

Rail Car Unloading Applications and Case Study

Rail car, or tank, unloading applications provide a number of unique challenges that PumpSmart is uniquely designed to manage. In many of these applications, a magnetic drive pump is used for unloading due to a hazardous nature of the chemicals being unloaded. Magnetic drive pumps are extremely susceptible to failure when operated outside of their design conditions. There are two main challenges associated with this type of application; operation outside of design conditions, and running the pump in a starved condition. In both these cases, premature failure of the pump or mechanical seal may result.

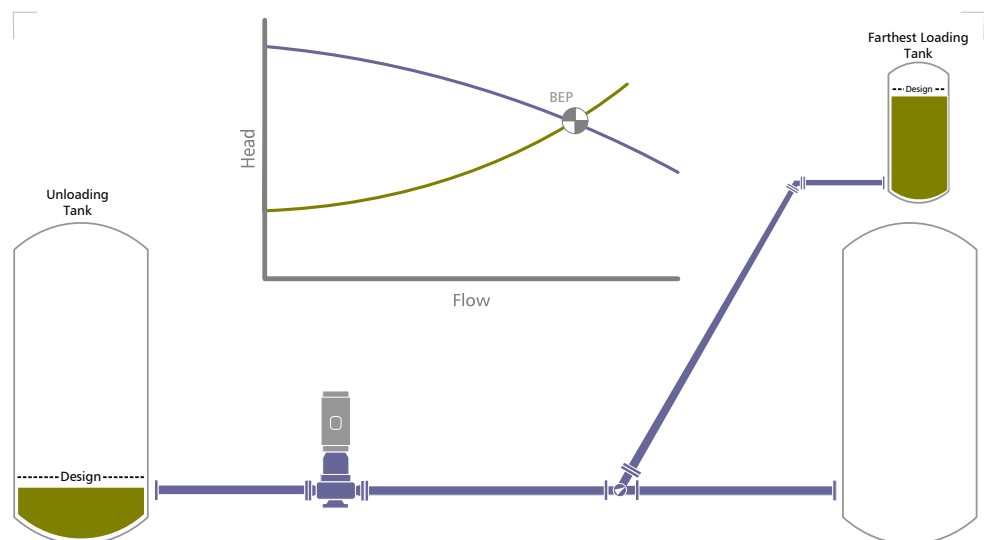
Challenge #1 – Tank level and tank location variability – The work a pump is required to perform for tank unloading pumps is typically highly variable for two reasons. First, unloading systems typically serve multiple storage tanks and the distance between tanks and resulting frictional (pressure) losses may vary greatly. The second reason is the highly variable tank levels between the tank being unloaded and the tank that is being filled. The difference in these tank levels represents the pressure the pump must overcome before any fluid can be moved. The tank levels and tank location variables can be combined in a limitless array and lead to conditions where the pumping is easy (low tank level, short pipe run), moderate and difficult (high tank level, long pipe run). If the pumping is too easy, the pump may run out past its maximum rated operating condition, cavitate, vibrate severely, and potentially suffer a mechanical seal failure.

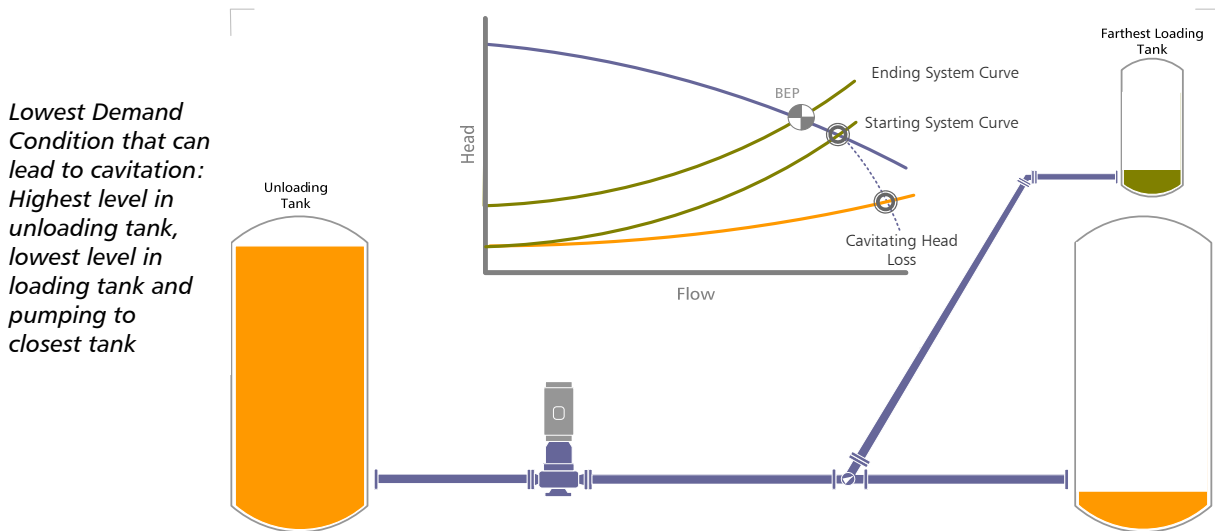
- PumpSmart Solution for constant flow applications** – By using the SmartFlow function, PumpSmart will automatically adjust the speed in response to the tank level and pipe run to maintain a constant flow. When pumping is easy, PumpSmart will run at slower speeds. When pumping is difficult PumpSmart will run at higher speeds. The SmartFlow function does not require the addition of an external flow meter or pressure transducers to the system.

Operation with Magnetic Drive Pumps

Because of the hazardous nature of many chemicals being transferred (caustics, acidic, etc....), many tank transfer and unloading pumps are magnetic drive. In some cases where the containment shell is metallic; eddy current losses also exist. PumpSmart automatically calculates eddy current losses and accounts for these conditions while operation and protecting your pump.

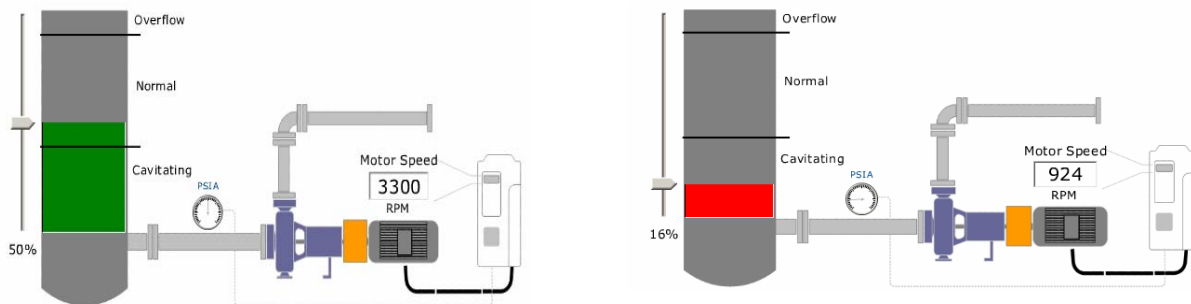
Worst case condition pumps must be sized for: Lowest level in unloading tank, highest level in loading tank and furthest tank.





Challenge #2 – Low suction tank level resulting in cavitation – When unloading of the rail car first starts, the liquid level in the tank being unloaded is sufficient to prevent the unloading pump from cavitating. As the level in the tank drops, the pump may begin to cavitate as suction pressure drops. Cavitation leads to reduced pump reliability and can also reduce product quality.

- **PumpSmart Solution for cavitation (Multi-Variable)** – By adding a pressure transducer to the suction of the pump, PumpSmart can monitor the fluid level in the rail car and can automatically reduce the pump flow and pump speed to avoid cavitation problems.

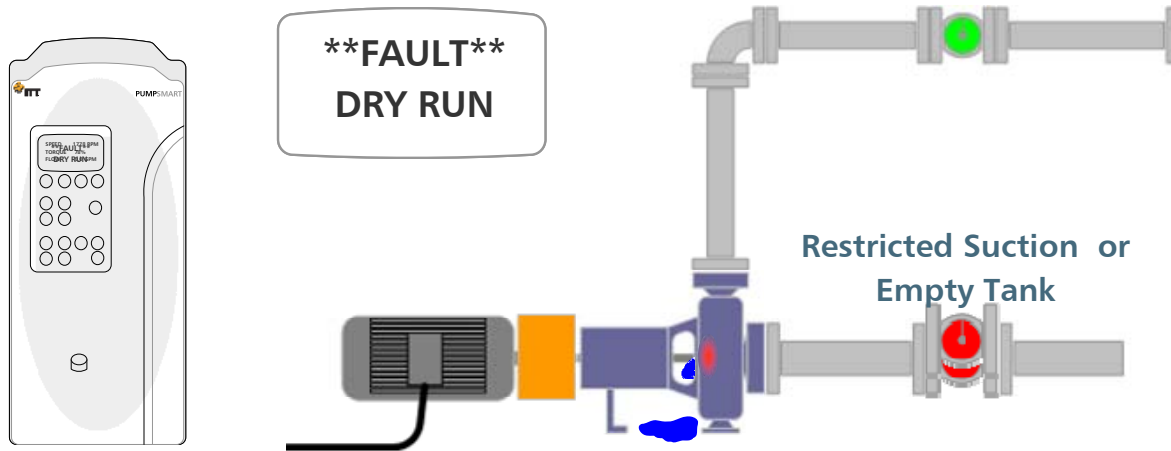


If cavitation is a concern for lower tank levels, pump speed and pump flow can be automatically reduced as the tank empties. In this example tank level is correlated to the suction gauge pressure.

Challenge #3 – Pump operation with an empty tank will result in dry running - Dry running will occur when a tank is emptied. The pump is continuing to operate but there is no flow of liquid into the pump. Mechanical seals that rely on lubrication and cooling from the pumping liquid will quickly heat up and fail. Magnetic drive pumps that also rely on cooling from the pumped liquid will also be prone to failure.

- **PumpSmart Solution for dry running (Multi-Variable and Sleep Mode)** – PumpSmart can monitor a tank level transducer or suction line pressure transducer and will put the drive in sleep mode when the tank is emptied. PumpSmart will automatically resume normal pump operation when a fully loaded tank is connected and suction pressure or tank level meets its set point. This action by PumpSmart will eliminate dry running mechanical

seal and pump failures. (Note: Without the aid of external sensors, PumpSmart is also able to detect dry running conditions via SmartFlow and advanced pump protection.)



PumpSmart will detect a dry run condition and can be configured to automatically shut down the pump to avoid a catastrophic mechanical seal failure.

Rail Car Case Study - "10 years of failures solved by PumpSmart"

System Challenge: For 10 years a food and beverage company experienced a high rate of cavitation induced mechanical seal and pump failures on all rail car unloading application. The pumps are located 400 feet from the rail cars and cavitation started once the rail car level dropped below 80% full. Cavitation severity increased as the tank level continued to drop. Noise levels were so severe, wearing ear protection when working near the pump was OSHA mandated. The cavitation was primarily caused by losses in 400 feet of suction piping. Converting from 4 inch to 6 inch piping was a solution that was determined to be cost prohibitive.

Pump Smart Multi-Variable Solution: PumpSmart was programmed to use SmartFlow as the primary variable and suction pressure as the secondary variable. PumpSmart operates at 300 GPM when the rail car is full and linearly steps down in flow to 150 GPM as the rail car is emptied. Given that the frictional losses in the suction pipe vary with the square of the flow, the losses when the tank is empty are 25% of what they are when the rail car is full. PumpSmart is also programmed to ramp up to 300 GPM after the rail car is emptied so the suction piping can be completely evacuated. This feature was extremely important to this customer.

Customer Testimonial: The plant manager was very interested in the installation and when he observed the pump operating without cavitation noise and vibration he asked if the tank car was near full. He was thoroughly amazed when the operators informed him that the rail car was only about 20% full and requested that a purchase order be immediately issued to install PumpSmarts on the other two pumps. With the aid of PumpSmart all three units are now running cavitation and failure free.