Chino II Desalter Concentrate Management Via Innovative Byproduct Resale & Treatment

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Introduction
With more than 800 wells, the Chino Groundwater Basin in Southern California provides a critical water supply for agriculture, industry, and public drinking water suppliers. Although over pumping of groundwater has resulted in subsidence in some areas of the Chino Basin, there is also a hydraulic surcharge that results in overflow of contaminated groundwater to the Santa Ana River. The primary groundwater contaminants of concern are total dissolved solids (TDS), nitrates, and volatile organic compounds (VOCs).

The Chino Desalter (Chino II) began operation in 2006 to expand the capacity of the groundwater treatment system with a combined ion exchange (IX) and reverse osmosis (RO) treatment capacity of 10 mgd. The Chino II is managed and operated by the Chino Basin Desalter Authority (CDA). The IX and RO treatment trains in Chino II are used to treat brackish groundwater from eight wells that also have elevated nitrate concentrations. A 6.5-mgd expansion of the Chino II RO plant has been constructed. However, due in part to the high cost of waste brine disposal, the CDA is evaluating means of maximizing the efficiency of the RO treatment system at Chino II to reduce brine disposal costs and increase permeate production.

Basis of Design
RO recovery is typically limited by precipitation of sparingly soluble salts on the surface of the membranes. With the current mineral content of the groundwater treated at the Chino II RO facilities, the primary RO recovery is 83.5 percent. The remaining 16.5 percent is discharged into the Inland Empire Brine Line (IEBL) line as RO concentrate.

The heart of the design of the Chino II Concentrate Reduction Facility (CRF) is a high-rate pellet softening and solids contact clarification system to remove the limiting foulants (specifically calcium and silica) from the primary RO concentrate. Seeded calcite precipitation occurs in the fluidized pellet reactors, where hard and durable pellets are generated, as shown in the photo above. The pellets naturally dewater and can be easily transported compared to the thick, heavy, wet sludge produced by a conventional softening process. The produced pellets are a value-added product that can be used in a variety of industrial applications, thus converting a waste stream of the Chino II process into a usable commodity.

Due to the turbid nature of the pellet reactor effluent solids, contact clarification is required to remove magnesium solids that are formed in the pellet reactors and carry over due to their lower density. After the fouling compounds are reduced in the pellet reactor and the clarifier, the softened primary RO concentrate is polished with dual media filters. The filtered effluent is sent as feed to the secondary RO (SRO) systems. Treated water will be blended with the primary RO permeate, and SRO concentrate will be disposed of into the IEBL. Using this approach, total water recovery from the RO system at Chino II will be increased from 83.5 percent to as high as 95 percent, substantially reducing the volume of brine disposed into the IEBL, while increasing permeate production.

Chino II CRF Overall Process
A process flow diagram for the proposed concentrate reduction facility is shown in Figure 1. The schematic shows the following major process elements:

- An energy recovery system upstream of the pellet reactor to recover excess energy from the primary RO concentrate.
- A process flow diagram for the proposed concentrate reduction facility is shown in Figure 1. The schematic shows the following major process elements:
- Pellet reactor softener system to remove calcium carbonate and some silica from the primary concentrate.
- Solids contact clarifier to remove the carryover of calcium, magnesium, and silica particles.
- Granular media filters to polish the clarifier effluent.
- SRO system to treat the softened and filtered primary RO concentrate to produce permeate (product water) and brine (SRO concentrate).
- Filter waste washwater basin to collect media filter spent washback water, gravity thickener supernatant, and supernatant from the dewatering process. The waste washwater is pumped to the clarifier influent for treatment and recovery.
- Backwash basin to store backwash and surface wash water for the granular media filters and equalize SRO feed.
- Gravity thickener and mechanical dewatering to treat clarifier sludge.
- The following chemicals and materials are required:
  - Lime and caustic soda are used to raise the pH and cause precipitation of the dissolved solids within the pellet reactor and clarifier.
  - Seed material (soda sand or calcium carbonate) is fed to the pellet reactor to act as the nucleus for calcium carbonate precipitation.
  - Ferric chloride is applied as a coagulant in the clarifier to improve solids settleability.
  - Polymer is added in the clarifier as a gravity thickener to improve solids settleability, and ahead of the mechanical dewatering process to improve the performance of the centrifuge.
  - Threshold inhibitor is applied to the SRO feed to control precipitation of silica and calcium carbonate.
  - Sulfuric acid is fed to the clarifier effluent to prevent continued calcium carbonate precipitation in the media filters and SRO systems.
  - Soda ash is added upstream of the pellet reactors and is used to provide a source of carbonate alkalinity.

The concentrate reduction process reduces the overall dissolved solids mass loading to the IEBL pipeline through the removal of calcium carbonate, magnesium hydroxide, and silica from the brine stream as solid precipitates. Figure 2 shows the 3-D rendering of the Dewatering Building at the Chino II CRF, where the pellet softening, solids clarification, and mechanical dewatering process are located. While Chino II continues to remove the same amount of dissolved solids from the groundwater basin, a smaller portion is discharged to the IEBL pipeline as a liquid waste and a significant amount of solids leave the Chino II site by truck in the form of pellets and dewatered sludge.