Accelerated Corrosion on Reinforcing Steel Bars Procedure: Accelerated Corrosion

Procedure title	Accelerated Corrosion on Reinforcing Steel Bars Procedure: Accelerated Corrosion	
Author	Victor Alejandro Calderon	
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Principal Investigator	Mervyn J Kowalsky	
Location	Building and room number	
1.	**This standard operating procedure (SOP) is for**	

☐ Specific laboratory procedure or experiment

This document outlines the procedure to perform the accelerated corrosion process on reinforcing steel bars. This process uses an electrolytic process to accelerate corrosion in reinforcing steel bars. The setup consists in providing an anode (stainless steel), cathode (reinforcing steel bar), and an electrolytic connection Sodium Chloride solution at 0.3M concentration (1.75% NaCl solution), and a current to accelerate the oxidation process. The process uses Faraday's law to calculate the amount of time the current must be sustained to obtain a prescribed level of corrosion.

2.	**Process or experiment description**

The reinforcing steel bars are placed in an airtight container and are submerged in a calcium chloride saturated solution.

The required chemicals are listed below:

- Sodium chloride
- Distilled water

Other equipment:

- Beaker 500 ml
- Glass mixing rod
- Disposable 1 gal bucket or equivalent glass container
- Measuring scale
- Spoon for handling of chemicals
- Paper sheets for spills
- Funnel
- Power supply
- Resistor
- Copper cable
- Terminal block
- Screw driver

3.	**Hazard and risk assessment**.
The chemicals used are not considered hazardous. No other source of considerable hazard is known.	
4.	**Safety equipment** *Specify all equipment needed to perform procedure safely and to respond to emergencies.*
4.a.	Engineering / ventilation controls N/A
4.b.	Personal protective equipment • Safety glasses/goggles • Nitrile gloves with puncture resistance • Lab coat
4.c.	Location of nearest emergency safety equipment

Item	Location
Eyewash / safety shower	**See laboratory floor plan**
First aid kit	**Safety box**
Chemical spill kit	**Contact lab manager**
Fire extinguisher	**See laboratory floor plan**
Fire alarm manual pull station	***See laboratory floor plan***
Telephone	**(919) 515-3000**
Other	

5.	**Step-by-step methodology** *The methodology explained below is made for 1 liter (L) of saturated solution. If required multiply the concentrations below by the desired volume.*

Step 1: With the desired density current, calculate the amount of current needed for the test set up. Low-density currents are preferred. With the current and the voltage output the resistor resistance can be calculated:

For example for a current density of $470\,\frac{\mu A}{cm^2}$, and a current of 150 mA and a 3V output, the resistor is calculated as follows:

$$J = 470\,\frac{\mu A}{cm^2}\;; i = 150\,mA;\; V = 3\,V$$

$$V = iR$$

$$R = \frac{V}{i} = \frac{3\,V}{0.15\,\mathrm{A}} = 20\,\Omega$$

Checking the power in the resistor is at most half of the rated power. In this example the rated power is 1 Watt

$$P = i^2R = 0.15^2 * 20 = 0.45\,Watts$$

Therefore, we have a factor of safety of approximately 2. If the power is less than the rating or close to the rated power, there is a high chance of the resistor burning, thus the current will not be maintained in the circuit.

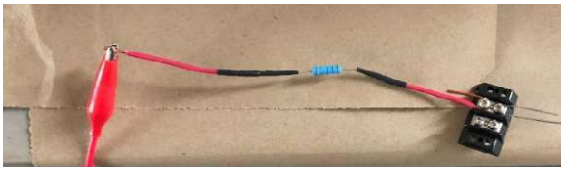
Step 2: Prepare the work area: put packing paper on counter or table of specimen preparation. Place underneath each specimen container.

Step 3: Turn on scale and ensure the scale is level. In the 1 gal container measure 0.3M of NaCl (17.5 g per L of water)

- 17.5 g of sodium chloride (NaCl)
- 1 L distilled water

Step 4: Saturate the assembly with Sodium Chloride solution.

Step 5: Connect the resistor to the terminal block. Connect the rebar wire to the terminal block The positive current is connected to the resistor wire. The negative pole is connected to the stainless steel mesh wire.



a) Connection of resistor and stainless steel wire in terminal block. Also shown connection to positive pole

b) Connect negative pole to stainless steel mesh wire

Figure 1 Connections for test setup

Figure 2 Final accelerated corrosion setup

Step 6: Turn on the power supply. Set the current and the voltage according to the values used to calculate the desired level of corrosion.

Step 7: Start the current.

Step 8: If necessary, adjust the voltage to maintain the desired current.

Step 9: Wait the amount of time calculated using Faraday's Equation for the desired level of corrosion.

Step 10: Continue with cleaning of the corrosion cleaning procedure

6.	**Designated area** .

Room temperature area.

7.	**Special handling procedures, transport, and storage requirements** *Describe special handling and storage requirements for hazardous chemicals used in this procedure, especially those that are highly reactive/ unstable, flammable toxic and corrosive. Describe secondary containment requirements for transport between laboratory rooms.*

The disposal of the solution should be performed as follows.

Step 1: In a container such as a bucket, slowly pour the solution in the bucket making sure to not spill the solution.

Step 2: Pour the solution in the cement waste designated container.

Step 3: Clean any droplets in the working area.

8	**Unwanted material disposal** **Identify and list all hazardous waste to be generated and appropriate disposal procedures. Include liquid and solid waste.**

The procedures outlined by EHS should be followed. The unwanted material generated in this process is the calcium hydroxide solution. A waste accumulation label should be obtained and correctly disposed after the passive layer generation process is performed.

9.	**Emergency procedures**

Life-threatening emergencies (for example, medical event, fire, explosion, large-scale spill or release, toxic or flammable gas leak, valve failure)

- Call 911. Provide dispatch the following information: your name and call back number, location of incident, material released, if known, if there are any injured person and their location.
- Pull the nearest fire alarm.
- Exit the building using the nearest stairway.
- Proceed to designated assembly area.
- Provide information to emergency responders as able.

Chemical spills

1. Determine if it is a "major" or "minor" spill. Minor spills are well contained, able to be cleaned using the spill kit at hand and clean-up would not require special PPE such as a respirator.

2. Assist anyone who may have been contaminated or injured during the spill.

3. Clean up minor spills using appropriate spill control equipment.

4. Call 911, NCSU Police ((919) 515-3000) and EHS ((919) 515-7915) for all major spills.

5. Contain major spill with appropriate absorbent only if trained to do so and your safety is not compromised.
6. Post "DO NOT ENTER" on entrance door and evacuate the area.

   Do not re-enter until Emergency Responders have cleaned up the spill and declare the area safe for reentry.

If personnel exposed to chemicals

1. Call 911 to seek emergency medical help.
2. Assist exposed person away from incident or source of exposure, to the emergency shower or eyewash. Do this only if able and personal safety is not compromised. Exposed person decontaminates using the nearest emergency shower or eyewash.

   2.1. Pull the safety shower lever to start the water flowing (or push the eyewash lever to start the water flowing).

   2.2 To wash off chemicals from your eyes, hold your eyes open to get the water under your eyelids.

   2.3 Remove all contaminated clothing and shoes to effectively wash chemicals off your body.

   2.4 Stay under the water for at least 15 minutes to wash all the chemicals off.
3. Report the incident
4. Seek follow-up medical treatment.

Building maintenance emergencies (for example, power outages, plumbing leaks, fume hood malfunction)
Call *(919) 515-2991* to report facility emergency.

10.	**Training requirements** *List the general and laboratory-specific training required for authorized users of this SOP*

☐ EHSA Chemical and Lab Safety Training
☐ CFL Safety Training
☐ Laboratory Unwanted Material Management Training