Replace High Resistance Ducts, Pipes and Fittings (Arc 2.5122)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est. Electric Consumption Savings	= ***248,229 kWh/yr***
Consumption Cost Savings	= ***$11,741 /yr***
Est. Electric Demand Savings	= ***340 kW***
Est. Electric Demand Cost Savings	= ***$4,158 /yr***
Est. Total Cost Savings	= ***$15,899 /yr***
Est. Implementation Cost	= ***$5,500***
Simple Payback Period	= ***4.2 months***

Recommended Action:

It is recommended that the plant use only one oxic recirculation pump instead of two to recirculate sludge from the oxic tank to the anoxic tank. To reduce the number of pumps being used, the plant needs to replace a broken check valve.

Background:

The plant was designed to have both anoxic and oxic tanks for sludge treatment also known as a Modified Ludzack-Ettiger (MLE) process. For the system to work, the sludge flows first into an anoxic tank where oxygen is not present. It then flows into an oxic tank which is aerated. In the oxic tank, nitrification occurs as microbes consume the substrate in the sludge producing nitrate as a product. This process has the potential to significantly decrease the alkalinity of the wastewater. To combat this, water from the oxic tank is pumped back to the anoxic tank. Because this tank is not aerated, the nitrate produced during nitrification is used as the terminal electron acceptor when the substrate is being consumed in a process known as denitrification. During denitrification, the alkalinity of the wastewater is increased offering a buffer to pH changes throughout the treatment process.

Another way to control the alkalinity is by the addition of chemicals like lime. The plant is currently in the process of rebuilding their lime addition equipment and once construction is completed, they would likely evaluate which option – recirculation pumping or addition of lime – is costlier for the plant.

Currently, two recirculation pumps are always being run to recirculate around 13 million gallons per day when it has been estimated that only 10 million gallons per day needs to be returned. One pump can return this much water, however two must always be run due to a broken check valve that would allow water to flow backwards without the second pump being on. It is recommended that the plant replace this check valve before doing their study to compare addition of lime to the cost of pumping from the oxic tank to the anoxic tank.

<u>Anticipated Savings</u>:

Currently, the two operating pumps are on VFDs running at 33% load. This mean the current energy consumption of the two 200 hp pumps (E_2 Pumps) can be calculated as follows.

$$E_2 \text{ Pumps} = (N \times HP \times C \times LF \times UF \times OH) / EFF$$

Where,

N	= Number of Oxic Pumps
HP	= Horse Power Rating of the Motor
C	= Conversion Factor - 0.7457 kW/HP
LF	= Load Factor
UF	= Usage factor
EFF	= Efficiency of the motor

$$E_2 \text{ Pumps} = 2 \times 200 \text{ HP} \times 0.7457 \text{ kW/HP} \times 0.33 \times 0.95 \times 87600.8$$

$$\boldsymbol{E_2 \text{ Pumps} = 1{,}023{,}943 \text{ kWh/year}}$$

The same calculation can then be completed for running 1 pump at 10 mgd which would be 50% load.

$$E_1 \text{ Pump} = 1 \times 200 \text{ HP} \times 0.7457 \text{ kW/HP} \times 0.50 \times 0.95 \times 87600.8$$

$$\boldsymbol{E_1 \text{ Pump} = 775{,}714 \text{ kWh/year}}$$

By operating only 1 oxic pump, the *electricity consumption savings* (ECS) is

$$ECS = E2 \text{ Pumps} - E1 \text{ Pump}$$

$$ECS = 1{,}023{,}943 \text{ kWh/year} - 775{,}714 \text{ kWh/year}$$

$$\boldsymbol{ECS = 248{,}229 \text{ kWh/year}}$$

At an electricity consumption rate (CR) of \$0.0473 per kWh, the estimated annual *electrical consumption cost savings* (*ECCS*) would be

$$ECCS = ECS \times CR$$

$$ECCS = 248{,}229 \text{ kWh/year} \times \$0.0473/\text{kWh}$$

$$\boldsymbol{ECCS = \$11{,}741/\text{year}}$$

The *electricity demand savings* (EDS) is

$$EDS = \frac{248{,}229\ kWh/yr}{8760\ hrs/yr} \times 12\ months/yr$$

EDS = 340 kW/year

With a demand cost (DC) of \$12.23 per kW-month/year, the *electricity demand cost savings* (EDCS) is

EDCS = EDS × DC

EDCS = 340 kW/year × \$12.23/kW

EDCS = \$4158/year

The total annual cost savings (TACS) is

TACS = ECCS + EDCS

TACS = \$11,741 + \$4,158

TACS = \$15,899

Implementation Cost:
It is estimated that a check valve around the size needed would be around \$2,000. In addition to this, installation costs would include labor. Assuming a team of three people could make the repair in a week, around \$3,500 would be a reasonable estimate for the installation cost. This brings the total implementation cost to \$5,500.

IC = \$5,500

Simple Payback Period:
Using the estimated \$5,500 for implementation, the *simple payback period* (SPP) is calculated below by dividing the *total cost savings* (TCS) by the *implementation cost* (IC).

$$SPP = \frac{IC}{TCS} \times 12\ months/yr$$

$$SPP = \frac{\$5{,}500}{\$15{,}900} \times 12\ months/yr$$

SPP = 4.2 months