Subject: 2021 Turbo Blower Technology in Niagara Region Wastewater Treatment Plants

Report to: Public Works Committee

Report date: Tuesday, March 9, 2021

Recommendations

1. That Report PW 14-2021 **BE RECEIVED** for information.

Key Facts

- Niagara Region's wastewater treatment plants currently utilize mechanical aeration and three different blowers types in diffused aeration systems; the selection is based on the size, design and age of the plant (Appendix 1).
- Currently Niagara Region operates APG Neuros turbo blowers at the Crystal Beach and Niagara-on-the-Lake wastewater treatment plants.
- As of January 17, 2021, the APG Neuros air bearing turbo blower has been added to the Approved Product and Equipment List (APEL) as the only unconditionally approved product in that category following a successful one year pilot at the Niagara-on-the-Lake plant.
- A pilot of the Sulzer magnetic bearing turbo blower product is to be undertaken as part of the Port Dalhousie Wastewater Treatment Plant Upgrades (2020-T-116) awarded to Maple Reinders Constructors Limited on December 17, 2020.

Financial Considerations

The costs associated with turbo blowers are included as part of existing projects in the approved capital budget.

Analysis

The Aeration Process in Wastewater

The activated sludge process is a type of wastewater treatment process for treating sewage or wastewaters using aeration and a biological floc composed of bacteria and protozoa. The activated sludge process is the conventional form of wastewater secondary treatment and is currently used at each of Niagara's wastewater treatment plants.

All activated sludge processes require a form of aeration. Aeration involves air being circulated through, mixed with and dissolved in wastewater in order to promote microbial growth. The microbes feed on the organic material, forming floc which can easily settle out. Aeration provides oxygen to bacteria for treating and stabilizing the wastewater. Oxygen is needed by the bacteria to allow biodegradation to occur. Without the presence of sufficient oxygen, bacteria are not able to biodegrade the incoming organic matter in a reasonable time resulting in septic conditions which are toxic, odorous, and do not effectively remove pollutants. These conditions can also lead to low pH making the water more difficult to treat, cause odours and lead to possible compliance issues.

Aeration is the most critical component of the activated sludge process. A well designed aeration system has a direct impact on the level of treatment achieved. Having appropriate and effective blowers incorporated into the design of an aeration system is key to achieving good wastewater treatment outcomes.

There are two main types of aeration systems in an activated sludge wastewater treatment plant; mechanical aeration and diffused aeration. Mechanical aeration operates from the surface of a tank or lagoon, whereas diffused aeration typically operates from the bottom. Diffused aeration systems offer many important advantages over their mechanical counterparts including a more efficient use of electricity, reduced maintenance and operating costs, uniform mixing and increased oxygen transfer which promotes the proliferation of helpful micro-organisms that are necessary for efficient biological decomposition. Blowers are a critical component of a diffused aeration system and are sometimes also used in the backwashing process at water treatment plants.

Blower Technology in Niagara Region Wastewater Treatment Plants

Niagara uses three types of blowers in diffused aeration systems: positive displacement, centrifugal and turbo blowers. The type of blowers currently in service is dependant on the plant’s designed capacity, influent flow/composition and the available technologies at the time of installation.

Turbo blowers are relatively new in the water-wastewater industry; however, industry case studies indicate that turbo blowers show potential benefits over centrifugal or positive displacement blowers. Turbo blower technologies reduce maintenance and installation costs and provide up to 40% energy savings for plant aeration processes which account for between 40-70% of the total energy used in a conventional activated

sludge wastewater treatment plant. That said, the type of blower used is determined by a variety of engineering and environmental variables and, ultimately, selecting the proper blower for a particular site and application is paramount in decision making. The evaluation and decision on which blower should be used is part of the design process as the choice must be compatible with related and connected design decisions.

Many of our wastewater treatment plants currently operate older, less efficient blowers or mechanical mixing systems. Operational improvements and energy savings can be realized with the use of turbo blowers; therefore migration to new, higher efficiency technologies is a priority.

Turbo blowers are currently used at Crystal Beach and Niagara-on-the-Lake wastewater treatment plants.

The first turbo blower installation was at the Port Colborne Wastewater Treatment Plant in 2011. A second installation was completed at the Crystal Beach Wastewater Treatment Plant in 2012. Both of these initial experiences with turbo blowers resulted in performance, reliability and operational issues. These failures caused several process upset events putting the facility's ability to meet the Ministry of Environment, Conservation and Parks (MECP) effluent quality requirements at risk. As a result, the first turbo blower installation in Port Colborne was decommissioned in 2015 and replaced with salvaged conventional blowers as an interim operational setup until a new permanent conventional system could be designed, built and put in service.

Turbo blowers have more recently been installed at the Niagara-on-the-Lake Wastewater Treatment Plant where a 12-month study that concluded January 17, 2021 found no operational issues with the blowers.

Turbo blowers, as part of another pilot study, were recently included in the Port Dalhousie Wastewater Treatment Plant Tender (2020-T-116) issued on Aug. 28, 2020.

Decision Making for Equipment - Overview

Staff's review and decisions around the inclusion of different types of blowers in our wastewater facilities have consistently focused on ensuring that the most appropriate and trusted technology is used to provide an efficient and effective aeration process for wastewater decomposition. Due diligence is exercised to evaluate the integrity of new technologies before wide-scale adoption into our treatment plants.

The Product Review Committee (PRC) plays a crucial part in our due diligence in their role of reviewing and approving only reliable and quality equipment for inclusion on the APEL. Per the committee's Terms of Reference (https://www.niagararegion.ca/business/tenders/prc/tor.aspx) the intent of the PRC and APEL is to ensure "that equipment that is specified in future contracts is appropriate in nature, represents best value and whenever possible, is similar to the equipment that is already incorporated in these facilities."

One of the prime objectives of the PRC is to ensure value for money through competitive procurement by having multiple products per equipment category.

The PRC through the APEL provides guidance on equipment to the designers. It may conditionally approve equipment, have equipment under evaluation, and recommend trial studies and pilots. In addition, the PRC may remove equipment from the APEL for performance issues and threats to process reliability. It is the purview of the committee to make recommendations and compile the APEL; however, per the Terms of Reference, inclusion of a product into the Approved Product Equipment List does not constitute mandatory use of the product. It is not intended nor appropriate for the APEL to be the sole determinant for equipment selection. Designers may deviate from the APEL providing an acceptable rationale is provided.

Ultimately the Divisional leadership team, informed by the APEL and design considerations, economic and resource factors, determines the strategic direction including which products to pilot and the most appropriate location for the pilot.

Decision Making on Turbo Blowers in Water-Wastewater

Staff and the PRC have been eager to gain confidence in turbo blowers through evidence of consistent performance, in order to realize potential savings through the energy efficiencies and reduced maintenance costs expected from this new technology. However, due to a history of performance issues resulting in multiple repairs and service interruptions, a cautious approach to implementing this technology in plant refurbishment projects was needed to ensure operational difficulties and maintenance issues would not negate any potential benefits and savings.

The recent industry introduction of magnetic bearing technology, has led to additional consideration for the potential use of turbo blowers in wastewater plants. The apparent benefits of magnetic bearing technology include extended life and service intervals, no

need for additional cooling systems, built in condition/vibration monitoring systems, high bearing damping and overload capacity and enhanced operational flexibility.

Pursuing a cautious approach to the evaluation and adoption of turbo blowers led to a series of decisions regarding their standing on the APEL and their inclusion in project design (Appendix 2).

Details of various decision points were outlined in memorandum PWC-C 49-2020. The decision points outlined per PWC-C 49-2020 were as follows:

"As a result, in 2015 the PRC, at the direction of the Director of W-WW Services of the time, temporarily removed the turbo blower sub-category and the two previously approved manufacturers from the APEL. Staff were directed to redesign all on-going capital works projects to use conventional blowers where feasible.

The Director agreed to proceed with the installation of turbo blowers at the Niagara-on-the- Lake WWTP as a trial study to continue to test the technology and because the plant was already under construction. He made this decision based on the substantial cost and time delay for the Region to change the design specifications at that phase of the project. The installation of the APG Neuros turbo blowers at the Niagara-on-the-Lake WWTP was agreed to be a 12-month trial study to assess and evaluate the performance of this product with consideration to reinstate them on the APEL if the equipment performed well… Recent advances in turbo blowers, specifically the introduction of the magnetic bearing technology, has led to new potential for the use of this technology in wastewater. On April 26, 2018 the PRC reviewed a submission for Sulzer ABS Turbo Blowers where the committee decided that the product would remain under evaluation during the completion of a 12-month pilot study. A key factor in this decision was the unique design features of the product, specifically the use of magnetic bearing technology in comparison to air bearings used by the Region's previous turbo blower manufacturers… The PRC identified an upcoming capital project at a facility suitable for the pilot. Similar to the approach with the Niagara on the Lake WWTP and the APG Neuros product, the Port Dalhousie Wastewater Treatment Plant was chosen as a suitable test site and Sulzer ABS Turbo Blowers were included as the sole acceptable turbo blower manufacturer in Tender 2020-T-116 to facilitate the pilot study."

"Port Dalhousie WWTP Upgrades Contract 1 project was executed through a competitive public tender process (2020-T-116) with included detailed specifications for this new blower technology adhering to the approved Product Review Committee (PRC)

Terms of Reference. Phase II Upgrades scheduled for 2023 will also be issued as a competitive procurement process."

Further to that report, staff would like to correct misstated information, review those decision points, add some additional information, and provide further clarity.

The Port Dalhousie Wastewater Treatment Plant Tender (2020-T-116) was issued on August 28, 2020. The tendered specifications listed Sulzer Aeration Solutions as the only acceptable turbo blower product. There were no revisions or changes issued through addendums regarding acceptable manufacturers for turbo blowers.

The decision to remove the turbo blower category from the APEL and to include only Sulzer turbo blowers in the Port Dalhousie WWTP Upgrades project to facilitate a pilot study was not accurately reflected on the APEL when the tender was issued. This was not corrected until a revised APEL was issued in October 2020.

In respect to the above decision making, staff hereby present additional details and updates for further clarification.

Staff acknowledge that the April 26, 2018 decision to approve Sulzer ABS Turbo Blowers, was stated incorrectly in PWC-C 49-2020. The record of the decision in the minutes of the PRC (Appendix 2) does show an unconditional approval of the blowers. In addition, although not stated above, the same decision was recorded for APG Neuros Turbo Blowers on August 26, 2019.

The unconditional approval of the turbo blowers was due to new members of the committee not having the historical information of the earlier decisions and restrictions placed on this equipment sub-category in 2015.

The PRC membership composition underwent significant membership changes in November through December 2017, including a change in leadership. The decision to reinstate the installation of the turbo blowers at the NOTL WWTP on a trial basis made by the previous Director was never formally documented. This direction, and the removal of the turbo blower category pending the result of successful one year trial test, was not conveyed to new members. This resulted in the unconditional approval being incorrectly applied to Sulzer in 2018 and APG Neuros in 2019. The inappropriate decisions of the PRC to approve the turbo blowers was later identified and corrected to again remove the turbo blowers sub-category from the APEL pending the results of the respective pilot studies.

Since the time of the previous report to PWC on December 8, 2020 (PWC-C 49-2020), the pilot study of turbo blowers at the Niagara on the Lake WWTP has successfully concluded and APG Neuros was unconditionally approved as of January 17, 2021 (Appendix 3).

Should the pilot being undertaken as part of the Port Dalhousie WWTP Upgrades be successful, the Region would have two turbo blower options on the APEL. This would provide a competitive source of procurement for future projects.

A **detailed timeline** with supporting documentation of the history, experience, communication and decision-making processes surrounding turbo blowers and the adoption of the technology in Niagara's wastewater plants is presented in **Appendix 4**. This process ultimately led to the approach of including a specification for magnetic bearing turbo blowers as provided by Sulzer who were conditionally approved vendors under evaluation by the PRC.

Port Dalhousie WWTP Upgrades – Aeration Design

The need for the Port Dalhousie WWTP Upgrades project was identified in 2013. The business case included various process areas requiring improvements, with the main upgrade identified as replacement of the existing aeration system. In 2011, Insyght Systems Inc. prepared an energy analysis report for the Port Dalhousie WWTP aeration system. The report recommended that fine bubble (diffused) aeration be implemented in order to meet design capacity, improve energy efficiency/savings, resolve maintenance and possible compliance issues. Dissolved Oxygen levels in the existing aeration tanks have been historically low and the existing surface (mechanical) aerators currently do not transfer sufficient oxygen to meet existing demands. The structural, mechanical and electrical equipment have reached the end of their service life and are in need of replacement. Increased maintenance efforts are needed to keep the current system in service.

Maintenance staff continue to expend significant resources to maintain sufficient operation of the aeration tanks including the rental of numerous mechanical aerators to supplement the existing equipment.

On March 24, 2016, the Port Dalhousie WWTP Upgrade Request for Proposal (2016-RFP-14) was issued for a competitive bid to a subset of the Successful Roster Listing developed from Contract 2015-RFPQ-03, specifically Category #2. The objective of the

assignment was to upgrade various areas within the Port Dalhousie WWTP. The scope of work relating to the aeration process included:

- Analyze the optimum configuration and location to upgrade the process aeration to Fine Bubble Diffusion including:
    - All components associated with constructing a new aeration tank east of the existing tank;
    - New fine bubble diffusers and process air blowers, complete with piping and valving;
    - New Motor Control Centres (MCCs) including all power, control cables, and wiring related to the aeration system;
    - New building to house the new aeration blowers and new MCCs;
    - Replace all process and control valves associated with the aeration system;
    - SCADA architecture and process narrative; and
    - Decommission and remove obsolete electrical and mechanical equipment (there are two MCCs for the aeration system; one has aeration motors and Variable Frequency Drives (VFDs); the other has VFDs, motors, lighting panel, new chemical feed system, and other small loads). Review and make recommendations on the removal of all mechanical in the existing aeration tank. Provide recommendations and design for repairs to and cleaning of the existing concrete structure. Existing concrete aeration tank is to remain.

On June 10, 2016 Hatch Corporation was awarded the contract. From June 2016 until November 2018 the project proceeded from project initiation to 90% design. Hatch's design was based on the 2013 Project Design and Technical Specifications Manual and the March 9, 2016 APEL. The 2016 APEL listed approved manufacturers for centrifugal and positive displacement air blowers. During the 40% design review meeting, the Region and Hatch agreed upon the inclusion of positive displacement blowers in the design. Seven (7) rotary lobe positive displacement blowers, complete with all accessories were specified in the 90% design. The design included five (5) blowers to provide process air to the two aeration tanks and two (2) smaller blowers dedicated to channel aeration.

Staff had previously considered the possibility of using turbo blower technology and specifically Sulzer magnetic bearing blowers at the Anger Ave WWTP to replace the existing centrifugal blowers; however, capital upgrades for this project were pushed out of the 10 year capital forecast to 2027. The Port Dalhousie WWTP Upgrades project

was in the final stages of design and in immediate need for construction of a new aeration tank and diffused blower system. As such, the focus was shifted to consider installation of the Sulzer blowers at the Port Dalhousie WWTP under the strategic direction of the Divisional leadership team.

When specifically looking at Port Dalhousie WWTP as a possible location for use of turbo blowers, it was determined that the use of turbo blowers would be applicable to provide process air to the aeration tanks, however turbo blowers would not be suitable for the channel aeration.

Realizing the potential energy savings in the aeration process, an evaluation was performed to compare the Life Cycle (LCC) of the positive displacement and turbo blower alternatives. A comparison was conducted on the rotary lobe positive displacement blower and turbo blower for the new aeration tanks at Port Dalhousie WWTP by WWW Energy Management Project Manager. Based on a 25 year LCC period, 50% load factor for 4 duty blowers and taking electricity inflation costs into account, a LCC comparison determined over $2.6M in savings could be realized by the use of turbo blowers compared to rotary lobe positive displacement blowers.

The comparison information presented by Hatch along with the LCC comparison developed by our Energy Management Project Manager was reviewed and discussed internally. Significant LCC savings would be realized with the use of turbo blowers and staff had a desire to trial the new magnetic bearing technology. Considering the benefits of having multiple approved turbo blower vendors, staff determined that updating the design and tender specifications to facilitate the pilot study of a second turbo blower vendor offered the greatest long-term return on investment for future projects. It was ultimately agreed upon that the Sulzer turbo blowers would be selected for the Port Dalhousie WWTP aeration tank process air design.

Upon internal agreement to proceed with the use of Sulzer turbo blowers at Port Dalhousie WWTP, Hatch was instructed to revise the design to replace the five (5) aeration tank positive displacement blowers with Sulzer turbo blowers. The design was completed and Port Dalhousie Wastewater Treatment Plant Tender (2020-T-116) was issued on Aug. 28, 2020. The tender issued documents included five (5) turbo blowers to provide process air to the two aeration tanks and two (2) smaller rotary lobe positive displacement blowers dedicated to channel aeration. The tendered contract documents listed Sulzer Aeration Solutions as the only acceptable manufacturer for turbo blowers. There were no revisions or changes issued through addendums regarding the acceptable manufacture for turbo blowers.

Alternatives Reviewed

N/A

Relationship to Council Strategic Priorities

This report is being brought forth by staff in response to a request from Public Works Committee to provide clarity around the decision-making process for review and adoption of turbo blower technology into wastewater treatment plant capital upgrades. Sharing details and rationale of this decision-making aligns with Council's priorities including:

- Using sound asset management planning to ensure sustainable investments in the infrastructure needed to support existing residents and businesses future growth in Niagara; and
- To drive evidence informed decisions by building staff skills and capacity, and by making information and data accessible across the organization.

Other Pertinent Reports

PWA-182-2005
PW 44-2020
PWC-C 49-2020

Prepared by:
Joseph Tonellato, P.Eng.
Director, W-WW Services
Public Works Department

Recommended by:
Bruce Zvaniga, P.Eng.
Commissioner of Public Works (Interim)
Public Works Department

Submitted by:
Ron Tripp, P.Eng.
Acting Chief Administrative Officer

Appendices

Appendix 1 Blower Types Currently in Service

Appendix 2 Meeting Minutes

July 23, 2015 – Maintenance Management Meeting

April 26, 2018 – Product Review Committee

August 26, 2019 – Product Review Committee

January 6, 2021 – Product Review Committee

January 18, 2021 – Product Review Committee

Appendix 3 January 18, 2021 Letter to APG Neuros re:APEL

Appendix 4 Timeline of Decision-making and Communication on Turbo Blowers