Improving Water Supply Reliability with DuPont™ AmberLite™ HPR Resins at the Aspropyrgos Refinery

The Challenge

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.

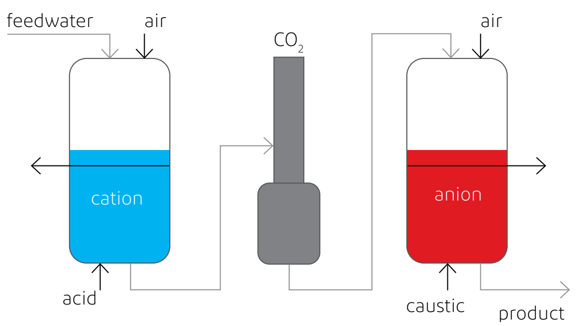
The System

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.

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

Figure 1. The original blocked bed system configuration



Fast Facts

Location: West Attica, Greece

End User: Hellenic Petroleum SA

Water Type: Municipal Water

Application: Softening

Technology: Ion Exchange Resins

Product Name: AmberLite™ HPR Resins: 8300, 1300H, 9600, 4200 Cl

Capacity: 70 m^3/h = 2 MLD [0.4 MGD]

Commissioning: 1980

Purpose: Maximize water production, reduce total cost of water, improve quality

Comparative Performance

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

The Solution

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.

Table 1. Feed water composition

Cations	Design	Anions	Design
Ca	2.6	Cl	0.11
Mg	0.5	NO_3	0.2
Na	0.21	SO_4	0.5
K	–	HCO_3	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 – DuPont™ 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 reduces caustic consumption.

The selected resin combinations can be applied without a physical separation plate, making it an excellent choice for the Apropyrgos 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

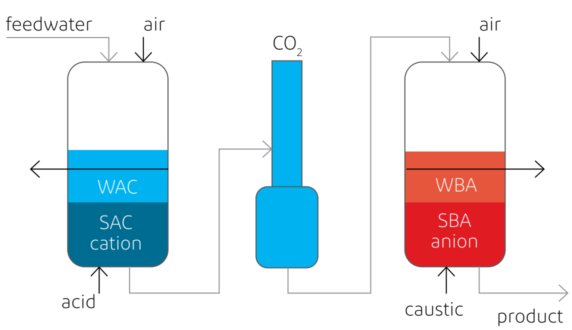


Table 2. Plant resin data based on technical assessment

	Old resin layout	New resin layout
Net throughput	60 m^3/h	70 m^3/h (potential 120 m^3/h)
Cation Vessel		
Weak acid cation resin (WAC)	No	AmberLite™ HPR 8300
Strong acid cation resin (SAC)	AmberLite™ IR 120H	AmberLite™ HPR 1300H
Anion Vessel		
Weak base anion resin (WBA)	No	AmberLite™ HPR9600 +
Strong base anion resin (SBA)	AmberLite™ IRA410Cl	AmberLite™ HPR4200 Cl
Cation vessel		
Available height	1816 mm	
Cation vessel		
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, helping to enable 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^3/h to 70 m^3/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^3/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 DuPont™ AmberLite™. Additionally, the quality of the produced demineralized water is better than the old system (lower conductivity).

The Technology

The AmberLite™ ion exchange resin portfolio allows enhanced operational resin performance by providing reliable, cost-effective operations at a very high 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 sytems, 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_2SO_4 (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^3)	~2750	~5000	81%
Regeneration / year	195	106	45%
Water to waste (m^3 / year)	37537	15900	57%
Conductivity (µS/cm)	~5	<1	

1 kg = 2.2lb

The Benefits

The next-generation AmberLite™ ion exchange resin portfolio is a reliable solution 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.

Water Solutions
Have a question? Contact us at:
dupont.com/water/contact-us

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