Valveless methanol metering pump designed for effluent denitrification

By Herb Werner

The release of high nitrogen concentrations in wastewater effluent is of great environmental concern as it can have a devastating effect on water ecosystems. Nitrogen is an end product of the bacterial degradation of ammonia, which is present in high levels in untreated wastewater.

Wastewater effluents containing nitrogen can cause excessive growth of plant and algae blooms in lakes, streams and rivers that deprive marine life of oxygen and sunlight. Nitrate is a primary contaminant in drinking water and can cause a human health condition called Methemoglobinemia, in which the oxygen carrying property of hemoglobin is altered.

Nitrogen created during the wastewater treatment process must be significantly reduced before being discharged into the environment. The challenge, however, is to not only reduce the nitrogen present in the effluent, but, if possible, to do so at an economical cost.

Through the denitrification process, water treatment facilities convert excess nitrate into nitrogen gas, which is then vented into the atmosphere. There are several processes that are commonly used to accomplish this; most of these utilize pre-treatment basins, aeration tanks and blowers. However, nearly 200 wastewater treatment plants in the U.S. add methanol to wastewater, accelerating the activity of anaerobic bacteria that break down harmful nitrate.

Methanol is a volatile, light, colourless, flammable and biodegradable liquid, readily available from suppliers. It's also estimated that methanol denitrification costs are about 1/8 of the cost associated with other methods.

In most cases, methanol is added into the effluent stream using a metering pump. The type of pump used can vary, but needs to meet certain application requirements. Two key areas include chemical compatibility of wetted parts, and electrical ratings for the area where the pump is being installed. Methanol is an alcohol that is considered an organic polar solvent. Therefore, all wetted parts need to have a degree of chemical resistance. Methanol is also both volatile and flammable, and, therefore, the pump used will need to meet approvals for use in hazardous locations.

Installation in a non-heated outdoor enclosure at a community college wastewater treatment plant.

Diaphragm pumps have traditionally been used for metering methanol for wastewater treatment applications. However, there is an alternative metering technology that has only one moving part in the fluid path. This eliminates internal check valves present in diaphragm and other reciprocating pump designs.

CeramPump® uses a rotating and reciprocating ceramic piston to accomplish both the pumping and valving functions. This technology is extremely precise and works particularly well in low flow volume wastewater treatment operations. Using sapphire-hard, dimensionally stable ceramic, allows for precise manufacturing of internal components with extremely tight clearances.

This, as well as the elimination of multiple check valves, provides a metering pump that can self-prime down to the microliter range. Also, it never loses prime due to air bound or check valves that don't seal well enough to prevent backflow at very low flow rates.

For metering methanol in the denitrification process, the CeramPump is driven by a 1/3-hp hazardous-duty motor rated for Class I, Group C,D; Class II, Group E,F,G.

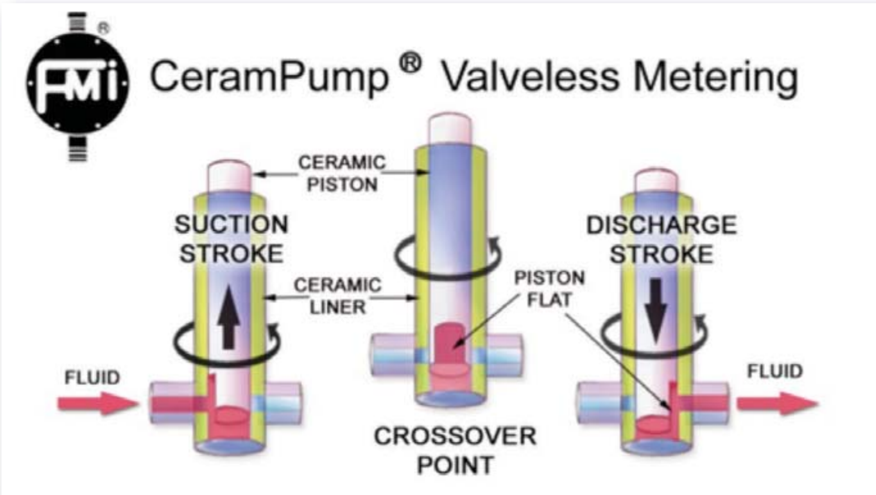

Figure 1: One complete synchronous rotation and reciprocation is required for each suction and discharge cycle as shown. At no time are the inlet and outlet ports interconnected, and, therefore, the need for check valves is eliminated.

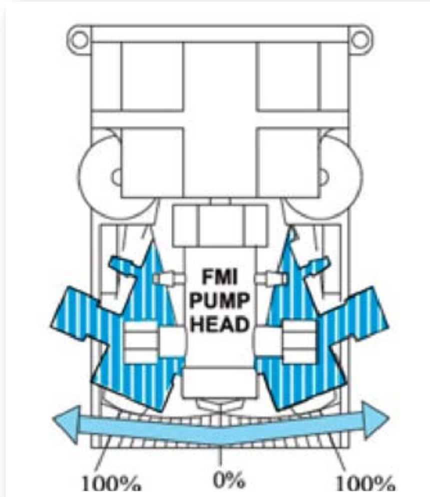

Figure 2: As the angle of the pump head increases above zero in either direction with respect to the drive, the piston reciprocates, and fluid is moved through the pump.

As the piston moves back, it draws fluid into the pump chamber. As it moves forward, fluid is pushed out of the pump. In addition to reciprocating, the piston also simultaneously and continuously rotates in one direction. It is designed with a flat cut into the end closest to the inlet and outlet port (Figure 1). As the piston rotates, the flat is alternately aligned with the inlet and outlet port, essentially functioning as a valve. At no time are the inlet and outlet ports interconnected, so there is no need for check valves.

Easy adjustment

The piston displacement (or volume pumped per stroke) is variable and controlled by the angle of the pump head to the drive. When the pump angle is zero, the pump head is in straight alignment with the drive and the flow is zero. In this situation, there is no reciprocation and the piston is only rotating. As the angle of the pump head increases above zero in either direction with respect to the drive, the piston reciprocates and fluid is moved through the pump (Figure 2). The greater the angle, the greater the displacement per cycle.

The pump is designed so that at any angle and flow rate, the piston always bottoms for maximum bubble clearance.

Adjustment is infinite between zero and 100 per cent and a flow rate indicator provides for accurate and simple linear calibration. The pump is designed so that at any angle and flow rate, the piston always bottoms for maximum bubble clearance. This is especially important at very small dispenses and flow rates, as the presence of even a minute bubble will significantly affect accuracy.

Herb Werner is with Fluid Metering, Inc.
E-mail: herb.werner@fmipump.com