Executive Summary

Today’s refineries are forced to deal with increasing operational complexity and constant change. Nowhere is this more evident than in the blending operations of a plant. With more product grades, increasingly stringent specifications, new government regulations, and fewer feasible blends, refineries face greater challenges to maintain and improve their bottom line.

To realize the greatest profitability in refinery blending operations, a blend optimization system is needed for management of the component and product tanks, blend header, online and laboratory analytical systems, planning/scheduling activities, and overall performance analysis.

At many refineries around the world, however, product giveaway, re-blending and product downgrading continue to add significant costs and directly impact the bottom line.

Now, more than ever, refining companies require a comprehensive solution that addresses these issues and solves blending problems in a unified, yet flexible manner to deliver cost savings and improved business results.
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Introduction

Refineries can't make generic blends, store them, and analyze them later anymore. That's why concepts like supply chain optimization, production management, and make-to-demand have been adopted by the industry. The idea of effectively managing supply, production and distribution operations has been understood by refiners for a long time—in fact, refining companies have often been among the first to adopt new technology to enable better performance.

Successful refining operations throughout the world utilize applications facilitating advanced planning and scheduling, advanced process control and real-time performance monitoring. Tools and technologies such as these provide greater control, improved execution, and safe and reliable production.

Today, these same industry leaders recognize that greater challenges to the industry require ever more sophisticated and advanced solutions. Worldwide, environmental regulations are being enacted that result in more product grades, increasingly stringent specifications, and fewer feasible blends. At the same time, the world demand mix of refined products reflects increasing requirements for transportation fuels as developing nations consume more gasoline and distillate products.

Operational Objectives

Refineries must find ways to be more flexible and agile, as well as reduce downtime between blends. Gone are the days when the same products were made day in and day out. Now, refineries typically make 50-80 different products. They also must use predictive properties, and account for opt-ins, such as adding ethanol, to save revenue.

In the future, refining complexes are going to see even more operational complexity, not to mention increasing regulations on conventional and biofuels mixes, and tighter rules for data capture and retention.

For an existing refinery, especially when it has been in operation for a considerable period of time, more and more shortcomings emerge, largely due to market dynamics and technology evolution.

For instance, an existing plant may not have enough capacity to meet current and future market demand, or it may not satisfy new environmental regulations and/or product specifications. The plant may also consume too much energy or lack sufficient reliability.

Specific operational objectives for refining blending operations can include:

- Reduce property giveaways
- Optimize component use
- Reduce product and component inventories
- Minimize touchups and re-blends, resulting in more reliable deliveries
- Adhere to product specifications for environmental compliance
- Ensure online blend quality analysis and certification
- Achieve faster response to immediate market opportunities
To maintain profit margins in an ever-changing environment, refineries must have smarter strategies for safe, flexible and adaptive operations. This means work processes, abilities and tools need to be well adapted to support distinct business scenarios, and the transition from one activity to the other has to be as quick and smooth as possible.

Current operational demands have caused a substantial increase in the size and complexity of the refinery decision-making process. Plants need to better understand blending processes and improve business performance by closing the loop on blend planning and execution. In this situation, reliable automation based on integrated, online advanced optimization tools is the key to achieve a refinery's true potential.

**Blending Challenges**

Product blending is a critical component in modern refining operations with direct impact on the bottom line of the facility. As the complexity of refinery operations has increased due to feed slate changes, local market requirements and environmental regulations, the ability to optimally plan and blend products to specification has become critical to business success.

Gasoline and distillate fuel blending are the “cash register” of a typical refinery, where optimized blending can represent more than 50 percent of the total advanced process control (APC) savings and exceed $15-20 million per year in cost reductions. In this scenario, small reductions in giveaway yield huge results through scale.

The blending system in a refinery is very important in the sense that any giveaway generated there is gone for good. In the meantime, there are many challenges to maintain optimal blending performance. They include, but are not limited to, maintaining an advanced blending system, dealing with associated near-infrared (NIR) analyzer and modeling issues, and coping with common resource shortages.

In refinery blending operations, there are different types of potential giveaway. Some of them are the result of weak planning tools, while others are linked to the refinery operation including:

- Hidden giveaway (component imbalances)
- Systemic giveaway (planning model inaccuracy)
- Built-in giveaway (component property uncertainty)
- Time giveaway (component availability)

In other cases, equipment problems can arise due to a lack of investment in off-sites. This leads to planned giveaway, which is attributable to poor equipment, execution and property measurement.

Furthermore, refineries can suffer from giveaway that results from incorrect planning. This includes:

- Measured giveaway (external upsets)
- Expected giveaway ($X \neq X$, the built in giveaway buffer over sales specifications because of poor planning and execution tools)
- Inventory giveaway (additional tankage)

An important business driver for refinery managers is minimizing ALL types of giveaway. And when a refinery can match its plan, it can plan tighter. This requires a unified approach to blending that closes the loop between planning, execution, monitoring and analysis. Each component must be tightly integrated within an overall solution to optimize blending performance. Only then can the refinery be certain that repeatability is up, inventory is down and it can execute blend after blend exactly as specified.
To achieve optimal blending outcomes, it is necessary to compare the predicted blend to the actual blend, as well as the starting recipe to the finished ratios. One property prediction model can't handle all the different blend grades. In addition, appropriate technology is required to implement the correct process incorporating analyzers and various blending modes.

Key to an integrated approach is to break down the individual causes of a large, cumulative giveaway on blended products. While not all root causes can be addressed, those that can often have significant and quick ROI benefits. An overall integrated approach to blending, including planning, execution, and analysis, provides the environment to both identify giveaways of all types and provide the tools to resolve those giveaways.

Experience has shown that blend planning using a spreadsheet never works as well as a multi-period, non-linear blend planning application. Also, without a precise and reliable tool to compare blending key performance indicators (KPIs), it is impossible to know the plant's blending outcomes. This has a material impact on world gasoline prices, with consumers left to compensate for the results of poor planning.

### Finding the Right Approach

In 2010, the energy consulting firm Solomon Associates reported a gap in gasoline blending of up to $1.30/bbl when comparing the effective refining of the best to worst companies. Another study projected that a blend planning and execution solution can deliver an ROI of up to $3.5 million in six months by improving blend practices with in-line blenders and analyzers. In one study, the end user achieved over $1M/year in benefits without any equipment changes. Clearly, there are huge financial implications in off-sites performance.

The first step in optimizing refinery blending is to understand how much each type of giveaway penalizes the overall bottom line. This metric is unique for each site. It begins with identifying the culprit(s) in poor blend performance, whether it's KPI analysis, blend planning, blend execution or in-line analyzers. Refineries will find the best approach is to enlist their main automation supplier to...
perform a study of their blending operation. The supplier can also perform tuning and maintenance of existing applications.

Leading automation suppliers like Honeywell Process Solutions have extensive experience in the refining industry and can assist customers on a global basis. They offer integrated tools to enable optimal in-line blending and maximum profits for refineries. For example, Honeywell’s Blending and Movement Management (BMM) Blending Suite provides applications that protect inventory constraints, delivery schedules and product specifications. It also executes basic component ratio control and advanced property control, performs blend data analysis and determines KPIs for continuous blend improvement. If needed, this solution can be integrated with Honeywell’s Movement Management Suite for complete movement control, monitoring and reporting.

Honeywell’s Blending Suite, part of the BMM family of applications and services, is a comprehensive solution for complete planning, execution and performance monitoring of a refinery’s blending operations. It consists of five tightly integrated modules: BLEND, Blend Instructions, Experion® Ratio Controller (ERC), Open Blend Property Control (OpenBPC) and Blend Performance Monitor.

The BLEND application is intended for off-line, multi-period blend planning and event-based scheduling. It offers planners and schedulers the best blending formulations for intermediate component blending to successfully meet final product demand on time while reducing quality giveaway.

Blend Instructions provides an interface for management and transfer of blend recipes and instructions. This application allows facilities to create, edit, copy and delete blending instructions that, in turn, are employed by ERC and OpenBPC to ensure the settings used by these applications match the physical blending process in the field.

Experion Ratio Controller controls in-line blending with multi-component blend sequences to confirm that blended products meet blend recipe specifications by managing the blend sequence from start to finish.

OpenBPC is a non-linear blend optimizer for online blend reformulation and optimization with dynamic recipe adjustment. It allows efficient blending of fuels to required specifications while optimizing the blend. OpenBPC uses industry-standard OPC server/client architecture to facilitate the interface between OpenBPC and Honeywell’s Experion Process Knowledge System (PKS) or third-party blend control systems.

Blend Performance Monitor is a decision support system that closes the loop on the business process, historizes all data, provides feedback to the planning tool, highlights variances in the operation, and evaluates KPIs at the business level.

How the Solution Works

Refineries of all sizes can benefit from a standardized, online, closed-loop, real-time optimization strategy. This is achieved by employing multi-period blend optimization scheduling and planning at the enterprise level, which downloads objectives and recipes to blend property control applications, which in turn determines the optimum recipes to be used, and then runs them on the refinery’s distributed control system’s (DCS’s) blend ratio control application using related instruments and analyzers.

By utilizing Honeywell’s BLEND application, refineries can take advantage of a linear programming (LP)-based planning, scheduling and operations decision-support system for gasoline and distillate fuel blending. The application also features built-in data interface facilities and data export to OpenBPC. The solution algorithm in BLEND combines a multi-product, multi-period LP with scheduling algorithms—producing an economic set of blending orders that meets specifications, reduces giveaway, and honors tank inventory and pumping constraints. The solution is capable of defining up to 35 periods, with each period representing one day or multiple days.

BLEND offers an extensive summary, as well as detailed data presented in
a spreadsheet and in a formatted report. This makes it easy to understand and allows a thorough analysis of the impact on existing blending operations. It provides a view of the entire blend schedule solution from the LP in a dynamic Gantt chart that sequences the blending operations by the time of day. This enables users to:

• Change the day and hour to start a blending operation
• Change the volume to blend
• Change the sequence of blending operations
• Determine whether sufficient inventory is available to support the changed blending schedule

**Blend Instructions** is a fully integrated application for creating, editing and managing blend recipe information and ensuring it is properly communicated to the ERC and OpenBPC applications. Blend Instructions delivers information such as:

• Blend header to be used
• Blending specifications, including component recipe type, blend grade and control mode
• Target blend volume
• Target blend flow rate and associated flow rate limits
• Blend destination equipment
• Destination heel volume and property values at the start of the blend (if applicable)
• Initial component recipe and associated optimization settings (e.g., target percentage or flow rate, limits, and cost)
• Initial additive concentration values
• Material source equipment, which will supply the components and additives to the blend header
• Property specifications, including target property values for the blended product, associated optimization settings and blend model values
• Rundown segregation flow rate targets, limits and costs (if applicable)

**Experion Ratio Controller** is built on the Experion PKS infrastructure using redundant C300 controllers. The system makes use of unique flow profiling and customization capabilities and can be deployed in either stand-alone form or fully integrated with Honeywell’s Movement Management Suite.

Experion Ratio Controller manages the blend sequence from start to finish to ensure blend accuracy. It manages blend component mixing to satisfy either flow ratio, volume ratio or property specifications. Key functionality includes:

• Automatic start up, operation and shutdown of the blender and associated equipment
• Master flow rate setpoint flow control
• Blend flow rate and volume control
• Recipe validation
• Maintenance of component percentages and additive concentrations as dictated by the blend recipe
• Pacing of the blend flow rate
• Blend header pressure control
• Blend report generation
• Redundant operation
**OpenBPC** provides model-based product property control and optimization. It can be applied to the operation of in-line blenders, which produce a wide variety of products such as gasoline, distillate and fuel oils. OpenBPC can also be used in crude oil or chemical blending applications. The tool supports multiple interactive blenders, and also handles combinations of rundown blending and component tank blending.

OpenBPC can be deployed for:

- Blend optimization
- Blending objectives and control modes
- Blend optimization model based on user data and rules
- Blend quality monitoring
- Multi-blender optimization
- Support of continuous rundown blends
- Reporting
- Off-line optimization

Finally, **Blend Performance Monitor** includes the tools for comparing plans to actual results and analyzing trends in performance. The system collects data on the planning and execution of blending operations for products such as gasoline, diesel and naphtha. It then provides operational and management reports to monitor and improve the performance of these operations.

Blend Performance Monitor uses Honeywell’s Uniformance® PHD (or other process historians) as the foundation for storing blending data, and provides custom reports as well as numerous standard reports, including:

- Blend analysis report
- Detailed recipes report
- Actual vs. target report
- Composition summary report
- Property summary report
- Blend values report
- Backcast report
- Detailed giveaway report
Closing the Loop on Blend Planning and Execution

Benefits to Refineries

Transforming data into meaningful business knowledge is vital to optimizing production and maximizing a refinery’s commercial potential. Effective performance management for blending systems involves integrating planning, scheduling, execution, monitoring and analysis, as well as the ability to respond to change immediately.

The implementation of advanced blend planning and execution technology can provide refiners with the means to perform complex calculations to blend components within specifications while at the same time reducing the time required to blend product and also minimizing losses. The specific operational benefits of this solution include:

Reduced property giveaway: When the blending objective includes minimum giveaway, the online blend optimizer ensures the least property giveaway while meeting all quality requirements. And for the selected property, a trim strategy offers the ability to remain close to the blend specification while responding to minor process disturbances.

Optimal component use: When the blending objective includes minimum cost, the online blend optimizer ensures all quality requirements are met while optimizing component usage. It identifies the contribution of all components relative to each property, and this information is used by the blend optimizer to determine the ideal component usage.

Lower product inventory: A well-performing blending system helps significantly reduce product inventory. Online blend optimization reduces the overall blend turnaround time while providing online blend certification capability.

Lower component inventory: The use of an online blend optimizer enables a refiner to react to online component disturbances—from swings to stratification and rundown drift, as well as many others. This includes blending directly from unit rundown streams buffered through a tank, thereby reducing component tankage. It also provides optimal component usage for property correction and improves the component consumption rates for low- or high-inventory components.

Fewer touchups and re-blends: A well-functioning blending system takes full advantage of available analyzers and instrumentation and ensures the blend meets specifications for all properties the first time. The measurement of blend qualities using online analyzers provides the opportunity to determine qualities prior to completion of the blend. And it is this measurement that facilitates quality control of the blended product during the blending process.

More consistent product mix: In-line mixing of components and additives ensures a higher degree of homogeneity in the product mix. By using trim strategies or property control throughout the blend, the variance in blend quality is reduced and the homogeneity of the blended product is enhanced.

Compensation for heel in finished product tank: Off-spec material products that are in the finished tank heel before the blend starts can be corrected using trim strategies. Recipes do not need to be recalculated based on the tank heel.

Tracking of blend performance: A robust blending solution such as Honeywell’s offers reports that detail blend performance statistics, as well as the deviation between measured results and those predicted by the model. The reports are useful for blend audit trails and analyzer performance data. Additionally, analyzer maintenance recommendations can be derived from these performance statistics.

Reduced cost through online blend certification: When used in conjunction with an analyzer validation and control package, Honeywell’s blending solution allows refiners to certify blends online. This further reduces blend turnaround time while driving down demurrage charges and product inventory.

Improved control for on-site units: Feedback gained from online blend analysis can be used to provide improved control to the refinery units. For example, if an overall surplus of octane is detected, it is possible to reduce the severity of operation and improve the effectiveness of the advanced control strategies employed on the process units.
Conclusion

An integrated blend planning and execution solution is a requirement for today’s refineries to compete successfully in the current global business climate. Such a solution consists of the integration of offline blend planning and scheduling, together with ratio control, online blend property control and optimization and blending performance analysis. The impact on refinery profitability achieved by implementing such a system is significant and quantifiable with high ROI and quick payback, and since the technology applied is readily available, these benefits can be captured by all refineries.

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