Hazen *Memorandum*

July 20, 2017

To: Erik McPeek, DCRSD

From: Scott Phipps, Hazen and Sawyer
Mark Strahota, Hazen and Sawyer

Re: DCRSD Scioto Reserve WRF – Aeration Blower Field Study Analysis

An aeration blower field study was performed at DCRSD Scioto Reserve WRF on July 13, 2017. DCRSD operational staff and Hazen performed the field study to investigate blower surging conditions that have been occurring recently due to the higher ambient temperatures. The following unit processes and equipment were operated:

- West aeration tank (AT) – Normally in-service tank with anoxic zone mixer.
- East AT – Normally off-line tank without anoxic zone mixer. Due to operational challenges, East AT has been operational to alleviate blower surging conditions while providing required treatment.
- Blower no. 2 – Normally dedicated to West AT. This blower has been experiencing surging conditions when operated at reduced air flow.
- Blower no. 3 – Dedicated to East AT when tank is in-service.

The field study consisted of the following operating scenarios:

- Determine the impact of two blowers supplying air to either the West AT or East AT. The intent was to determine the individual blower air flow capacities when operating together to a single AT.
- Determine air flow capacity to West AT. Typically, the West AT operates at a higher discharge pressure than East AT due to age of diffusers.
- Determine air flow capacity to East AT with the typically lower discharge pressure.

Job no

Blower Equipment Capacity Comparison between West and East Aeration Tanks

Figure 1 shows a comparison between blower nos. 2 and 3 when aerating the West AT (top of figure) and East AT (bottom of figure).

- Values shown on bar graphs are the inlet valve position for each blower. For example, "90" corresponds to 90-degree position, which is fully open position and maximum capacity.
- The study proceeded by operating blower no. 2 at full capacity and turndown to surge conditions. Following maximum turndown, blower no. 3 was started at minimum capacity to operate in parallel. Blower capacities were incrementally increased for parallel operation.

West Aeration Tank Field Results

- Blower no. 2 was operated from full capacity to surge conditions as shown by test points 1 – 6. Maximum air flow was 520 cfm (test point 1) with surging conditions occurring at 370 cfm (test point 6).
- Blower no. 3 was started at test point 7 at minimum capacity (valve position 40 degrees open). Significant drop in air flow from blower no. 2 occurred when blower no. 3 was started. Blower no. 2 air flow capacity decreased from 370 cfm to 220 cfm. Blower no. 3 had an air flow of 370 cfm. This clearly indicates that blower no. 3 was "overpowering" blower no. 2 during combined operation.
- Blower no. 2 valve positioning was opened for test points 8 and 9, but could not move out of surging conditions. Blower no. 2 was unable to overcome the operating discharge pressure to increase air flow production.
- Blower no. 2 was shut down due to unstable operation and potential damage due to surging conditions.
- Blower no. 3 was operated from minimum to maximum capacity in test points 10 – 14. Maximum air flow was 530 cfm (test point 14) with surging conditions occurring at 390 cfm (test point 9).

East Aeration Tank Field Results

- Blower no. 2 was operated from full capacity to surge conditions as shown by test points 1 -7. Air flows ranged from 670 cfm (test point 1) to 320 scfm (test point 7) at surging conditions.
- Blower nos. 2 and 3 were operated in parallel for test points 9 – 15 with step wise increases in inlet valve positioning for both blowers.
- Test points 9 – 15 show that blower nos. 2 and 3 operated within 10% of each other at the various inlet valve positions. This indicates that blowers did not "overpower" one another, and both operated successfully in parallel.

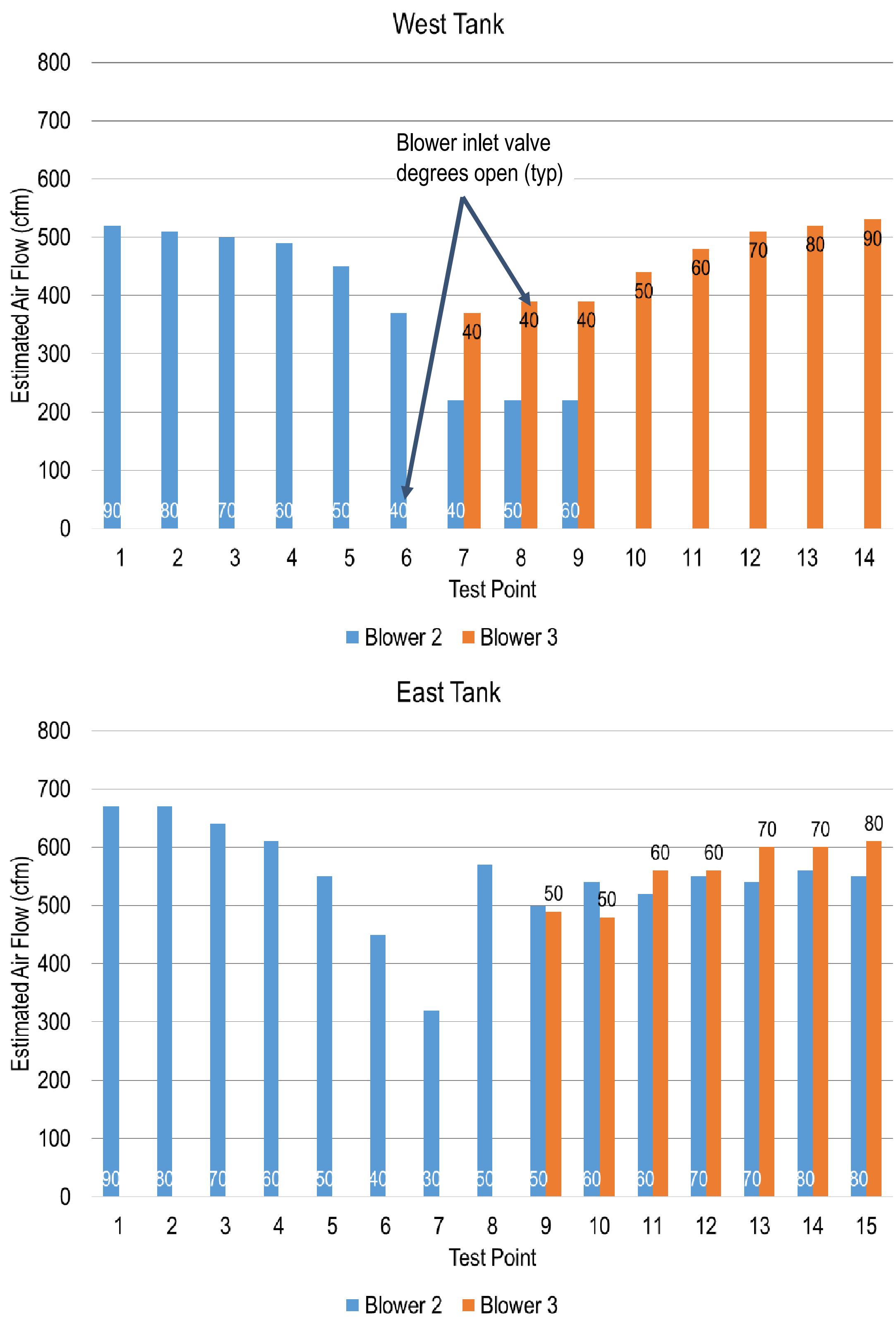


Figure 1: Blower Equipment Capacity Comparison between Aeration Tanks

Aeration System Capacity and Operating Pressure Comparison

Figure 2 shows a comparison between West AT (top of figure) and East AT (bottom of figure) aeration capacity and operating pressures.

West Aeration Tank Field Results

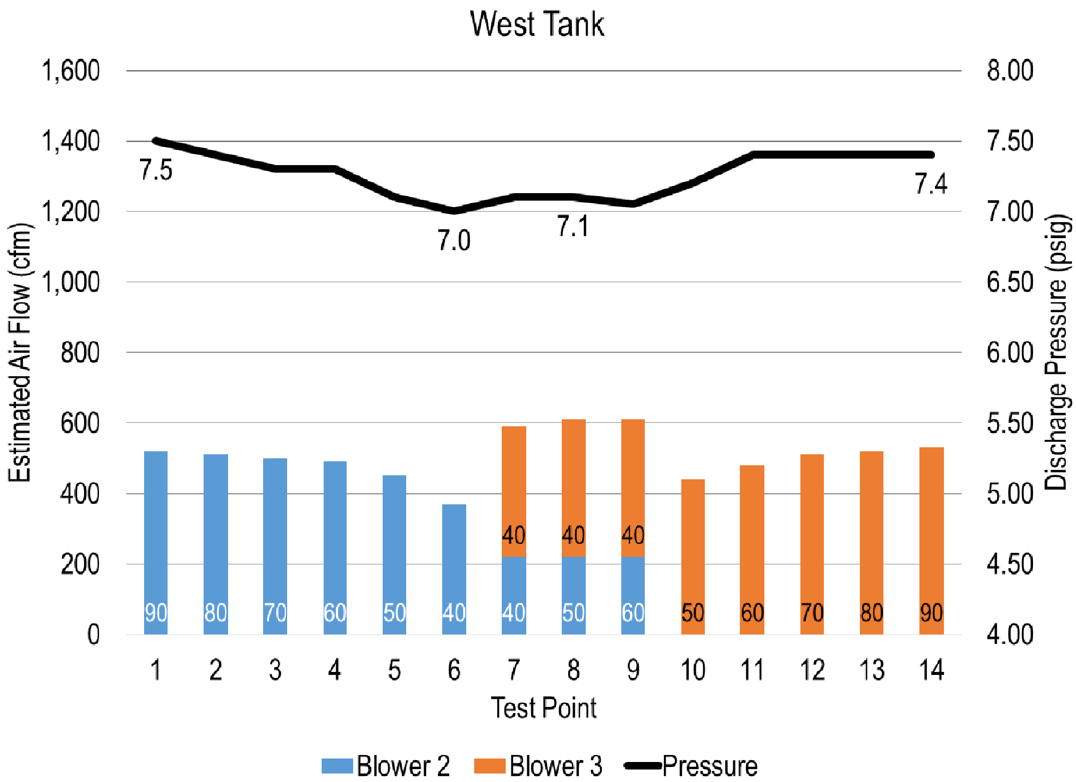
- Average operating condition during the test was 510 cfm at 7.3 psig.
- Minimum air flow was 370 cfm at 7.0 psig (test point 6), which was maximum turndown of blower no. 2. This was also the minimum operating pressure observed at 7.0 psig.
- Maximum air flow was 610 cfm at 7.1 psig (test point 9). This air flow value is questionable because the operating pressure of 7.1 psig is lower than test points 1 and 14 (7.5 and 7.4 psig, respectively). Higher air flows have higher operating pressures due to more headloss across the diffuser membranes. Therefore, the highest air flow should have the corresponding highest operating pressure. The estimated air flows for blower no. 2 are generally questionable due to the surging conditions occurring during the test.
- Maximum operating pressure was 7.5 psig with an air flow of 520 cfm (test point 1).

East Aeration Tank Field Results

- Average operating condition during the test was 810 cfm at 6.8 psig.
- Minimum air flow was 320 cfm at 5.7 psig (test point 7). This was also the minimum operating pressure observed.
- Maximum air flow was 1,160 cfm at 7.2 psig (test point 15). Blower nos. 2 and 3 were operating at maximum capacity with inlet valve 80-degrees open. This was also the maximum operating pressure observed.

Conclusions

- Recent blower surging conditions are associated with operation of the West AT with two blowers in parallel. Operation of two blowers in parallel to the West AT typically occurs during warmer temperatures (wastewater and ambient) due to lower oxygen transfer efficiency.
- Surging of blowers is caused by higher operating pressures occurring in the West AT, but not in the East AT. Figure 2 clearly shows the impact of higher operating pressure on the blower system capacity between West AT and East AT.
- Pressure losses need to be reduced in West AT to increase the air flow for biological treatment. This reduction in pressure is critical because the West AT has the dedicated unaerated zone with floating mixer for denitrification, which is necessary to meet the LAMP requirement of 10 mg/l total inorganic nitrogen (TIN).



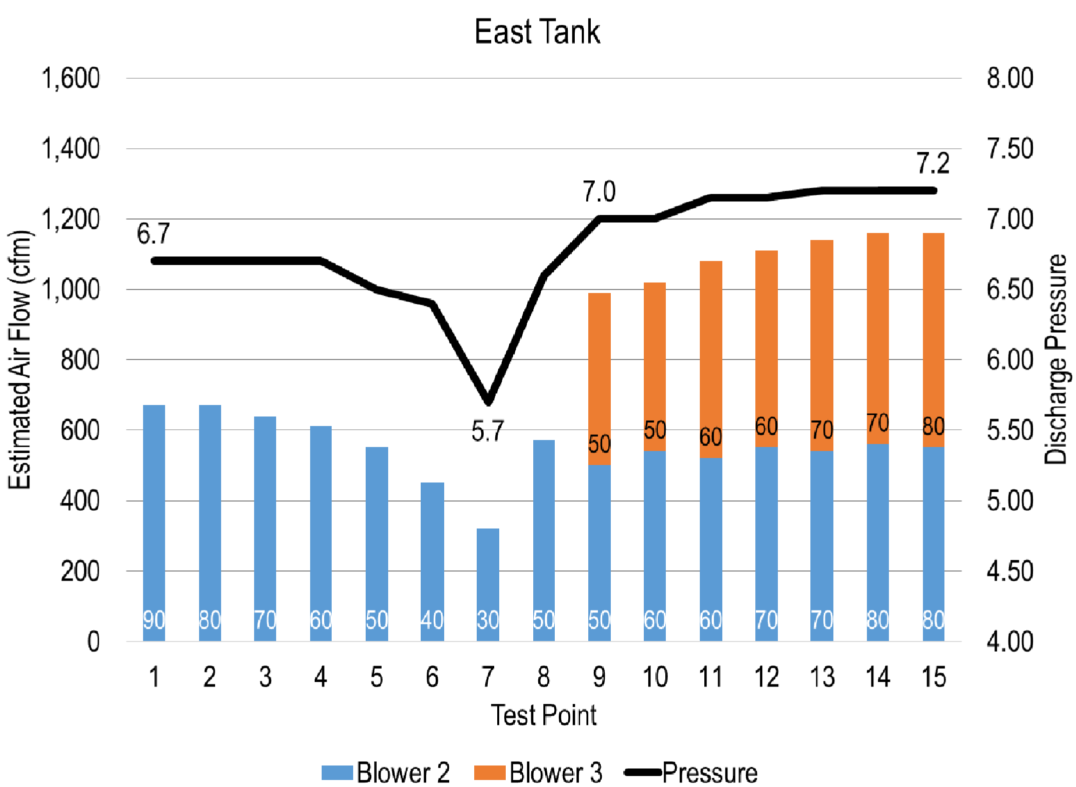


Figure 2: Aeration System Capacity and Operating Pressure Comparison

Recommendations

Short term operational recommendations:

- Maintain operation of West AT and East AT together to minimize surging conditions on the blowers.

- Reduce or turn off air flow to first cell of East AT to allow low dissolved oxygen (DO) concentrations for denitrification of return activated solids (RAS).

- Following "air off" operational sequence, operate blower at maximum capacity to increase DO concentration. Blower capacity can be reduced when DO concentration ranges between 0.5 – 1.0 mg/l, which provides aerobic treatment for CBOD removal and nitrification. Maintaining DO concentration of 2.0 mg/l is not required for biological treatment.

- Operate a dedicated blower per aeration tank. Based on the piping configuration, blower no. 2 is dedicated to West AT and blower no. 3 is dedicated to East AT. Blower no. 1 could also serve West AT with blower no. 2 available to operate as a "swing" blower to either West AT or East AT.

Long term improvement recommendations:

- Adequately clean or replace West AT diffuser membranes. Based on the different operating pressures between the West AT and East AT observed in the field study, the diffuser membranes are believed to be significantly fouled in the West AT. The West AT has been in continuous operation for many years, while the East AT has been out of service for the same time period.

- Implement internal mixed liquor recycle (IMLR) pump to eliminate the "air off" operational sequence. The "air off" operational sequence is likely contributing to the diffuser membrane fouling and associated higher operating pressure. This contribution may be associated with mixed liquor settling on the diffusers and the initial membrane flexing required at the end of the "air off" operational sequence, which impacts elasticity of the diffuser membranes. IMLR pumps will provide the necessary conditions for denitrification to meet the effluent TIN requirement and eliminate the "air off" operational sequence.

- Implement auxiliary mixing equipment in the first cell of East AT, similar to the West AT. This will increase the denitrification capacity of the biological treatment process to meet the effluent TIN requirement, and permit continuous operation of both West AT and East AT.