Food and Beverage


# Oenoflow™ PRO XL System Demonstrates Significant OPEX Savings at Wineries

## Introduction

From lees filtration during harvest to final filtration at bottling, Pall's mission is to provide wineries with a full range of cutting-edge solutions for all aspects of filtration. Pall's Oenoflow hollow fiber filtration systems have set the standard for cost-effective clarification in the wine industry for over 20 years and Oenoflow systems can be found in every winemaking region in the world.

Since the first systems were installed in 1995, new developments of the Oenoflow product line have kept Pall's solutions at the forefront of separation technology. New high-area modules, technologies for lees filtration and protein stabilization, and enhancements to optimize cleaning, have answered the call for continuous improvement in wine quality, yield and efficiency while reducing operating costs.

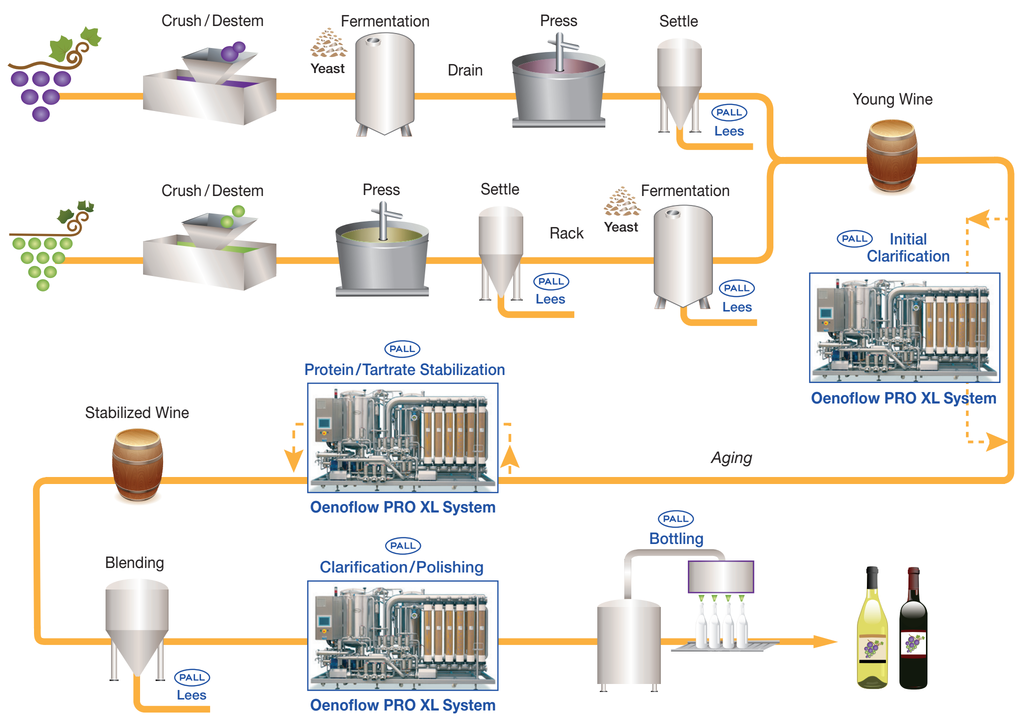
The Oenoflow **PRO** XL system is Pall's latest development in wine filtration technology. This new system includes the Oenoflow **PRO** Optimizer algorithm, which adjusts system settings in real time, enabling wineries to attain the most efficient filtration results for every batch.

This article summarizes results from field studies that demonstrate how Pall delivered over 10% savings in Operating Expense (OPEX) by using the Oenoflow **PRO** XL system with the Optimizer algorithm.

## Oenoflow XL Hollow Fiber Systems

Oenoflow XL systems have become the preferred technology in the wine-making industry. They enable clarification of wine without the need for centrifugation, filter aids, and filter sheets. In a single reliable process step, suspended contaminants are removed from wine without impacting its chemical, physical and organoleptic properties. The technically superior hollow fiber membrane at the heart of the system provides excellent filtration throughput and robust performance. Figure 1 illustrates the typical placement of the Oenoflow XL systems in wine production.

Figure 1: Process Flow Diagram with Oenoflow Solutions in Wine Production




*Filtration. Separation. Solution.*SM

## The Challenge

Due to varying wine requirements stemming from local wine styles, grape varieties, harvest variations and local cellar conditions, there is no one-size-fits-all approach to operating Oenoflow systems. While achieving optimal filtration efficiency for every wine is the goal, this can sometimes prove to be elusive.

The standard Oenoflow XL system has many automatic functions but it does not have the ability to automatically adjust filtration parameters in real time, *e.g.*, due to changing wine types and their filtration performance. Quantitative real-time filtration data for different wines, and the resulting impact on system throughput and operating expenses is not transparent to operators and therefore cannot easily form the basis for manual process adjustment and improvement.

Efficient wine *filtration can be defined as "filtration of a given volume of wine within the shortest possible time at the lowest operating expense, with no negative impact on wine quality."* Two factors that measure filtration efficiency are **system throughput** and **operating expenses**. Refinement of both represents opportunities to improve efficiency for each individual batch of wine.

## System Throughput

System throughput refers to the volume filtered per unit time. It is controlled primarily by the total filtration surface area of the system and the flux rate (flow per unit surface area). For example, a system with 200 $m^2$ of area and flux rate of 40 liters/$m^2$/hour is capable of filtering 200 x 40 = 8000 liters per hour.

Flux rate is influenced by the characteristics, or "filterability" of the unfiltered wine. Harder to filter wines typically display a lower flux rate. While no single parameter can precisely predict filterability, turbidity measurements (NTU) often provide a general indication.

Filterability is related to many factors including:

- The presence of higher amounts of colloids, suspended solids and sugars in the wine typically results in faster membrane fouling and lower average flux rates.
- Filtration temperature can also impact flux rate. Lower temperatures often increase viscosity resulting in decreased flux rates.
- Red wines are typically harder to filter than white wines resulting in lower flux rates.

Membrane cleanliness influences system throughput:

- Regular system cleaning is required to keep the membranes at their best performance. The system cleaning activities needed may vary from day to day depending on the wine types and volumes being filtered.

System maintenance activities impact system throughput:

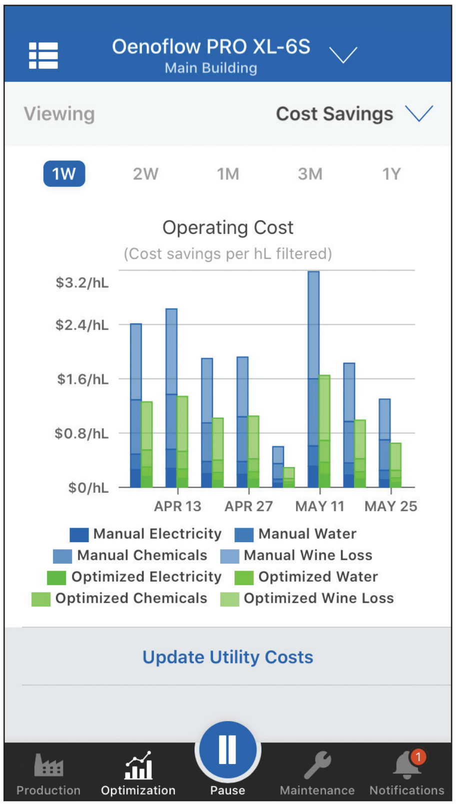
- When maintenance is needed on short notice, it can result in system downtime which negatively impacts the overall winery schedule. To maximize production time and therefore system throughput, it is essential to implement a thorough preventative maintenance program to reduce the risk of unplanned service.

In summary, system throughput not only depends on the characteristics of the wine, but also on system operation characteristics, *i.e.*, filtration temperature, membrane cleanliness, production time versus cleaning time, and system uptime versus downtime.

## Operating Expenses

Operating expenses, or OPEX, comprise utility costs and the value of wine losses. Utility costs include energy (electrical, heating), water consumption and disposal, and cleaning chemicals consumption. Wine losses expressed as OPEX are calculated based on the value of the wine per unit volume multiplied by volume loss. Wine losses are directly related to frequency of cleaning, either due to batch changes or the need to stop and clean during a batch. Wine filterability and filtration flux rate play a role in determining cleaning frequency. Longer filtration runs result in lower wine losses and higher yields.

Operating expenses associated with filtration may be significant when considered in aggregate, but often users do not have a way to track them accurately. As a result, this OPEX is frequently only estimated. If the performance of a system is acceptable in terms of daily throughput, OPEX-related costs are often overlooked and so the opportunity to reduce OPEX is lost.




## The Solution — Optimizer Algorithm Development and Field Trials

To ensure optimal filtration efficiency, Pall initiated the development of the Oenoflow **PRO** XL Optimizer Algorithm. The goal was to improve filtration efficiency, *i.e.*, increase system throughput while reducing operating cost for every wine filtered. The solution needed to respect the individuality of every wine, by tracking, adjusting and optimizing filtration parameters in real time.

## Customer Field Trials

With the collaboration of several experienced Oenoflow XL customers, Pall installed trial hardware and software on systems currently in operation. These systems were connected to Pall servers which allowed remote access for development of the new algorithm. Four sites in two countries were used for development (Table 1). All sites operate year-round and produce both red and white wines. Annual production volumes range from 100-450 thousand hectoliters.

### Table 1: Field Trial Sites

| Site | Country | Operation Type | Approximate Annual Volume (hl) | Ratio Red Wine | White Wine |
|---|---|---|---|---|---|
| GR1 | Germany | Year-round production | 200,000 | 33% | 66% |
| GR2 | Germany | Year-round production | 200,000 | 90% | 10% |
| HT | Germany | Year-round production | 450,000 | 50% | 50% |
| SO | Italy | Year-round production | 100,000 | 30% | 70% |

### Phase 1 — Baseline System Throughput and Operating Expense Evaluation

Initially each site was connected to Pall servers for a duration of 5 weeks. System throughput was quantified and a baseline OPEX was calculated for each site. Costs for electricity, water supply and disposal, water heating and CIP chemicals were quantified. Wine value per unit volume was identified by the wineries. Data collected during this initial phase allowed Pall to fully assess the impact of the Optimizer algorithm when implemented in Phase 2.

### Phase 2 — System Throughput and Operating Expense Optimization

After completing Phase 1, the new Optimizer algorithm was activated at each site. Phase 2 data collection ran for 5 weeks. System throughput data was collected only during production hours, which was the time when the system was filtering, not including filling, emptying or cleaning. OPEX data was collected during total uptime hours, or all hours when the system was available for use, including filtering, filling emptying, cleaning and idle modes.

## Results

System throughput and OPEX data from Phases 1 and 2 were analyzed, to reflect improvements in overall filtration efficiency during Optimizer-enabled filtration.

*The field trials at customer sites demonstrated increased system throughput and significant OPEX reduction.*

It should be noted that only sites GR1 and SO were able to supply data based on significant Optimizer-enabled production volumes.  Despite lower Optimizer-enabled production volume at GR2 & HT during the field trials 3 of the 4 sites demonstrated increased system through put ranging between 21% – 58%. The SO site results were heavily influenced by the types of wines filtered during Phase 2 which were generally harder to filter, and therefore does not give a like for like comparison.

### System Throughput Improvement

Table 2 summarizes the results. Higher throughputs were observed with Optimizer-enabled filtration allowing the wineries to process more wine.

The variability in throughput data among sites reflects the fact that each winery situation is different, influenced by the unique combination of wine varieties and filterabilities resulting in varying opportunities for Optimizer-enabled improvement.

**Table 2: System Throughput Comparison based on Phase 1 and Phase 2 Throughput Performance**

| Site | Production Time (hr) | Production Volume (hl) | Throughput (hl/hr) | Throughput Improvement (%) | Optimizer Use (% of Production Time[1]) |
|---|---|---|---|---|---|
| GR1 Baseline **(Phase 1)** | 132 | 15,971 | 121 | | |
| GR1 Optimizer-Enabled Production **(Phase 2)** | 140 | 22,496 | 161 | 32.88% | 94% |
| GR2 Baseline **(Phase 1)** | 60 | 2,856 | 48 | | |
| GR2 Optimizer-Enabled Production **(Phase 2)** | 67 | 5,050 | 75 | 58.35% | 66% |
| HT Baseline **(Phase 1)** | 181 | 22,730 | 126 | | |
| HT Optimizer-Enabled Production **(Phase 2)** | 34 | 5,162 | 152 | 20.90% | 22% |
| SO Baseline **(Phase 1)** | 204 | 31,196 | 153 | | |
| SO Optimizer-Enabled Production **(Phase 2)** | 257 | 37,311 | 145 | -5.18%[2] | 78% |

[1] Optimizer-enabled operation hours expressed as a percentage of total production hours.

[2] The lower throughput found at site SO is attributed to a situation in which generally harder to filter wines were processed during Phase 2; therefore, unfortunately a true comparison cannot be made between baseline and Optimizer-enabled system throughput.

### Operating Expense Improvement

The combined OPEX improvement found during Phase 2 Optimizer-enabled filtration was significant. Table 3 shows an average 17% combined OPEX improvement based on data aggregated from sites GR1 and SO. Tables 4 and 5 show how the individual sites demonstrated significant OPEX improvements.

**Table 3: Combined OPEX Improvement Based on Phase 1 and Phase 2 Site-Aggregated Expenses**

| Aggregated OPEX (Sites GR1 and SO) | | | | | | |
|---|---|---|---|---|---|---|
| | Baseline (Phase 1) | | | Optimizer-Enabled (Phase 2) | | |
| | | Baseline Volume | AVG Baseline | | Optimized Volume | AVG Optimized |
| | | 47,167 hl | 0.30 €/hl | | 59,808 hl | 0.25 €/hl |
| Week | Total OPEX (€) | Total Production (hl) | BASELINE OPEX (€/hl) | Total OPEX (€) | Total Production (hl) | OPTIMIZER OPEX (€/hl) |
| 1 | 1,629 | 6,107 | 0.27 | | | |
| 2 | 1,909 | 7,090 | 0.27 | | | |
| 3 | 4,162 | 13,243 | 0.31 | | | |
| 4 | 4,192 | 12,920 | 0.32 | | | |
| 5 | 2,225 | 7,808 | 0.28 | | | |
| 6 | | | | 4,550 | 19,057 | 0.24 |
| 7 | | | | 2,047 | 6,338 | 0.32 |
| 8 | | | | 2,697 | 13,579 | 0.20 |
| 9 | | | | 4,153 | 15,837 | 0.26 |
| 10 | | | | 1,442 | 4,997 | 0.29 |

Table 4 summarizes data based on individual OPEX categories at site GR1. As different volumes were filtered during Phases 1 and 2, the OPEX calculation is adjusted for Phase 2 volumes in order to calculate estimated cost savings during Phase 2 (5 weeks), annually (40 weeks) and over a 10-year period (not adjusted for inflation).

The result of this analysis indicated significant improvements in all OPEX categories except for cleaning chemical consumption, which increased during Phase 2. It was found that more cleaning chemicals were needed in order to achieve more effective cleaning, resulting in higher flux across the membranes, longer batch lengths, and reduced wine losses due to the lowered cleaning cycle frequency. While this means that a higher cleaning chemical consumption is needed, the positive effect of this improved cleaning is better filtration efficiency, which drives down the overall OPEX.

**Table 4: Individual and Combined OPEX Comparison Based on Phase 1 and Phase 2 GR1 Site Data[3]**

| Site: GR1 | Baseline Phase 1 | Optimizer-Enabled Phase 2 | Improvement vs Baseline | OPEX for Phase 2 Volume Using Baseline Costs | OPEX for Phase 2 Volume Using Optimized Costs | Savings Phase 2 vs Baseline | Annualized Savings | 10-Year Savings |
|---|---|---|---|---|---|---|---|---|
| **OPEX** | **0.37 €/hl** | **0.29 €/hl** | 22.55% | 8,356 € | 6,472 € | 1,883 € | 15,071 € | 150,718 € |
| Electricity (pump) use | 0.44 kWh/hl | 0.3 kWh/hl | 32.39% | 1,965 € | 1,329 € | 636 € | 5,091 € | 50,918 € |
| Water use/disposal | 5.280 l/hl | 4.026 l/hl | 23.75% | 570 € | 435 € | 135 € | 1,083 € | 10,833 € |
| Heating costs | 0.000160 €/hl | 0.000120 €/hl | 25.37% | 3.60 € | 2.69€ | 0.91 € | 7.31 € | 73.14 € |
| Chemical consumption | 0.0093 l/hl | 0.0110 l/hl | -18.49% | 834 € | 988 € | -154 € | -1,233 € | -12,331 € |
| Wine loss | 0.222% | 0.165% | 25.39% | 4,986 € | 3,720 € | 1,266 € | 10,129 € | 101,298 € |

[3] The following unit costs were used to calculate individual OPEX costs: Electricity – 0.2 €/kWh; Heating Gas – 0.06 €/kWh; Clean Water – 1.8 €/m$^3$; Water Disposal Cost – 3 €/m$^3$; Cleaning Chemicals – 4 €/liter; Wine Loss – 1 €/l; Compressed Air – 0.03 €/m3; Nitrogen – 1 €/l.

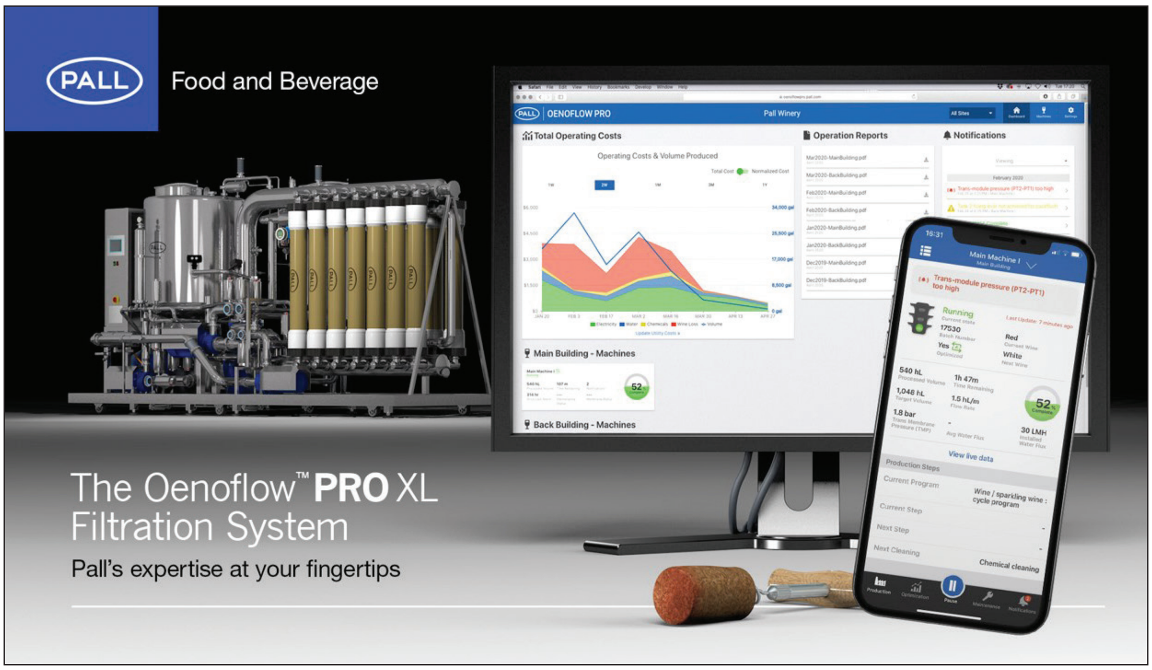
Similarly, Table 5 summarizes data based on individual OPEX categories at site SO. The result of this analysis indicated significant improvements in all OPEX categories except for electricity consumption, and wine losses which both increased during Phase 2. This was attributed to the fact that harder to filter wines were run during Phase 2: this meant higher pumping energy usage was necessary as transmembrane pressures were generally higher for longer periods of time, and harder to filter wines required more membrane cleaning, meaning greater wine losses. In spite of this condition, other OPEX categories showed significant improvement resulting in a combined OPEX cost improvement against baseline of 14%.

### Table 5: Individual and Combined OPEX Comparison Based on Phase 1 and Phase 2 SO Site Data[3]

| Site: SO | Baseline Phase 1 | Optimizer-Enabled Phase 2 | Improvement vs Baseline | OPEX for Phase 2 Volume Using Baseline Costs | OPEX for Phase 2 Volume Using Optimized Costs | Savings Phase 2 vs Baseline | Annualized Savings | 10-Year Savings |
|---|---|---|---|---|---|---|---|---|
| **OPEX** | **0.26 €/hl** | **0.23 €/hl** | 13.99% | 9,783 € | 8,415 € | 1,368 € | 10,947 € | 109,465 € |
| Electricity (pump) use | 0.359 kWh/hl | 0.363 kWh/hl | -1.11% | 2,678 € | 2,708 € | -30 € | -237 € | -2,375 € |
| Water use/disposal | 4.34 l/hl | 2.70 l/hl | 37.67% | 777 € | 484 € | 293 € | 2,340 € | 23,402 € |
| Heating costs | 0.000092 €/hl | 0.000070 €/hl | 23.71% | 3.43 € | 2.62 € | 0.81 € | 6.51 € | 65.06 € |
| Chemical consumption | 0.0187 l/hl | 0.0103 l/hl | 44.69% | 2,784 € | 1,540 € | 1,244 € | 9,955 € | 99,550 € |
| Wine loss | 0.095% | 0.0995% | -3.95% | 3,540 € | 3,680 € | -140 € | -1,118 € | -11,178 € |

[3] The following unit costs were used to calculate individual OPEX costs: Electricity – 0.2 €/kWh; Heating Gas – 0.06 €/kWh; Clean Water – 1.8 €/m$^3$; Water Disposal Cost – 3 €/m$^3$; Cleaning Chemicals – 4 €/liter; Wine Loss – 1 €/l; Compressed Air – 0.03 €/m3; Nitrogen – 1 €/l.

It is interesting to note, that the percentage change in each of the 5 OPEX categories was not the same at each site. This illustrates how the filtration requirements of a given winery and operation of the filter are not always in perfect alignment and may influence the overall OPEX significantly. The Optimizer algorithm removes these variations and delivers consistent system performance for any site where it is installed.



## Summary

Field trials demonstrated that the Oenoflow **PRO** XL system with its Optimizer algorithm delivers superior performance over conventional Oenoflow XL system operation. Data collected from two customer sites was based on significant production volumes and confirmed at least 10% reduced OPEX. Results from two other sites, while limited due to low production volumes trended in the same direction.

Pall's new Oenoflow **PRO** XL system simplifies process control for the winemaker. The Optimizer algorithm tracks relevant operational data and adjusts filtration system settings in real time. By adapting to the very varied physical and chemical nature of each wine, the system enables best possible results for each filtration. The Oenoflow **PRO** has the potential to expose weaknesses in operation that can be corrected. It helps to eliminate operator error or performance variability among operators.

Harnessing the power of data and drawing on Pall's global experience, this solution provides next generation performance by delivering optimal filtration efficiency for every wine.

Oenoflow **PRO** XL-A System

Oenoflow **PRO** XL-S System

Pall Corporation

*Better Lives. Better Planet.*SM

**Pall Food and Beverage**

25 Harbor Park Drive
Port Washington NY 11050
+1 516 484 3600 telephone
+1 866 905 7255 toll free US

foodandbeverage@pall.com

**Visit us on the Web at www.pall.com/foodandbev**

Pall Corporation has offices and plants throughout the world. For Pall representatives in your area, please go to www.pall.com/contact

Please contact Pall Corporation to verify that the product conforms to your national legislation and/or regional regulatory requirements for water and food contact use.

Because of technological developments related to the products, systems, and/or services described herein, the data and procedures are subject to change without notice. Please consult your Pall representative or visit www.pall.com to verify that this information remains valid.



*Filtration. Separation. Solution.*SM

FBTAOENOPROM5ENa October 2020