

## OVERALL FEEDBACK REPORT 1/6

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Northeastern University  
Social Science Environmental Health  
Research Institute



## CORROSION COUPON INFORMATION & RESULTS

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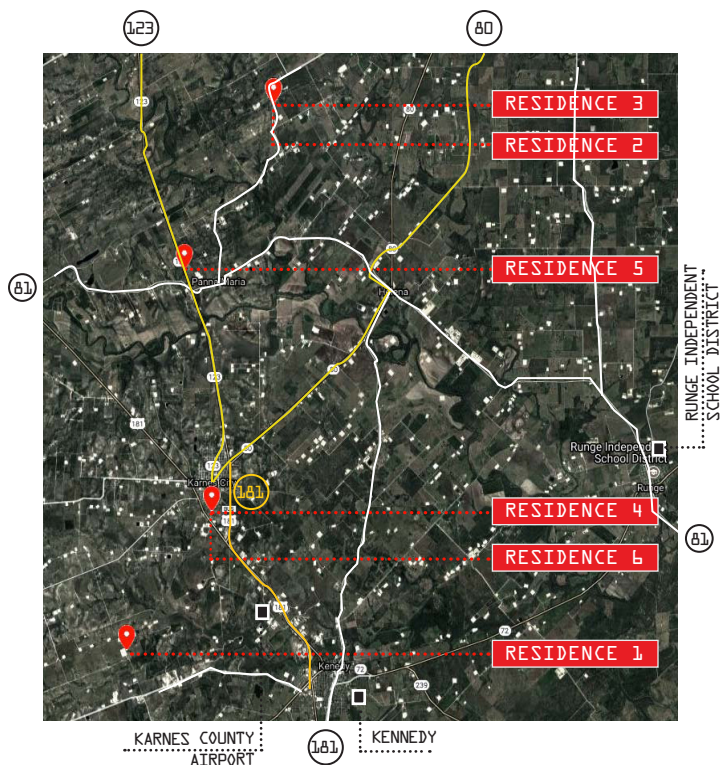
## WHY ARE WE USING CORROSION COUPONS?

Residents in the Karnes area have complained about rotten egg smells and corrosion, and the Eagle Ford Shale is known to be rich in  $H_2S$ . Also, the flaring of waste gases could be burning Hydrogen Sulfide ( $H_2S$ ) and Sulfur Dioxide ( $SO_2$ ). We want to see if corrosion and  $H_2S/ SO_2$  are problems in the Karnes area relative to other places. If they are, we would like to discuss next steps with residents for further air testing.

Given the limited availability of affordable methods to monitor  $H_2S$ , we have been trying methods commonly used in industrial monitoring, such as corrosion coupons, to see if they can be used by communities.

## WHEN & WHERE WERE THESE TESTS CONDUCTED?

Participants in the Karnes area put their corrosion coupons outside their homes between the dates of February 22 2017 and April 8 2017. Participants' locations were distributed throughout the Karnes area.



## WHAT IS A CORROSION COUPON?

Purafil Corrosion Classification Coupons (CCCs) do not deliver instantaneous results. CCCs have one copper and one silver surface that corrode (rust) due to air contaminants such as hydrogen sulfide ( $H_2S$ ) and sulfur dioxide ( $SO_2$ ). The CCCs are exposed to air, and then Purafil analyzes the silver and copper corrosion.

They are designed for industrial uses where corrosion might impact wiring in electronic devices. They are typically used indoors, not outdoors as we used them in this study. Using the coupons outdoors can increase corrosion as they are exposed to more water from dew and rain.

The copper is particularly sensitive to temperature and humidity (water). It is also more sensitive to  $H_2S$ . The silver surface is less sensitive to humidity and temperature, and it is more sensitive to  $SO_2$  than  $H_2S$ .

Purafil recommends that humidity does not exceed 50% during testing. An increase in humidity could increase the corrosion severity. For example, a coupon that is moderately corroded at 50% humidity, could show a harsh level corrosion, at 60% of humidity.

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### WHAT WERE THE RESULTS ?

All of the corrosion coupons, except for one, exceeded maximum levels of corrosion and were labelled as severe by Purafil. The corrosion was so thick on the test strips that some of it fell off. Because they could not measure the thickness of the corrosion, Purafil lab was unable to approximate levels of H<sub>2</sub>S or SO<sub>2</sub> that contributed to the corrosion.

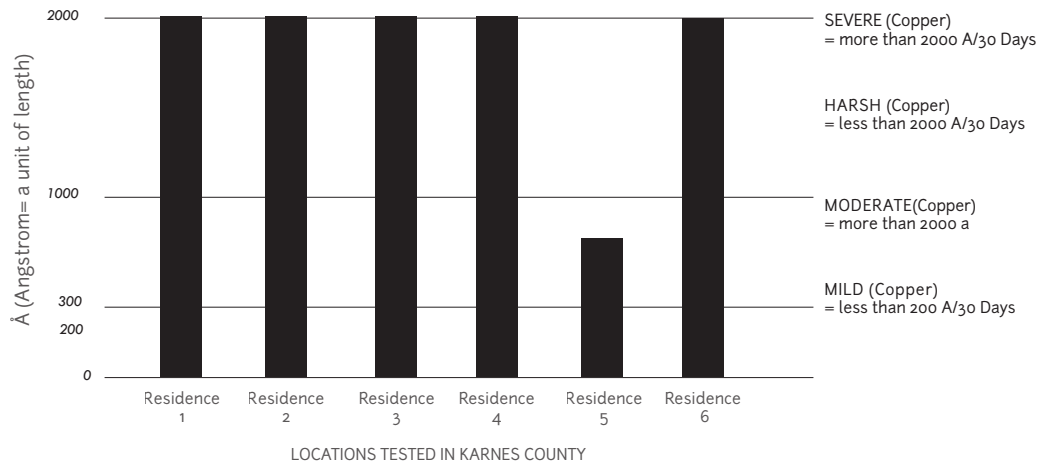
### WHAT WERE MY PERSONAL RESULTS?

Your results are attached to this report.

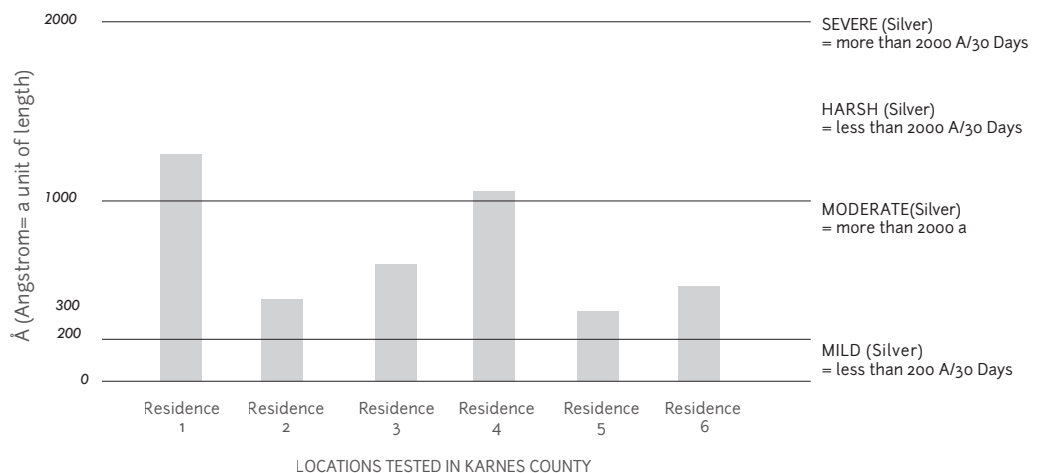
### HOW DO MY RESULTS COMPARE TO OTHER RESIDENCES? ?

All of the results, except one, showed severe corrosion for copper. There was a wide range of result classifications for silver. For the corrosion coupon that could be analyzed, H<sub>2</sub>S was approximated to be between 3-10 ppb.

#### COPPER



#### SILVER



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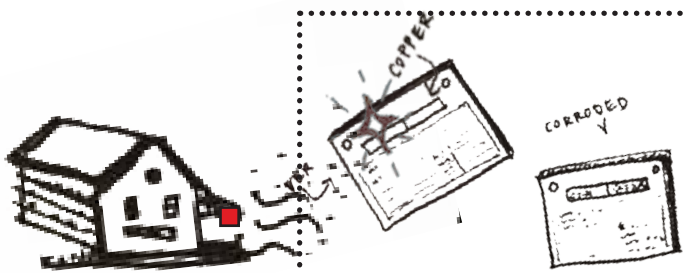


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## CORROSION COUPON

## INFORMATION & RESULTS



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## HOW DO CORROSION COUPONS WORK?

The metal strips on the corrosion coupon react with corrosive gases which form visible layers of corrosion on the test strip. The coupon manufacturer measures the thickness in Angstroms and chemical composition of these layers to determine what caused the corrosion and to approximate the concentration of gases causing the corrosion. The level of corrosion is classified into four levels: mild, moderate, harsh, and severe.

### ISA STANDARD ANSI/ISA-71, 04-2013\*

Severity Level	Copper Corrosion	Silver Corrosion
G1- Mild	<300 Å/ 30 days	<200 Å/ 30 days
G2 - Moderate	<1000 Å/ 30 days	<1000 Å/ 30 days
G3- Harsh	<2000 Å/ 30 days	<2000 Å/ 30 days
GX- Severe	>2000 Å/ 30 days	>2000 Å/ 30 days

Most of the corrosion was labelled as "Severe"

Å (Angstrom)- unit of measure

## WHAT IS H<sub>2</sub>S?

Hydrogen sulfide (H<sub>2</sub>S) is a neurotoxic gas that often smells like rotten eggs and can be emitted from oil and gas facilities. Neurological problems including fatigue, loss of appetite, irritability, impaired memory, altered moods, headaches, and dizziness are associated with chronic exposure to low level concentrations.

## WHAT IS SO<sub>2</sub>?

Sulfur dioxide is a colorless and pungent gas that is commonly produced from plants that burn oil and gas. It can form from the combustion of H<sub>2</sub>S, which may occur through flaring. When it is released into the air, it can dissolve into water and cause acid rain. The EPA reference concentration for one hour of exposure is 75 ppb, and health effects near this level include trouble breathing.

## EITHER H<sub>2</sub>S OR SO<sub>2</sub> CAUSED CORROSION

In all cases, the corrosion of copper and silver produced copper sulfide (Cu<sub>2</sub>S) and silver sulfide (Ag<sub>2</sub>S), not copper oxide or silver chloride. This suggests that a sulfur-containing gas, either H<sub>2</sub>S or SO<sub>2</sub>, produced the corrosion.

### EXAMPLE DATA FROM ONE REPORT:

COPPER	30 DAYS	SILVER	30 DAYS
Cu <sub>2</sub> S	20000 Å	AgCl	0 Å
CU <sub>2</sub> O	0 Å	Ag <sub>2</sub> S	632 Å
Unknowns	0 Å	Unknowns	0 Å
Totals	20000 Å	Totals	632 Å

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## CORROSION COUPON

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## WHAT CONCENTRATION OF H<sub>2</sub>S OR SO<sub>2</sub> WERE FOUND?

We cannot say for sure what concentration of H<sub>2</sub>S or SO<sub>2</sub> produced the corrosion. The lab estimates concentration of gases by the thickness of the corrosion formed on the metal. Unfortunately, the layer of corrosion on the test strips was so thick that some of it fell off. This made it impossible for the lab to estimate the amount of corrosive gases.

However, at the maximum severe level, where corrosion builds up to a thickness of 20,000 angstroms, the concentration of H<sub>2</sub>S is approximately 50 ppb (assuming 50% humidity). We cannot know sulfur levels for sure and cannot approximate them when the corrosion coupon is too corroded to be analyzed but it could be over an average of 50 ppb over 30 days.

In one case, moderate corrosion was identified. In this case, the concentration range of H<sub>2</sub>S and SO<sub>2</sub> could be approximated. The coupon manufacturer estimates that ambient concentration of hydrogen sulfide was 3-10 ppb. Health effects in this range include a detectable odor, nuisance to odor, Eye irritation, and chemical changes in blood and muscle tissue.

In this case, they estimate that the sulfur dioxide levels were between 10 and 100 ppb. EPA's threshold for an hour long exposure to SO<sub>2</sub> is 75 ppb, and concentrations above 100 ppb may cause difficulty breathing. This threshold was potentially exceeded during the sampling period and further testing is warranted.

## IS FINDING A SEVERE CORROSION CONCERNING?

This finding is potentially concerning. Severe corrosion like this is not expected in normal outside air, especially around residential communities, unless there is high humidity over 50%.

Given our analysis of weather data during the testing period, humidity, or the percent of water in the air, could have increased the corrosion on the coupons. Unfortunately, there was high humidity likely not from rain but from morning dew during the testing period. During our testing period, 17 out of 46 (37%) of the days had an average humidity level over the recommended 50%. Overall, humidity varied greatly from 1%-96%, and the average level was above 60% on 10 out of 46 (22%) of the days.

Further testing is needed to determine if the high levels of corrosion of the copper in particular was due to H<sub>2</sub>S or the combination of H<sub>2</sub>S and humidity.

If the severe corrosion is due to H<sub>2</sub>S, this finding is concerning as this level is similar to CCCs put inside homes containing "chinese drywall" in a study conducted by the Center for Disease Control (CDC). This building material caused controversy because it was found to include chronic, low levels of H<sub>2</sub>S that led people living in homes built to chinese drywall to become sick. Severe levels of corrosion on CCCs are also commonly seen around refineries.

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## WEATHER SUMMARY KARNES COUNTY WEATHER STATION [ 28.883, -97.856 ]

FEB 22, 2017 - APRIL 8, 2017

	HIGH	LOW	AVERAGE
Temp.	90.7 °F	45.1 °F	68.8 °F
Dew Point	71.2 °F	-48.1 °F	27.5 °F
Humidity	96%	1%	41.8%
Precipitation.	5.28 in	--	--
Wind Speed	38 mph	--	8 mph
Wind Gust	46 mph	--	--
Wind Direc-	--	--	SE
Pressure	30.51 in	29.52 in	--

## IS THIS LEVEL OF CORROSION NORMAL?

Since these CCCs were placed outside, rain, wind, and other chemicals in the air can cause corrosion. These outdoor factors might lead to inaccurate results, but our weather data from the testing period show that there was no rain or high winds, however humidity from dew could be increasing the severity of corrosion.

To assess whether these results are abnormal, we can compare them to available data from the TCEQ monitor located near the Karnes County Courthouse. Unfortunately, a day before the first corrosion coupon was deployed, the monitor went offline for repairs and will not be up and functioning again until August (from what the TCEQ had communicated to us via e-mail). Therefore, we cannot compare our results with the TCEQ monitor. However, some portions of the monitor were working for the first week of sampling (2/22-2/27), and we retrieved weather data via weather underground ([www.wunderground.com](http://www.wunderground.com)).

Compared to the TCEQ data for just this first week and the same period of time last year, the average level of H<sub>2</sub>S recorded by TCEQ is far below the maximum level of corrosion by H<sub>2</sub>S of 50 ppb could have been exceeded for our test coupons.

TCEQ PARAMETER MEASURED	HYDROGEN SULFIDE (ppb)
2/22/2017	0.66
2/23/2017	0.46
2/24/2017	0.37
2/25/2017	0.21
2/26/2017	0.38
2/27/2017	0.36
Averages	0.46

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### WHAT ARE SOME NEXT STEPS ?

In order to collect more specific information and measure approximate levels of  $H_2S$ , we would like to conduct the corrosion coupon test one more time over one or two week spans before the coupon becomes completely corroded. Since the coupons in Karnes were placed outside, we want to consider testing corrosion indoors in order to control for corrosion from wind and rain. We would also like to add other sampling instruments such as  $H_2S$ -sensing photopaper and  $H_2S$  radiello diffusion tubes.

### WHY ARE THE SILVER & COPPER CORRODED AT DIFFERENT LEVELS?

Copper and silver do not react to the same degree or rates as one another. These reactions also depend on humidity and types of gases the CCCs are exposed to. Higher humidity will cause copper to corrode more quickly than silver, while chlorine affects silver more than copper. If only one of the metals is measured to have high corrosion, it is considered corrosive. However, we are still unsure whether the severe corrosion was due to  $SO_2$  and  $H_2S$  since humidity could have added to the corrosion as well.

### WHAT OTHER CHEMICALS MIGHT CORRODE THE COUPON?

Chlorine and ammonia are other compounds that are measured by Purafil and might cause the coupon to corrode.

### DO YOU HAVE ANY INPUT & IDEAS ? PLEASE CONTACT:

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**THANK YOU FOR READING THIS REPORT.  
YOUR RESULTS ARE ATTACHED ON THE NEXT PAGE**