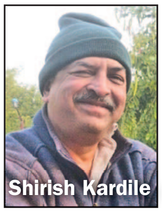
From the Board

Water Temperature Changes Can Create Clarifier Problems



Shirish Kardile

I was once asked to investigate a seawater clarification plant (1,250 m^3/hr capacity) used to pretreat process water for a reverse osmosis (RO) system (450 m^3/hr permeate capacity) experiencing problems at an industrial plant near Bhavnagar, Gujarat. The turbidity of the raw water source, a bidirectional creek in the Gulf of Khambhat, ranged from 500 to 3,000 ntu.

The clarification plant comprised a stilling chamber, weir mixers, a mixing basin, mechanical flocculators, and tube settlers with a multihopper bottom tank. The detention time in the flocculation zone was 25 min, and the surface loading rate for the tube settlers was 6,000 L/h/m^2.

The raw water was conveyed to the plant through a series of storage lagoons. As a result, turbidity received at the plant's inlet was reduced to 20–30 ntu. The vegetation growth in the lagoon increased chemical oxygen demand to 15–20 mg/L. The raw water pH was 8.2–8.5, and alkalinity was above 100 mg/L. The seawater's total dissolved solids were 30,000–35,000 mg/L.

During commissioning, the raw seawater was pumped to the plant directly from the storage lagoons. The raw water temperature was 20–22°C. Prechlorination of 8–10 mg/L was required to maintain residual chlorine of 1 mg/L at the outlet of the succeeding filtration units.

Ferric chloride ($FeCl_3$) was selected as a primary coagulant, and anionic polyelectrolyte (PE) was selected as coagulant aid. For raw water turbidity of 20–30 ntu, the optimum doses of $FeCl_3$ and PE were 12–15 mg/L and 0.1–0.15 mg/L, respectively. The plant's clarified water turbidity ranged from 2 to 3 ntu.

However, the clarified water quality deteriorated daily between 1100 and 1700 because the sun heated the raw water in the shallow storage lagoons and the exposed pumping main. The temperature increase each afternoon disturbed the plant's delicate physiochemical balance, as the site's summer ambient temperature rose to 38°C–42°C during the daytime. Nothing could be done about this phenomenon, which is also observed in some of India's seashore water treatment plants with a shallow bed shelf.

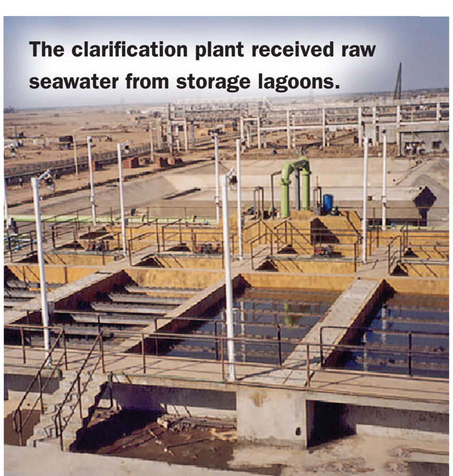
After a year, the clarifier began malfunctioning, allowing large floc particles to escape and disrupting plant operations. Upon investigation, it was noted the treatment plant received raw water from the plant's heat exchangers. As a result, the temperature of the raw seawater increased and varied between 35°C and 45°C.

Somehow the operators didn't correlate this to the plant's poor performance, although the temperature fluctuations were observed hourly as a result of the load variation on the heat exchangers. As a result, the applied coagulant dosages became excessive and resulted in the large-floc particle carryover.

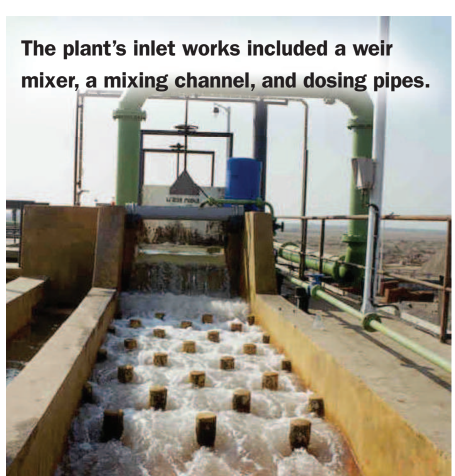
Jar tests indicated the $FeCl_3$ and PE dosages now required were 9.0 +/– 0.50 mg/L (30 percent less) and 0.08 +/– 0.005 ppm (40 percent less), respectively. Minimum clarified water turbidity of 3 ntu was achieved with these dosages. Moreover, the PE dosing range was very narrow; variations by +/– 0.005 ppm deteriorated the clarified water turbidity appreciably.

It was determined the hourly temperature variations were inducing small density change in the seawater. To minimize the effect, operators supplemented continuous online temperature-monitoring with modified coagulant dosages. Now the plant has been expanded to generate 900 m^3/hr permeate from RO. The experience is a good illustration of the type of investigation often required to resolve operational problems.

—Shirish Kardile,
AWWAIndia Strategic Board Chair



The clarification plant received raw seawater from storage lagoons.



The plant's inlet works included a weir mixer, a mixing channel, and dosing pipes.

The plant's sludge was drained manually from the hoppers.