2019 Award Nomination

Title of Innovation:
Adjustable Atmospheric Corrosion Test Rack

Nominee(s)
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Category: Testing

Coatings and Linings	Instrumentation
Cathodic Protection	Testing
Materials Design	Integrity Assessment
Chemical Treatment	Other—fill in

Dates of Innovation Development:
January 2018 to May 2018

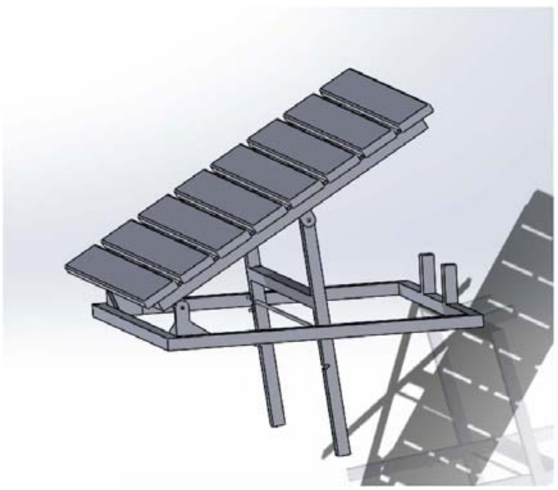
Web site: https://www.uaa.alaska.edu/academics/college-of-engineering/

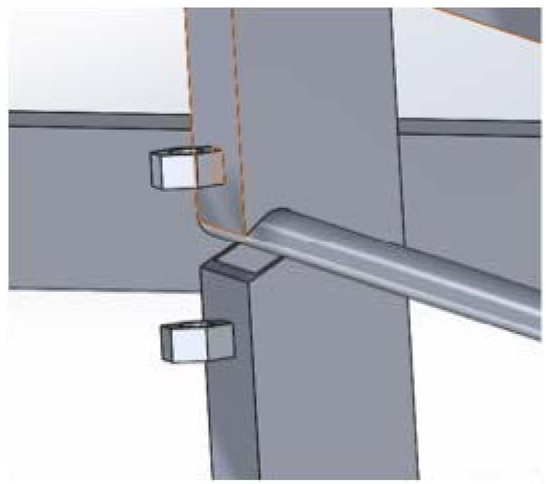
Summary Description: Modular and adjustable atmospheric corrosion tests were designed and installed on the roof of the University of Alaska's Engineering Parking Garage. Racks were 46 inch by 46 inch and can be adjusted to three different angles (0, 30, 45-degrees to the horizontal) similar to car hood. The angle of exposure affects the snow/ice retention and this leads to the formation of varying thicknesses of moisture on metal surface. The angle of exposure also affects the wash off from rain and this could change the atmospheric corrosion mechanisms. This rack helps in identifying the weather parameters by isolating the corrosion inducing variables and their primary effect on corrosion in extreme cold climates.

Full Description:
(Please provide complete answers to the questions below. Graphs, charts, and photos can be inserted to support the answers.)

1. What is the innovation?
Innovation is in the design of modular corrosion test rack that can be adjusted to three different exposure angles.

2. How does the innovation work?
Design has two notches cut out in the support arms, one for an angle of 30-degrees and one for 45-degrees above the horizon, where it will rest on a half inch bar will. A pin was placed outside of the notches to secure the bar in place. Separate backstops made of square tubing and mounted to the bottom frame will support the rack at a 0-degree angle.





3. Describe the corrosion problem or technological gap that sparked the development of the innovation? How does the innovation improve upon existing methods/technologies to address this corrosion problem or provide a new solution to bridge the technology gap?
Atmospheric corrosion experiments are conducted in accordance with the American Society of Testing and Measurement (ASTM) testing standards. ASTM Designation: G 50 – 76 (Reapproved 2003) describes the standard practice for conducting atmospheric corrosion tests on metals. ASTM G4-01 (Reapproved 2014) describes the standard practice for conducting corrosion tests in field applications, and G 92-86 (Reapproved 2003) describes the suggested methods for creating an atmospheric test site. Overall, it recommends an exposure angle of 30 degrees from the horizontal, facing south, and that the lowest specimens are at least 30 in. above the ground. The time of wetness and chloride deposition are the two main parameters for atmospheric corrosion testing and these variables depend on the angle of exposure. This modular and adjustable corrosion test racks allows us to change the direction of exposure (north, south,

east or west) and the angle of exposure (0, 30, 45-degrees to horizontal). These changes can be made relatively easily and saves time of designing further for exposure angles and direction.

4. Has the innovation been tested in the laboratory or in the field? If so, please describe any tests or field demonstrations and the results that support the capability and feasibility of the innovation.

Theoretically, the maximum expected load of 750 lbs was calculated by accounting for 660 lbs of snow and 90 lbs of testing samples. It was assumed that packed snow weighs up to 30 lbs/ft3. With 1.5 ft or 18 in. of densely packed snow covering the 46 in. by 46 in. surface, the total volume of snow would be about 22 cubic feet. That much-packed snow calculates to a weight of 660 lbs. The test samples are assumed to weigh no more than 90 lbs. An FEA analysis was performed based on the maximum expected load of 750 lbs. The analysis initially showed excess stress on the steel vertical support arms near the support notches. The area affected was reinforced with a steel plate welded on each side of the problematic area. With the final design, the structural integrity far exceeded acceptable stress levels. Also of consideration was the ability of the rack to resist corrosion with no human intervention for over a decade. The use of corrosion resistant materials as well as a powder coating the structure should prevent any critical failures from occurring.

5. How can the innovation be incorporated into existing corrosion prevention and control activities and how does it benefit the industry/industries it serves (i.e., does it provide a cost and/or time savings; improve an inspection, testing, or data collection process; help to extend the service life of assets or corrosion-control systems, etc.)?

The corrosion behavior of a material or a component is evaluated by service history, field tests, or accelerated corrosion tests. The service history predicts the system's life more accurately followed by field tests and accelerated laboratory tests. But time and budget constraints make service history and field tests almost impossible for material selection and evaluation. This design will help testing material exposed to different angles, which in turn helps predicting predicating actual service life more closely than the accelerated corrosion tests.

In general, the environment is categorized as rural, urban, industrial, and marine based on the corrosion rates of exposed samples and atmospheric conditions. The most common assumption is that there is very little to no corrosion in arctic and cold environments. However, previous studies in Antarctic and Arctic regions has dispelled that notion and the corrosion rates are substantial. The atmospheric corrosion damage in cold environments are close to the main human activity which is concentrated close to the sea/coastal areas. Previous studies in the sub-arctic region of Canada, Norway and Russia show extensive atmospheric corrosion rates (when compared to Antarctica) due to the human developments and the resulting increase in mining and metallurgical industries. Experimental and theoretical work has shown that the electrochemical process proceeds at temperatures as low as -25ºC to -20ºC. Winds can bring in salt-laden snow from the marine environment, and the use of deicing salts can also contribute to high levels of chlorides. With the combination of critical relative humidity, the TOW of the metal samples will be high, thus extensive atmospheric corrosion damages are observed. Another factor that contributes to high corrosion rates is low rainfall, which in turn cannot periodically wash off the deposited chloride on top of the samples. The long hours of sunlight in the summer increase the surface temperature of the metal samples compared to the ambient temperatures and this can melt the snow/ice. The temperature of the samples are not too high to evaporate the snow/ice deposited but high enough to melt them and keep the samples wet for longer periods of time. In addition, the ever-increasing ambient temperatures due to global warming in recent years affects the snow presence on top of the metal samples. This leads to the formation of varying thickness of wet ice/snow layers on metal surface. The combination of urbanization and close to marine environments make artic and sub-arctic region in North America an important natural laboratory to study atmospheric corrosion. Only very few corrosion data are available in cold climate. This innovation can be used in cold climates to study the snow retention on top of the metal samples as function of exposure angles and it's effect on atmospheric corrosion. This can be added to the existing standard to test material at different exposure angles.

6. Is the innovation commercially available? If yes, how long has it been utilized? If not, what is the next step in making the innovation commercially available? What are the challenges, if any, that may affect further development or use of this innovation and how could they be overcome?

No. It is not available commercially as it is a design concept developed by faculty and students at a university and we are not looking to commercialize this. This is for a greater cause of research and development in the field of atmospheric corrosion.

7. Are there any patents related to this work? If yes, please provide the patent title, number, and inventor.
No.