Heat Exchanger Tube Vibration Test Stand (HETVTS)

Me-444W Cooperative Engineering Center

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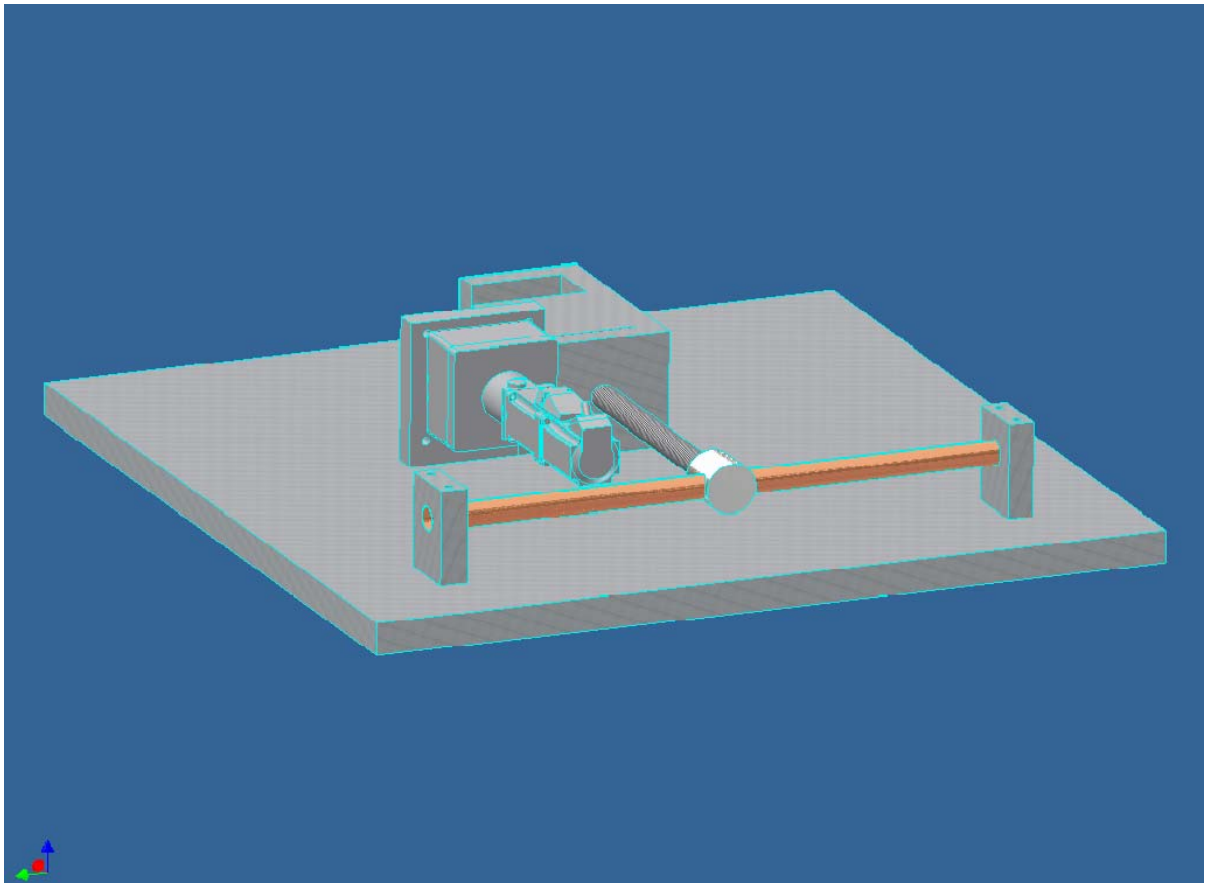

Over the past few years the price of copper has risen such that it is now cost effective to invest money into designing products to use the least amount of copper. A product that this is critical to is heat exchanger tubes. When looking at tubes it makes sense to eliminate as much of this cost as possible. This cost savings must be paired with the cost of a failure of a heat exchanger, a costly event not only in repair but also in lost of productivity. Johnson Controls, a leading manufacturing of heat exchangers, must be able to predict failure and design a tube that requires a minimal amount of materials.

The most common failure mode, and hardest to predict, is fatigue. It is easy to design a copper tube so that it won't yield under the loading in a shell and tube heat exchanger; however it is harder to design for the cyclical motion of the water over the tubes. The project was to design and build a test stand to test fatigue and produce an S-N curve for tubes used in shell and tube heat exchangers. This S-N curve below has been prepared by Johnson control and was provided as an example of what they wanted.

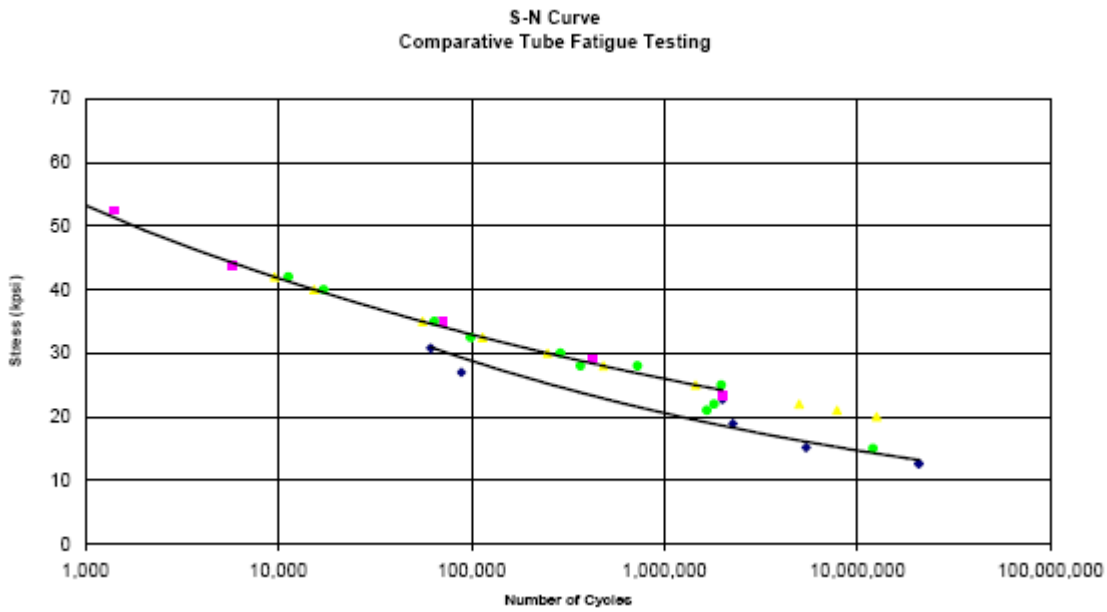

Figure 1 provided by Johnson Controls

The test stand was designed to use an available servo motor. This would be coupled through a gear box to a power screw. A load cell would be placed on the screw and then the screw would be connected to the copper tube, which would be anchored to the base. This would flex the tube back and forth at a point in the middle, very similarly to what is experienced in a heat exchanger. A set of photodiodes would be placed inside the tube and when a failure occurred light would have be let in through the cracks and signal a failure with the photodiodes.

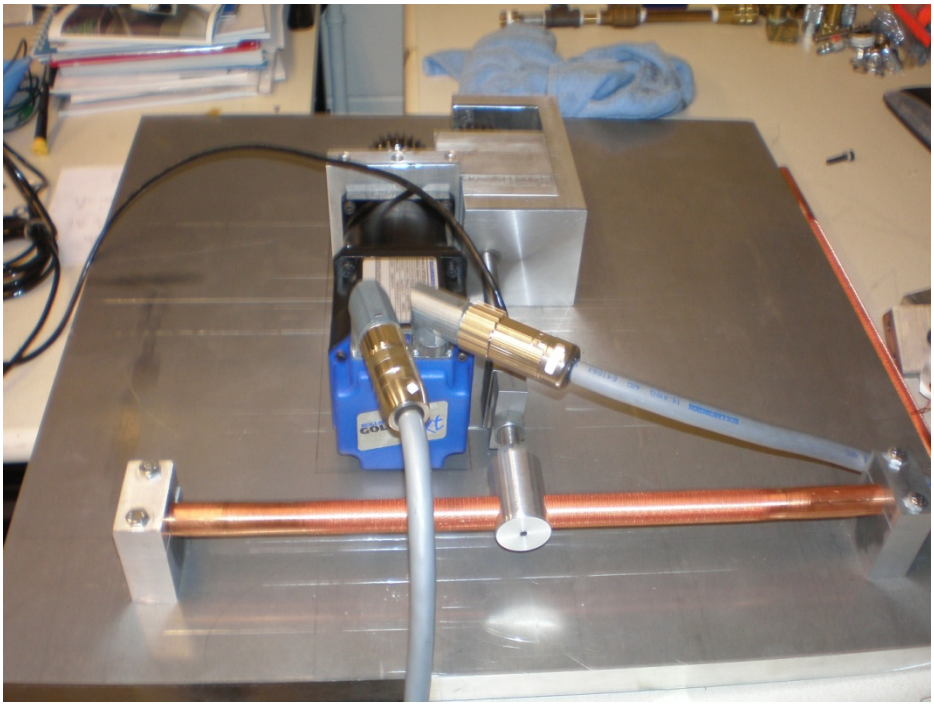

Figure 2 the completed prototype

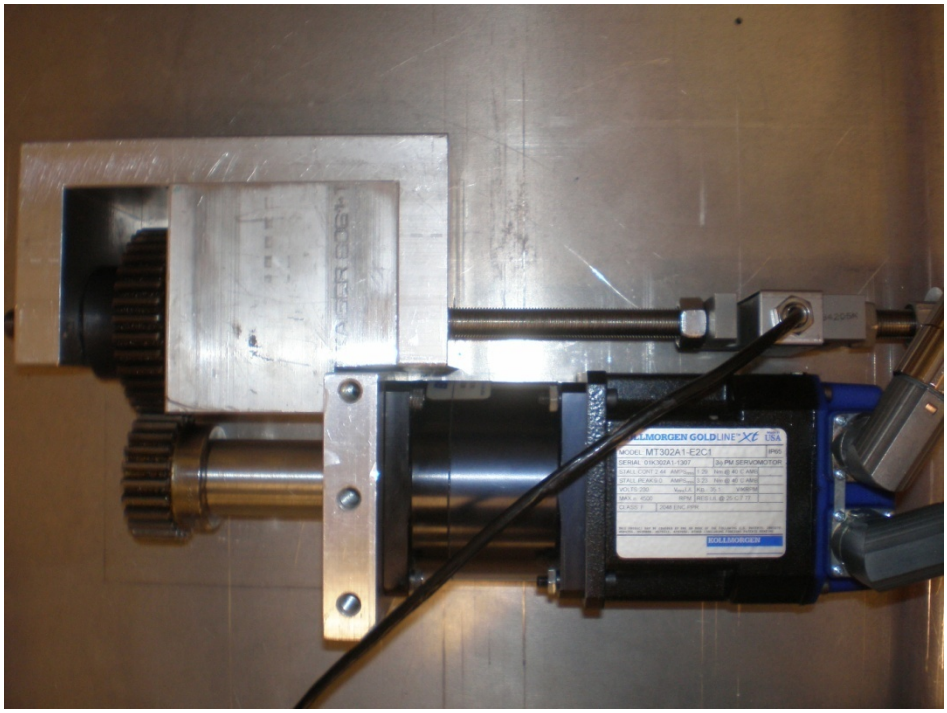

Figure 3 over head view