Steinbach's new pumping station

By Doug Lemon, ITT Flygt

The City of Steinbach is located 50 kilometres southeast of the city of Winnipeg. The community was founded in 1874 by 18 Mennonite families who emigrated from Russia. Since then, it has grown to be a vibrant cultural and business centre with a population of 10,000 people.

As the population and business community grew so did the need for infrastructure improvements. In the mid-1980s it was realized future development would be limited unless steps were taken to expand the collection and treatment system. Furthermore the existing sewage lagoon had reached full capacity and expansion was not an option. Design work began to install a new trunk sewer system, which would feed into a new wastewater pumping station. This new pumping station would transfer wastewater to a new sewage lagoon.

This profile focuses on the phase of the project to supply a new wastewater pumping station, including pumps and appurtenances. It reviews mechanical and electrical modifications done during the design phase and since its commissioning date.

Although the City of Steinbach has several submersible wet well pumping stations, City Engineer Phil Kalyta felt such a large wastewater pump station would be easier to maintain if its design was based on having the pumps in a drywall adjacent to the wet well. The consultant proposed the traditional choice of a vertical pump connected through a flexible shaft to an electric motor. The electric motor was to be mounted on the valve room floor, which was below ground level. Kalyta asked what would happen to the motors should the station flood. He was advised this was not likely to occur but if it did the electric motors would have to be rebuilt.

Concerned about this possibility Kalyta contacted ITT Flygt to inquire whether their submersible pumps could be used in a dry-well application. Kalyta was advised submersible pumps are readily available for large permanent dry well installation and provide many advantages over conventional pumps:

1. Flood proof. Submersible pumps will continue to operate even when completely submerged.
2. Reduced maintenance cost. Complete motor/shaft/impeller unit is quickly removed for routine maintenance and inspection. There is no shafting to remove, replace, realign and no bearing frame to maintain. Submersible design completely eliminates bearing maintenance and alignment problems inherent in long flexible drive shafts.
3. Safer. Submersible design eliminates the danger of injury to personnel from exposure to rotating components.
4. Environmentally friendly. Submersible pumps are sealed units therefore no messy packing leakage, stuffing box maintenance or pump drainage is required.
5. Lower installation cost. Submersible design does not require enclosure for grade mounted motors, structural member to support the motor or maintenance platforms for intermediate shaft bearings.

Kalyta asked the design consultant to analyze the cost difference to use submersible dry mounted pumps versus conventional vertical shaft driven units. The review showed a minimal premium to supply submersible pumps. However, the cost difference was basically a wash when you factored in the additional maintenance required to maintain a vertical shaft drive system. It was at this point that the City encouraged the Consultant to proceed with a design using submersible dry-mounted pumps.

Tenders for the new wastewater pumping station came out in the fall of 1991 based on using submersible dry-well mounted pumps. The structural design allowed for a total of four pumps, three of which were part of the tender and the fourth for future installation. The pump controller is an ITT Flygt Mactec unit capable of communicating with existing ITT Flygt SCADA system. ITT Flygt Model CT-3230 150HP 1800 RPM 455HT pumps were approved and supplied to site in June of 1992. They have a specified duty point of 345 L/S with two pumps operating in parallel against a variable static head plus friction losses in the forcemain. The new lift station was commissioned in November of 1992.

Over the next several months pump vibration became a concern. High vibration levels were particularly noticeable with one pump running. As normal flow rates were handled by one pump this condition was a major concern.

During the summer of 1993, an operational field analysis was performed. The pumps were inspected to see if the vibration had caused any damage. Measurement results indicated the pumps were running out past their design duty point. Analysis of the impeller vanes pointed towards cavitation damage although pitting on the top of the impeller would prove to have another source, which will be discussed later. In order to confirm pump vibration was not pump design related, a unit was removed and sent to ITT Flygt's Pointe Claire testing facility. Test results verified the pump was operating within manufacturing tolerances and HI standards. The cause of pump vibration therefore must be a system-related problem.

Over the next several years, different solutions were tried to eliminate the vibration. This included reducing the impeller trim in order to reduce output and NPSH requirements. Adjusting the pump(s) stop/start operating points to provide higher NPSH available values. Installing a restrictor plate

downstream from the pumps to artificially raise the head pressure and bring the operating point back on the pump(s) performance curve. Although these adjustments helped it did not eliminate pump vibration or system water hammer. It was then suggested a lower speed and horsepower motor be tried. This proved to be the answer in eliminating pump vibration and system water hammer.

The original Design Duty Point of 345 L/S with two pumps running was selected based on meeting projected capacity in 2010. In 1999, a consultant was asked to review present and future station capacity requirements based on data collected since commissioning. They were also asked if proposed pump performance change would be able to meet these new projections. The proposed pump change would give capacities as follows:

One pump pumping:	245 L/S
Two pumps pumping:	300 L/S
Three pumps running:	325 L/S

It was determined based on the current projections, station capacity will not be exceeded until 2008 (two pumps running) or 2013 (three pumps running).

In the fall of 1999, all three Flygt CT-3230 150HP 1800 RPM 455HT pumps were modified. The drive ends were changed to 100HP 1175RPM motors and impellers trimmed from 440mm to 430mm. These changes effectively eliminated pump vibration and system water hammer.

Over the course of the last couple of years, the City of Steinbach has experienced several extreme rain events. During these events the drainage system became overwhelmed and water started infiltrating into the sewage collection system. During three such instances the main pump station could not keep up so the wet well flooded. In each case it also led to flooding of the dry pit pump room however the submersible pumps continued to work. One such event occurred in July 2002, where water levels inside the dry pit reached a depth of five metres completely filling the pump room and a portion of the valve room. On-site evaluation by the operators determined inflow rate of 375 L/S and the three pumps were producing a combined output of 360 L/S. This did not prove to be a catastrophic situation as all three submersible pumps kept on running. Eventually the station caught up to the inflows and the submersible sump pump drained out the dry pit area.

The severe rain event of July 2002 prompted the City of Steinbach to undertake various flood mitigation projects. One such project was to increase the main sewage stations pumping capacity. The City took a design build approach using preferred contractors and suppliers. It was determined that if all trunk sewers were full the main pump station could be subject to an inflow rate of 500 L/S.

After reviewing several different proposals from ITT Flygt, the city decided to purchase a CT-3312 470HP 1200RPM pump which was installed and commissioned for operation in March 2003. The pump will be manually activated only during periods of significant rainfall. This flood pump is run for one or two minutes a month to keep the mechanical seals and bearings in good working order.

Based on a study done by an electrical consultant, the City has made some noteworthy modifications, which have greatly improved the station's reliability:

1. Main station is at the end of the power line, which meant inconsistent power supply to stations electrical equipment. This created problems with peak power consumption and harmonics. Added to the station was an automatic power factor correction system. This is a continuously variable capacitor bank device. Depending on the load the device automatically puts capacitors on line to end up with peak power efficiency level between 98% and 100%. The device also filters out harmful harmonics to maintain peak power factor efficiency. Within two years the device has paid for itself in power savings. The City has now standardized its use for installations using larger than 20HP motors.
2. They knew there was a cavitation problem with the original pumps due to the run out condition when only one pump was running. But what could not be explained was the damage found to the top portion of the impellers. The City had an electrical analysis done of the building and found that it was not properly grounded. It was determined that the pumps were absorbing all the unused energy when the power was shut off or turned on. This energy was travelling through the pumps into the liquid and damaging the impeller. They have since made modifications to fix the grounding at the panel and have also made sure all the pipes and pumps are physically grounded.

Noise and vibration are good indicators of the functioning and condition of a pump and its installation. Therefore, the design duty point should always be as close as possible to the design point of the pump. And finally the flood proof feature of submersible dry-installed pumps certainly proved their worth at this sewage pumping station.

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