



**CASE STUDY: HOW THE FIRST OCCUPANT BEHAVIOR DEHUMIDIFICATION SOLUTION
 FOR APARTMENT LIVING WAS CREATED**

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ABSTRACT

This paper-presents a case study of the investigation of a typical multi-family dwelling exhibiting moisture (or high indoor air humidity) problems. This dwelling is located in the Sandhills of North Carolina, where normal outdoor humidity levels are above average.

The first stage of this investigation began with the purpose to find and fix any indoor environments where visible mold growth and elevated humidity levels were present on ground floor apartments in a multi-family community. It was from this first stage investigation and remediation process that the discovery was made that occupant behavior outside of the owner and management teams control played a major role in the relative high humidity inside the ground floor units (Unit #101 will be used a specific example below). It became the belief of the investigators that visible microbial growth and environments conducive to visible mold are created by the combination of occupant behavior, current products utilized, as well as energy and standards of construction typical of today's apartment communities (commonly referred to how "tight" they are constructed). We will briefly discuss the original, or existing, conditions that led to the the creation of an in-wall mounted dehumidifier solution (IW25-1) by Innovative Dehumidifier Systems, LLC (www.innovativedehu.com), as well as an analysis of the problems and recommendations for correction.

This specific project can be classified a wood frame constructed building with each unit individually heated and cooled by heat pump, in a hot, humid climate, and subject to the problems and design issues typical of standard apartment or multifamily construction practices, as well as those issues caused by occupant behavior. It is important to note, that all of these causes out of the control of the property owner at the time the investigation began. This case study discovered and proposes a solution to that very problem; helping property owners fix and prevent issues caused by high humidity and indoor moisture despite occupant behavior.

APARTMENT DWELLING, MULTI-FAMILY HOUSING: SOUTHERN PINES, NORTH CAROLINA

Background

The entire multi-family building consisted of 16 units, 8 on the ground floor and 8 on the second floor. Four units on the ground exhibited various moisture and indoor humidity issues, ranging from minor to major. These issues included window condensation, wet sheetrock surfaces, wet carpet/flooring, and the presence of mold. This case study broadly analyzes the entire range of issues, while specifically focusing on the one unit with the most inherent moisture and humidity problems (Unit #101). Because of the high humidity and excessive moisture, Unit #101 was plagued by sweating windows, musty odors, and poor air quality with the elevated humidity levels.



Unit #101 was a ground floor unit that was north facing and located very near a wooded area, which prevented the unit from being exposed to direct sunlight for more than just 4 to 5 hours a day. At the time of our inspection of this multi-family complex, Unit #101 had the highest Relative Humidity (RH) readings, ranging from 75.8% to in excess of 90%. For visible mold growth to occur an elevated relative humidity, typically higher than 60%, needs to be present.



On top of the issues already discussed, the occupant of Unit #101 did not properly operate the air conditioning during the summer months (AC set to 80 degrees), kept the blinds closed on all windows preventing direct sunlight exposure inside the dwelling, did a lot of cooking (boiling water/liquids), and other behaviors that assisted in creating an environment conducive to high humidity and visible mold growth. The humidity level climbed to levels that made daily living uncomfortable, saturating furniture, window coverings, floor coverings, clothes and even the walls themselves.

The owner and property management team attempted to consult with the residents of the apartments to discuss proper use of HVAC and a portable dehumidifier to ensure these issues did not continue. Upon regular checks the property owner and management staff recognized the residents were not willing to follow these guidelines and concluded that occupant participation could not be part of a sustained solution to high indoor humidity. The rationale that was received by the occupants in most cases ranged from not wanting to empty the water, to the noise, or the amount of electricity they felt the portable dehumidifier used. In most similar scenarios, management found the portable dehumidifiers stored in a closet and not operating during their inspections.



STAGE ONE:

Ensuring Outside Environment Wasn't Responsible & Typical Mold Remediation Practices

The owner's initial belief was that high indoor humidity was caused by construction installation issues or voids in the exterior that allowed for the outside humidity to penetrate the indoor environment of the ground floor units. They investigated and repaired any issues with the current window installation, as well as following a detailed plan to ensure voids allowing the outside environment to cause the issue were eliminated. This plan consisted of the removal of siding, addressing any issues existing with the window taping details and commercial water & air barrier / "house wrap", penetration sealing, changing a rowlock flashing detail, etc.

STAGE TWO:

Creating a Sustained Solution for High Indoor Humidity Caused by Occupant Behavior

Several weeks after this scope of work and initial remediation were completed, a reoccurrence of the issues inside the apartment (sweating windows, musty odors, and visible mold growth) was observed. It was in these observations and research that they found elevated indoor relative humidity, (and thus the negative effects caused by high humidity such as musty odors, poor air quality, mold growth, and condensation) is becoming a more common characteristic inside apartments. This is due to increasing construction standards, progressive energy code requirements that result in a much "tighter" indoor environment with respect to air movement, other miscellaneous construction items (ex: short cycling HVAC units based on sizing), and occupant behavior.

The hypothesis for the subject property was that the elevated indoor relative humidity was not caused by construction methods, but by the current construction standards combined with specific occupant behaviors. It was concluded that if there was a way to control the relative humidity regardless of how the occupant lived inside the property the resulting problems would diminish, if not disappear.



Innovative Dehumidifier Systems & IW25-1 Dehumidifier

It was at this point that a search began for an appropriate stand-alone dehumidifier with certain requirements:

- Appropriate capacity for typical sized apartments (not too large or too small)
- Ability to measure current relative humidity and run only when needed
- Ability to be drained into existing plumbing
- Ability to be hardwired or plugged into 110V outlet
- Offer simple and affordable installation methods into a standard stud cavity
- Quiet operation
- Relatively tamper proof by occupants
- Applicable in both new construction and retro-fit applications

Unable to buy what met the specific needs of the Southern Pines project (and the needs of other multifamily complexes just like it), the conversations for the design and manufacturing of the IW25-1 Dehumidifier began. The purpose of Innovative Dehumidifier Systems, LLC was to create a dehumidifier solution that not only met these specifics but also allowed the relative humidity inside an apartment to be controlled by the owner, thus eliminating or greatly reducing the impact of occupant behavior.

Our analysis indicated the property owner needed a solution that combated the occupant's behavior, without the occupant being required to change those behaviors or assist in the solution. For this case study the first prototype of the IW25-1 Dehumidifier was created to address each of the items listed above with the following features:

IW25-1 Features Include:

- Mounted in-wall
 - Designed to fit within 16" O.C stud spacing
 - Installs easily for new construction or retro-fit applications
- Sound levels less than 47 Dba
- ETL listed
- Uses R134A Refrigerant
- Plastic grill w/ metal chassis
 - Tamper proof grill screws
 - On/Off switch & humidity control behind the grill
 - Built-in digital humidistat
- Re-usable & washable filter
- Automatic restart (in the event of power failure)
- Easily hard wired or plugged into outlet (depending on application)
 - 10' removable chord
- Drains directly to plumbing
 - 10' removable condensate hose
 - Easily connected to hub drain, hard pipe or to a drain (depending on application)

Conclusions, Results & Recommendations

The prototype unit was installed in unit #101 and monitored for a 18 month period by the owner, management staff, and Innovative Dehumidifier Systems representatives. If the prototype achieved the desired results additional units were to be created and installed in the remaining impacted ground floor apartments.

After the prototype was installed relative humidity and moisture readings were taken inside the apartment on a weekly basis or bi-weekly basis. Relative humidity readings in every visit ranged from 41 – 50% RH, well below the 60% RH noted as the environment which encourages visible mold growth.

In addition to the test results, regular discussions with the owner and management / maintenance staff for the apartment community occurred. What was determined is that the prototype did have the intended results from controlling the relative humidity and therefore met the need. Each of the targeted improvements to the dehumidifier solutions available commercially prior to the-prototype, as it pertained to apartments specifically, had been achieved satisfactorily. In addition, to the owner and maintenance staff the occupant of the apartment also noted more satisfaction with the overall humidity and air quality inside the apartment, and noticeable impact on the power bill for the dwelling.

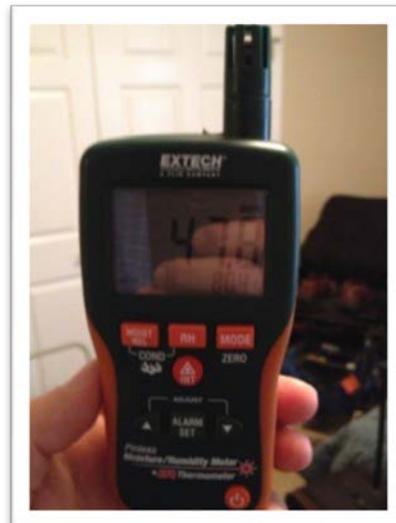
The apartment community owner determined that all of the ground floor units in the subject apartment community required an IW25-1 to be installed. In addition, additional communities owned by the developer were requested to have dehumidifiers installed in both due to similar needs or as proactive method. Currently, the subject prototype has been installed in the apartment in similar relative humidity conditions as our test period indicated for over two years. The results have remained the same as the indoor relative humidity has been stabilized within the recommended range.

This trial, and the experience and knowledge gained, directly resulted in Innovative Dehumidifier Systems, LLC creating and offering the IW25-1 to apartment communities and others with the need to independently control humidity in living spaces.

Relative Humidity Conditions after installation



Kitchen 46.0% RH



Rear Bedroom 47.8% RH



Sample Reading Results Period
(7 months of IW25-1 operations observation)

Humidity/Temperature Log

Apt #: 101

Date	Temperature	Humidity	Notes
6/23			Installed dehum.
6/30	-	-	Dehu. working fine, checked filter
-	-	-	Tenant states "it feels better"
7/5			_____ stopped by and checked, all working fine
7/12	81 / 91 outside	46% / 82% ^{outside}	_____ stopped by. All working fine
7/18	76 / 83 outside	41% / 78% ^{outside}	checked filter all is well
7/27	80.7 / 91.6 out	50% / 54 outside	
8/9	78.9 / 93.2	47.2 / 59%	
8/23	79 / 87	46.3 / 74%	
9/8	76 / 90	47.2 / 71%	
9/22	74 / 79	44.1 / 48%	
10/11	78 / 76	45 / 52	
10/20	77 / 70	46.1 / 58	
11/1	75 / 60	47 / 62	
11/23	73 / 56	46.3 / 54	
12/13	72.5 / 52	46.7 / 63	
12/28	76 / 50	46.5 / 59	
1/17	75 / 55	46 / 32	
1/31	76 / 67	45.3 / 47	

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