

# Improving Water Supply Reliability at the Aspropyrgos Refinery



Installation of AMBERLITE™ HPR resin technology adapted to original system design without costly modifications

## Background

In the Attica region of Greece, a booming population over the past century has resulted in an increased demand for freshwater and placed pressure on local resources. The Aspropyrgos Refinery is an oil refinery complex located in West Attica, Greece owned and operated by Hellenic Petroleum SA. The refinery was commissioned in 1958 and has a nominal capacity of about 285,000 barrels per day. The operator was in search of a solution to maximize their onsite water production. To meet this demand, two demineralization systems were installed – both regenerated as counter current air holddown systems (also known as blocked bed systems). Each system is comprised of two identical production units.

The system, constructed in 1980, was planned to undergo maintenance, which included an ion exchange resin replacement. With the goal of improving water supply reliability and cost optimization, while avoiding large investment in new equipment, the Aspropyrgos plant utility management reached out to Water Solutions.

## The System

Aspropyrgos Refinery's blocked bed system is characterized by a relatively large, water-filled freeboard on top of the resin bed. To prevent the resins from fluidizing while the regeneration chemicals are dosed at the bottom of the vessel in upflow direction, simultaneous air is introduced at the top of the vessel. This helps push the free water downwards through the submerged collector. Both the cation and the anion vessels are considered single compartment vessels intended to hold one single resin type.

The feed water passes through a cation vessel that holds a standard grade strong acid cation resin. To remove carbon dioxide, the water also passes through a degassifier tower and an anion vessel that holds a standard grade strong base Type 2 anion resin.

## Fast facts

Location: West Attica, Greece

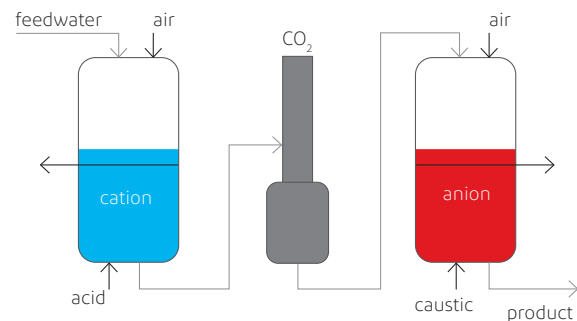
Purpose:

- Maximize Water production
- Reduce total cost of water
- Improve quality

## Comparative Performance

- 50% reduction of regenerant chemicals at double the production run length

Figure 1. The original blocked bed system configuration



Together with a local supply partner, Water Solutions found an optimal solution compliant with the high quality expectations and reliability standards of the Aspropyrgos refinery with AMBERLITE™ HPR resin technology.

## The Study

Raw water was obtained from the local Athens drinking water provider, and its composition was used as a baseline metric for plant improvement projects. Table 1 lists the feed water composition.

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**Table 1. Feed water composition**

Cations	Design	Anions	Design
Ca	2.6	Cl	0.11
Mg	0.5	NO <sub>3</sub>	0.2
Na	0.21	SO <sub>4</sub>	0.5
K	–	HCO <sub>3</sub>	2.5
–	–	Silica	0.08
Total Cations	3.31	Total Anions	3.31

Unit: meq/L

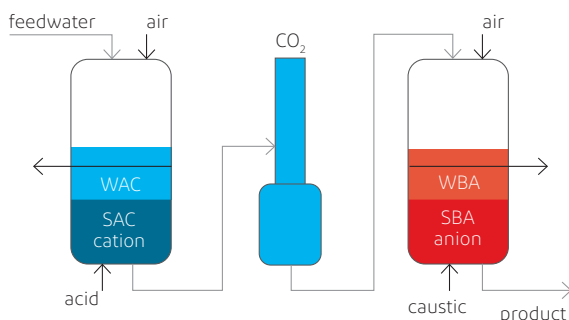
Based on the water composition, the introduction of a high capacity weak acid cation – AMBERLITE™ HPR8300 resin – combined with AMBERLITE™ HPR1300 was evaluated and found to significantly increase capacity at a lower acid consumption.

For the anion vessel, the introduction of the high capacity weak base anion, AMBERLITE™ HPR9600 resin, combined with the multi-functional resin AMBERLITE™ HPR4200 Cl or OH, has found to increase capacity and lower silica leakage. The chemical consumption from the combination of these two resins significantly reduce caustic consumption.

The selected resin combinations can be applied without a physical separation plate, making it an ideal fit for the Aspropyrgos refinery's single compartment vessels.

The change in resin types was possible without any modification to the vessel. The new resin configuration is shown in Figure 2, and system details are listed in Table 2.

**Figure 2. New AMBERLITE™ HPR resin configuration**



**Table 2. Plant resin data based on technical assessment**

	Old resin layout	New resin layout
<b>Net throughput</b>	60 m <sup>3</sup> /h	70 m <sup>3</sup> /h (potential 120 m <sup>3</sup> /h)
<b>Cation Vessel</b>		
Weak acid cation resin (WAC)	No	AMBERLITE™ HPR 8300
Strong acid cation resin (SAC)	AMBERLITE™ IR 120H	AMBERLITE™ HPR 1300H
<b>Anion Vessel</b>		
Weak base anion resin (WBA)	No	AMBERLITE™ HPR9600
Strong base anion resin (SBA)	AMBERLITE™ IRA410Cl	AMBERLITE™ HPR4200 Cl
<b>Cation vessel</b>		
Available height	1816 mm	
<b>Anion vessel</b>		
Available height	1995 mm	

When a resin configuration is changed, operational settings must be carefully adjusted. The whole system, including the regeneration program was recalculated by using DuPont's Water Application Value Engine (WAVE) design software to ensure system reliability and compliance with water quality standards.

- Regeneration conditions minimized waste and reduced chemical consumptions (for resin regeneration and the neutralization of waste streams).
- Small adjustments of the holddown pressures were made to achieve the required bed compaction, enabling the lowest possible sodium and silica leakage.



## The Results

With the existing equipment and without any other investment beyond the resin replacement, the system throughput was increased from 60m<sup>3</sup>/h to 70 m<sup>3</sup>/h. However, with a modest investment in a larger feed pump, the hydraulic capabilities of the system could potentially be stretched up to 120 m<sup>3</sup>/h production rates.

The system performance was improved (see Table 3) and resulted in:

- A more efficient regeneration and increased throughput with the introduction of the weak acid cation resin.
- Reduction in the high demand of wasted neutralization chemicals.
- Lower number of regenerations annually, making the water recovery of the new resin lay out twice as high, compared to the old system.
- Reduction of the caustic consumption and increased capacity with the introduction of a high performance weak base anion AMBERLITE™. Additionally, the quality of the produced demineralized water is better than the old system (lower conductivity).

## The Technology

The new AMBERLITE™ High Performance Resins portfolio allows maximized operational resin performance by providing reliable, cost-effective operations at the highest quality. These advanced resins can lower chemical consumption and waste discharge, and are designed to be fitted in all available system technologies including:

- Blocked bed systems, like water or air hold down
- Resin hold down systems like Econex
- Packed bed systems like UPCORE, AMBERPACK, Floating bed
- Co-current systems

**Table 3. Consumption of regenerant chemicals**

Parameter	Old resin	New resin	Improvement
Consumption H <sub>2</sub> SO <sub>4</sub> (ton 100% / year)	146	121.9	16%
Consumption NaOH (ton 100% / year)	146	82.9	43%
Neutralization NaOH (ton 100% / year)	95	5.3	94%
Production per cycle (m <sup>3</sup> )	~2750	~5000	81%
Regeneration / year	195	106	45%
Water to waste (m <sup>3</sup> / year)	37537	15900	57%
Conductivity (µS/cm)	~5	<1	

1 kg=2.2lb

## The Benefits

The next-generation AMBERLITE™ High Performance Resin is a reliable element for state-of-the-art performance that can upgrade existing system performance to meet the highest standards of current water production. With these resins, the Apropyrgos water treatment system now operates at a much higher standard of chemical efficiency and uses scarce freshwater responsibly increasing water recovery by more than 50 percent.

The increased capacity and flowrate was able to improve site supply reliability without a major investment. Subsequently, system downtime was reduced by over 40 percent, almost 50 percent of operating costs were cut, and the quality of the demineralized water was improved.



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