DAF Expansion and Upgrade Saves WRRF Millions

New and Retrofit Units Exceed Expectations, Eliminating Need for Phase II Thickening

CASE STUDY

Location: **Western Canada**

Problem

Like many cities in North America, a city in Western Canada is growing. To accommodate this growth, the city planned a two-phase expansion at its water resource recovery facility (WRRF). Phase I consisted of rehabilitating four of the plant's five existing dissolved air flotation (DAF) units and installing new DAF equipment in an empty concrete basin that was added in 1994 to accommodate future growth. Phase II would involve a separate project to add several new rotary drum thickeners.

The design sludge loading rate of each DAF unit in the plant's current system was 12.5 kg/m^2/h (2.6 lbs/ft^2/h). However, the four units to be rehabilitated were functioning at about 79 percent of this design value (9.8 kg/m^2/h – 2.0 lbs/ft^2/h).

Phase I was projected to raise the WRRF's total solids thickening capacity from 63,000 kg/d (138,891 lbs/d) to 75,600 kg/d (166,669 lbs/d), which would be sufficient to support a population of about 1.7 million. Phase II would increase the total capacity to 100,600 kg/d (221,785 lbs/d) and support a population of approximately 2.3 million.*

Recommended Solution

Observing the capacity difference between the four underperforming units and the newer fifth unit, the plant's decisionmakers determined that they could improve the performance of the four older tanks by updating them to include some of the newer tank's features. With the newly furnished empty basin, this would bring the plant's DAF treatment train to a total of six units.

Calculating the units' DAF loading rate at a conservative 10 kg/m^2/h (2.1 lbs/ft^2/h), the plant determined that the total capacity for all six units would be approximately 75,600 kg/d (166,669 lbs/d).

The city accepted and evaluated bids based on specifications that differed from WesTech's standard design. WesTech was awarded the contract for equipping the one empty basin and was later tasked with supplying equipment to replace the four older DAFs.

Implementation

Our design for the empty concrete basin included WesTech DAF equipment and additional components. Some of the modifications to WesTech's standard design required an additional layer of design creativity. For example, splash guards were needed when WesTech's fixed chain-and-flight system replaced a pivoting model.

The four older units were refurbished according to our design with new effluent water pumps, headers, and upsized piping in addition to the equipment listed below. All five tanks were commissioned on time and within the city's budget, giving the WRRF six DAF units that were uniform across the entire treatment train.

WesTech®

WesTech provided pressurization vessels for the plant's new unit and four upgraded units.

WesTech equipment for the five Phase I units included:

- Fixed chain-and-flight mechanisms
- Pressurization systems
- Distribution headers
- Skimmer drives
- Skimmer mechanisms
- Weirs

The DAF system operates as follows:

- A flow-splitting, modulating flow-control valve distributes waste activated sludge (WAS) to each DAF unit.
- The pressurization system saturates recycle water with air, providing microbubbles, which are mixed with the WAS to float biological solids to the surface.
- After polymer addition, a pressure-control valve releases the saturated recycle into the WAS stream.
- Microbubbles flocculate with and carry thickened WAS (TWAS) floc to the surface.
- The chain-and-flight mechanism pushes the floated TWAS into a float box.

Results

The new and retrofitted DAF tanks performed 50-percent better than the city expected based on its design values.

While the city's design rate was 10 $kg/m^2/h$ (2.1 $lbs/ft^2/h$) per unit, with an expected total capacity of 75,600 kg/d (166,669 lbs/d) of sludge, each unit performed at a rate of 15 $kg/m^2/h$ (3.1 $lbs/ft^2/h$), resulting in a sludge loading capacity of 113,400 kg/d (250,004 lbs/d). At this loading rate, the DAF system can support a population of 2,637,209, which is 879,069 more than both phases combined were projected to support.

Since Phase I provides a greater loading capacity than the city's projection for both phases combined, the plant is able to indefinitely defer Phase II, saving millions in capital expenditures.

We determined that increasing the design pressure on the recycle system to 450 kPa (65.3 psi) over the city's design specification of 350 kPa (50.8 psi) contributed to this success. The increased pressure yields smaller bubbles, which provide better sludge floatation (increased rise rate and higher removal rate).

As an added benefit to the city, the new DAF treatment train has achieved a 98-percent solids capture rate. Our fixed chain-and-flight mechanism, which can push heavier sludge loads into the float box than the specified pivot design can, helped contribute to this high percentage. (Typical rates are 90-95 percent.)

Pivoting chain-and-flight mechanisms were replaced with a fixed design.

DAFs typically thicken to 3-percent to 5-percent solids and the city reasonably assumed it would get 4-percent solids. Once operational, the upgraded DAFs were able to reach 6-percent solids, significantly exceeding expectations and making additional, expensive, Phase II thickening unnecessary, avoiding millions of dollars* in costs.

*Based on Information and data taken from a plant publication.

Results	Expected (Design)	Delivered
Sludge loading rate (per unit)	10 $kg/m^2/h$	15 $kg/m^2/h$
Capacity (all six units)	75,600 kg/d	113,400 kg/d
Thickened solids percent	4 %	6 %
Supported population Phase I	1,758,140	2,637,209
Supported population Phase II	2,339,535	Achieved in Phase I

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