**BACKGROUND**

Municipal water supply companies are only able to take pipeline pressure readings at major junctions and pumping stations. To read the pressure in the middle of pipes, special sections with built in sensors would need to be installed, which is expensive. Low-cost alternatives are needed to monitor the safety and integrity of current pipelines. The project is focused on creating a new technology to replace the current industry standard.

**OBJECTIVE**

The system must wirelessly transmit power and data across a pipeline wall and be able to attach to the curved wall of a pipe. For the power, the focus is on the amount of power in milliwatts that can be sent and the efficiency of the power transmission. For the data, the focus is on the bit error ratio and keeping it as low as possible.

<table>
<thead>
<tr>
<th>Design Metrics</th>
<th>Goal</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Error Ratio</td>
<td>None</td>
<td>0.2%</td>
</tr>
<tr>
<td>Efficiency</td>
<td>10-20%</td>
<td>1.97%</td>
</tr>
<tr>
<td>Power (Watts)</td>
<td>5 mW</td>
<td>9.84 mW</td>
</tr>
</tbody>
</table>

**PIEZOELECTRICS**

Piezoelectric materials can produce a charge from an applied mechanical stress (direct effect) or undergo a strain in response to an applied electrical field (converse effect).

The device uses this effect to feed power into the piezoelectric materials in order to send power through a solid pipe in the form of ultrasonic waves. Data can be modulated in these waves using Amplitude Shift Keying (ASK).

**SCHEMATICS**

**PERFORMANCE ANALYSIS**

**Power Transfer**

Power output was measured when the system was supplied a 10 Vpp sine wave at the resonance frequency of 1.07 MHz.

The outputted power was found to be 9.84mW, which exceed our goal of 5 mW by 4.84 mW.

The efficiency was lower than expected due to dispersal of the ultrasonic waves through the pipe wall.

Further efficiency could be achieved with larger piezoelectric discs on both sides of the pipe wall.

**Bit Error Ratio**

It is currently possible to send data at 4 bits/second with 0% bit error ratio by programmatically resetting the receiver and transmitter after 50 bytes have been sent.

Bit error ratio is estimated at 0.2% for continuous data sending.

**FUNCTIONALITY**

This system is successful in meeting its goals and has high feasibility for implementation within the industry.

Currently, the system is capable of successfully sending power across the pipe wall to power an internal battery. It is also capable of sending modulated data across the pipe wall and demodulating it successfully.

**CONCLUSION**

Future considerations:
- Downsized and integrated circuitry
- Higher efficiency
- Higher data transfer rate
- Waterproofing