

EFFECT OF SUB-SLAB PRESSURIZATION ON INDOOR BASEMENT TEMPERATURE AND RELATIVE HUMIDITY

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Abstract

Pressurization as a mitigation strategy in radon mitigation is mentioned in training courses but is not widely practiced. Allied Radon Services, Inc. has encountered a house in which portions of the top of the foundation and sill plate are below grade. It is believed that radon is being drawn into the basement through the sill plate/foundation joint. By pressurizing the basement slab with two systems, the radon level is reduced to an average between 2.0 and 3.0 pCi/L. In order to determine the effect that pressurizing the slab has on indoor temperature and relative humidity, data loggers have been deployed. One is measuring conditions outdoors; two are measuring conditions at communication test holes in the slab; and the fourth is measuring conditions in the basement. This data will assist in determining whether it is necessary to take precautions to protect the indoor environment of the house.

Introduction

The house which is the subject of this paper is one that would be considered to be a very normal mitigation project. The house is approximately 30 years old. It is a two-story brick veneer frame house with a poured basement that is 75% finished. There is a sump pump that has been added after construction with a bolted down cover; a slab on grade Sun Room on the rear of the house; an attached garage; and an in-ground pool in the back yard with brick pavers between the house and the pool. The house has a high efficiency furnace that did not have a source of exterior makeup air and was pulling makeup air from the basement. The basement has one exit door and no basement windows. The initial radon level was 6.7 pCi/L

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An exterior picture of the house is shown in Figure (1).



Figure (1) Exterior Picture of house.

Methodology

The initial mitigation strategy was to install a single suction point sub-slab depressurization system routed through the garage with an RP140 fan in the garage attic and discharge through the garage roof. The bolted down sump cover was replaced with a gasketed cover that had a site glass. Caulk was applied to the wall/floor joint, to the extent possible. Subsequent testing revealed that the radon level was still greater than 4.0 pCi/L.

The following unsuccessful adjustments were then made to the mitigation system.

- Fan: The fan was upgraded to an RP145. Diagnostics indicated that communication did not readily extend across the slab.
- Suction points: Suction points were added to the garage and sunroom slabs.
- Suction points: Three additional basement slab suction points were added.
 - When adding additional suction points in the basement, it was discovered that the center of the basement slab was sitting on sandstone.
- Exterior makeup air for furnace was added.
- A second system.
 - When adding the second system, it was discovered that portions of the sill plate were below grade. Even though the basement was not under substantial negative pressure to the atmosphere, with the basement having no windows, the house was apparently drawing makeup air through portions of the sill plate joint that was below grade. As a result, the house was effectively mining radon around the foundation.

Even with two systems and six suction points, the radon level remained above 4.0 pCi/L.

At this point, the decision was made to reverse the fans and pressurize the slab. This house is located in Southern Illinois which can have some zero degree Fahrenheit days in the winter. The concern was the impact that pressurizing the slab would have on inside temperature and humidity.

In order to measure that impact on temperature and relative humidity, four data loggers were deployed. One measured data outdoors; one measured data in the basement; and the other two measured data directly above two communication test holes in the basement floor.

The closet data collection point was approximately 10 feet from the system pressurization point and the bench data collection point was approximately 20 feet from the other system pressurization point. Data was gathered from December 19, 2014 through February 9, 2015. The data loggers were set to record data at five minute intervals resulting in 15,027 data points each for temperature and % relative humidity per data logger.

Pressurization of the slab resulted in reducing the radon levels to below 4.0 pCi/L. Tests ranged from 2.2 pCi/L to 3.6 pCi/L.

The maximum and minimum temperature, % relative humidity, and dew points are shown in Figure 2.

	Data Ranges			
	Basement	Bench	Closet	Outside
Max Temp	66	62	60	63
Min Temp	59	58	52	5
Max % RH	70.5	100	100	98.5
Min % RH	33.5	100	100	44
Max Dew Point	52.4	64.3	61.9	52.6
Min Dew Point	31.3	58.1	53.5	-2.6

Figure (2) Data Ranges

Pressurization did have some impact on basement temperature. While exterior temperatures ranged from a high of 63 F to a low of 5 F, basement temperatures ranged from a high of 66 F to a low of 59 F. Basement temperatures generally correlate to outside temperatures. It is felt that the closet data logger temperatures tended to be less than the other interior data logger readings because the data logger was located approximately 10 feet from the pressurization point versus approximately 20 feet for the other data logger. A graph of the basement temperature data is shown in Figure (3). Figure (4) displays the temperature comparisons of all data points.

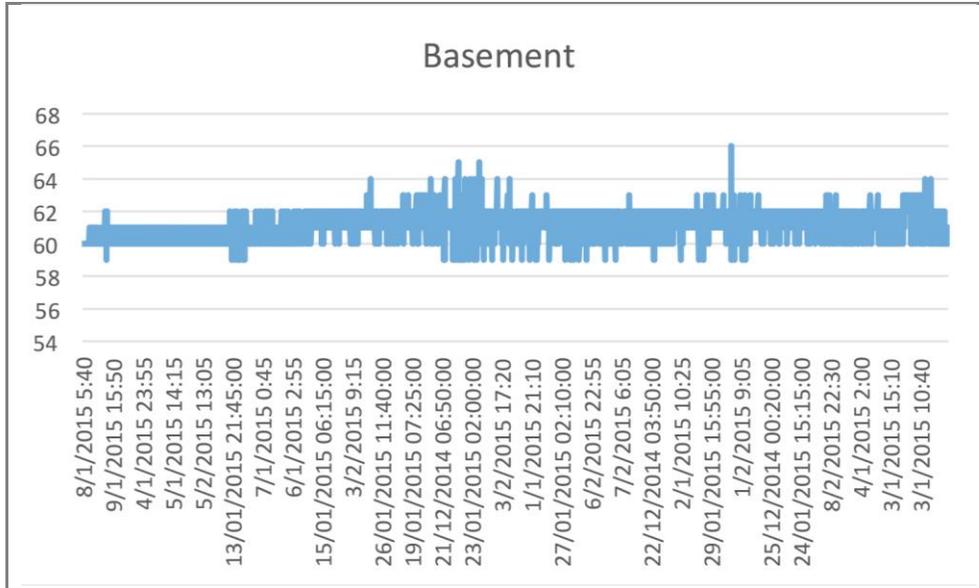


Figure (3) Basement Temperature

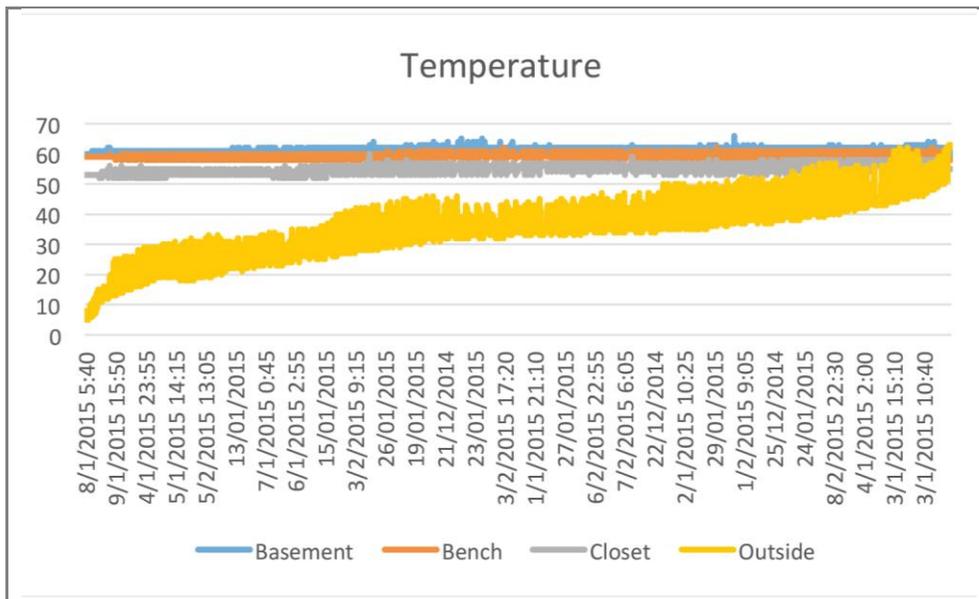


Figure (4) Temperature data

Pressurization of the subslab had a definite impact on relative humidity levels in the basement. Initially, relative humidity levels were in the 35% range. By the end of the data collection period, relative humidity levels were consistently in the 55% range. A graph of basement % relative humidity is displayed in Figure (5).

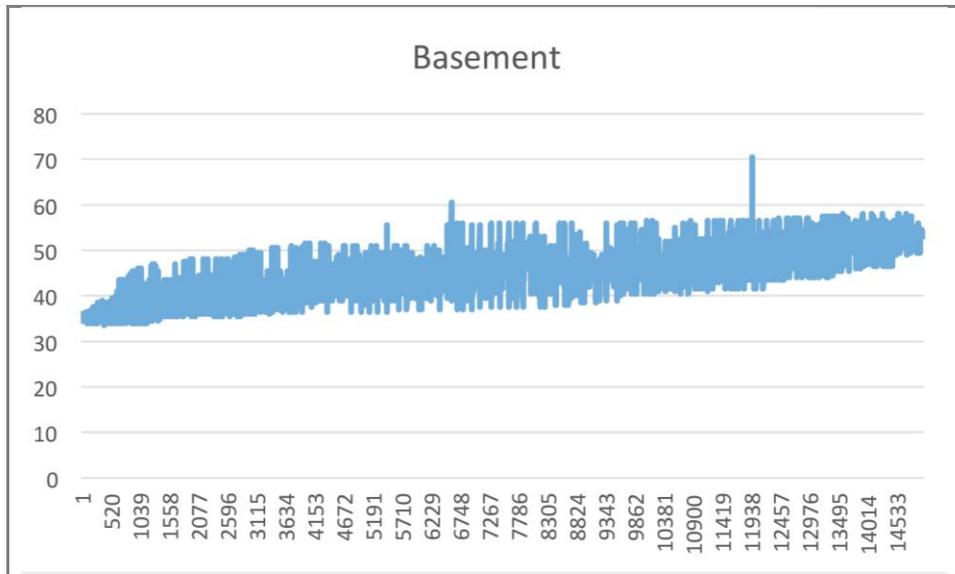


Figure (5) Basement humidity

Mitigation systems utilizing subslab depressurization over time tend to decrease the humidity level beneath the slab. In the case of pressurizing the slab, the % relative humidity at both communication test holes consistently displayed 100%. For some reason, the data loggers recorded % relative humidity at the test holes in excess of 100%. A graph showing % relative humidity in the basement, at both test holes, and in the exterior atmosphere is shown in Figure (6).

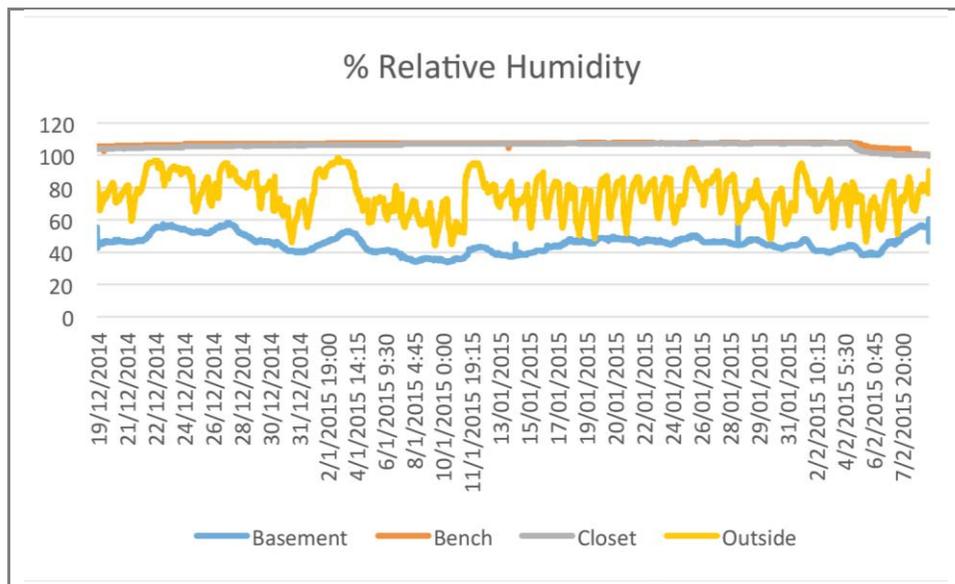


Figure (6) % Relative humidity

The data loggers also calculated dew point. At the beginning of the data collection period, dew point in the basement was 32 degrees F. As % relative humidity rose during the collection

period, dew point increased to 43 degrees F. A display of basement dew point is displayed in Figure (7) and a comparison of basement, test holes and exterior dew points is shown in Figure (8).

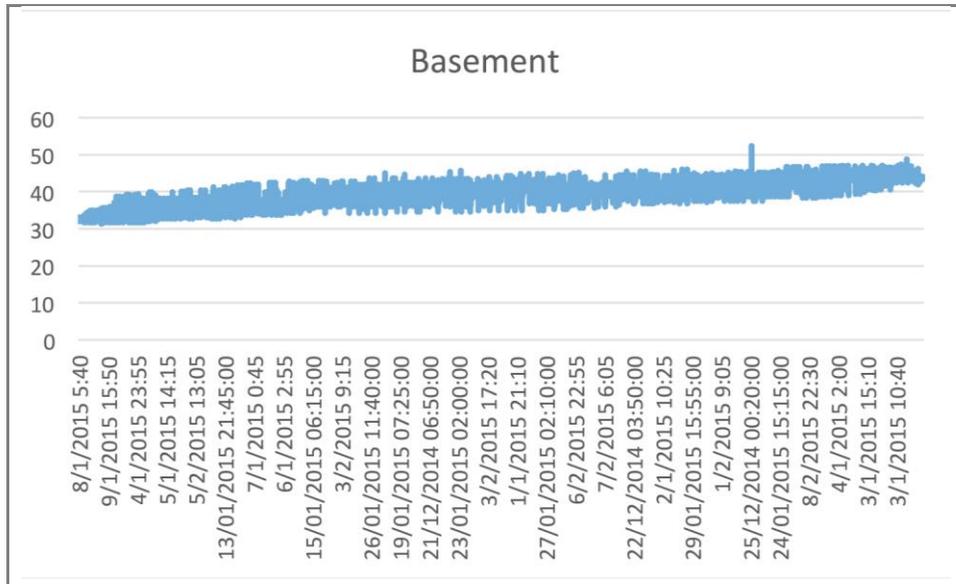


Figure (7) Basement Dew Point

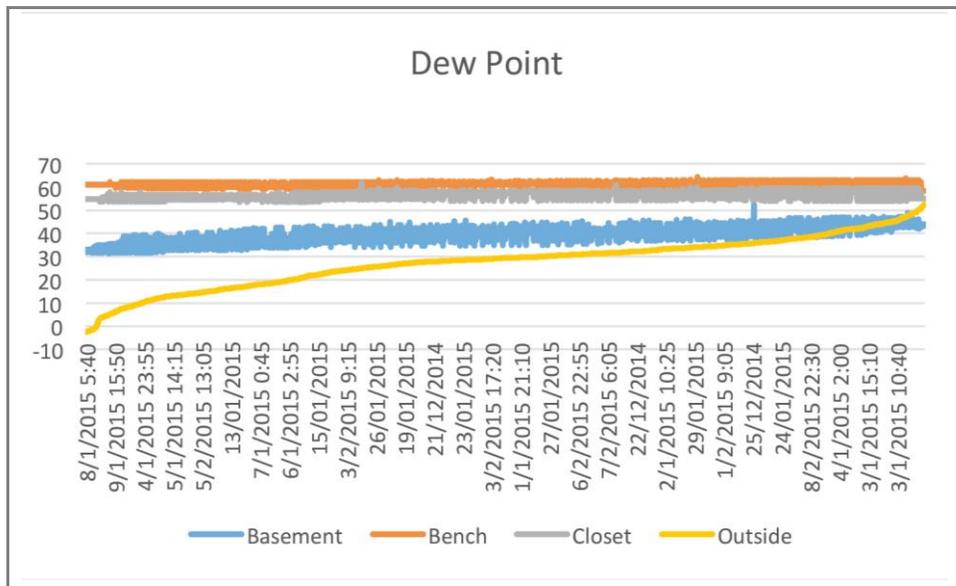


Figure (8) Dew Points At Multiple Locations

Pressurization of the slab did result in a very severe derogation for the smell of the air in the basement. The objectionable smell in the basement rendered pressurization, as a strategy, not a viable option. The interesting observation was that when the fans were reversed and the slab was depressurized, there was an immediate improvement in the smell of the air in the basement.

The radon at the house was finally mitigated by depressurizing the slab with two systems. One system has a RP 140 fan and the other has a RP145 fan. In order to obtain makeup air, the blower on the high efficiency air handler is being run continuously.

Testing using activated charcoal test kits indicated the following levels throughout the house from April 1, 2015 through April 6, 2015.

Basement	0.9 pCi/L
First floor	0.8 pCi/L
Second floor	0.6 pCi/L

Conclusion

Subslab pressurization may result in reducing radon levels to less than 4.0 pCi/L. Based on this house, pressurizing the slab will impact basement temperature and relative humidity levels in the basement will increase dramatically which may create other issues.