 913	\$721 304	\$722 736	\$724 211	\$725 731	\$727 296	\$728 908	\$730 568	\$732 278
Discount Factor	0.87	0.76	0.66	0.57	0.50	0.43	0.38	0.33	0.28	0.25
Discounted Cash Flow (DCF)	\$624 838	\$544 358	\$474 269	\$413 227	\$360 061	\$313 753	\$273 417	\$238 281	\$207 673	\$181 008
Cumulative DCF	\$624 838	\$1 169 196	\$1 643 465	\$2 056 692	\$2 416 753	\$2 730 506	\$3 003 924	\$3 242 205	\$3 449 878	\$3 630 886
ROI	-20%	61%	141%	222%	303%	384%	465%	547%	628%	710%

Figure 4. Cumulative savings over 10 years for the brownfield scenario



Integrated MOTIV–FlexiPro Chrom Solution Reduces Buffer Loss Compared with Conventional Tank Operation

The integration of the FlexiPro Chrom with the MOTIV® Inline Buffer Formulation System via real-time OPC-UA communication creates a synchronized, closed-loop buffer production workflow. Through continuous digital exchange, the FlexiPro Chrom transmits the live buffer consumption profile to MOTIV system, enabling demand-driven buffer generation without traditional safety margins.

During each chromatography step, MOTIV system adjusts its production rate dynamically to match actual consumption, particularly when end-of-step conditions are governed by conductivity targets. This precise “end-of-step finishing” significantly reduces overproduction and unnecessary buffer preparation.

As a result, total buffer losses decrease from 595.9 L to 292.5 L per batch, an absolute reduction of 303.4 L corresponding to a 50.9% decrease. Lower buffer volumes also reduce SU consumable usage and bag changes, contributing to measurable sustainability improvements.

In addition, the fully automated workflow is launched through a single method at the start of the process, which reduces operator intervention and improves volumetric accuracy. While the direct financial impact of reduced buffer waste remains secondary compared with major downstream OPEX drivers, the MOTIV–FlexiPro integrated solution delivers clear environmental and operational benefits.

Overall, this setup enhances process control, reduces waste, and supports greener downstream manufacturing without requiring additional capital investment beyond core system integration.

CONCLUSION

The integrated MOTIV–FlexiPro solution provides a modern, space-efficient, and cost-effective alternative to traditional tank-based buffer preparation. By replacing large buffer-tank infrastructure with precise on-demand formulation, facilities can significantly reduce operational complexity, labor burden, and cleaning requirements—all while accelerating batch turnaround. In summary, the economic advantages are:

- Reduced infrastructure-related capital intensity
- Lower labor and cleaning requirements
- Minimized buffer losses in case of 1:1 allocation with a FlexiPro Chrom system
- Sustained reductions in operational complexity

Beyond these economic and operational gains, the FlexiPro Chrom adds a meaningful sustainability advantage. Its high-precision flow control and automated buffer management reduce unnecessary buffer production, limits SU consumable consumption, and improves resource utilization across downstream steps. The result is a more streamlined, environmentally conscious, and flexible purification workflow that supports both current manufacturing demands and future process intensification strategies.

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