Chinese Wallboard – The Corrosion Challenges

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1

DRYWALL CAN BE A SOURCE OF CORROSION

- DRYWALL IS A PAPER COATED PRODUCT COMPOSED PRIMARILY OF PARTIALLY HYDRATED GYPSUM (CaSO$_4$·½ H$_2$O)
- GYPSUM (IN ANY HYDRATION STATE) IS NOT, IN GENERAL, A MATERIAL CORROSIVE TO METALS
- RAW GYPSUM COMES DIRECTLY (OR IN THE CASE OF FLUE GAS DESULFURIZATION PRODUCT, INDIRECTLY) FROM MINES
- MINED PRODUCTS CONTAIN IMPURITIES
- SOME IMPORTED DRYWALL PRODUCTS CONTAIN IMPURITIES THAT EVOLVE SULFUR-CONTAINING SPECIES RESPONSIBLE FOR CORROSION OF METALLIC COMPONENTS IN HOMES

CORROSION CAN TAKE A NUMBER OF DIFFERENT FORMS INCLUDING:

- SCALE BUILD-UP INVOLVING
  - DIMENSIONAL CHANGES
  - SPALLING (FLAKING)
  - MATERIAL LOSS
- PITTING
- INTERGRANULAR ATTACK
AN AIR CONDITIONER UNIT WITH COOLING COILS TAKEN FROM A HOME WITH DRYWALL FROM CHINA IS SHOWN HERE WITH BLACK DEPOSITS/CORROSION ON THE COPPER COILS
COPPER COILS FROM AC UNIT

AS-RECEIVED

AFTER ACID ETCHING TO REMOVE CORROSION SCALE - NOTE EXTENSIVE PITTING
ENERGY DISPERSIVE X-RAY SPECTRA FROM THE COPPER TUBING SHOWN

TOP – COPPER SULFIDE

MIDDLE – MIXED COPPER OXYGEN/SULFUR PRODUCTS

BOTTOM – COPPER OXIDES (PRIMARILY)
TUBING FIELD SAMPLES

POLISHED CROSS SECTIONS FROM AIR CONDITIONING UNIT COPPER TUBING (OPTICAL AND SEM MICROGRAPHS)

NOTE ENERGY DISPERSIVE X-RAY SPECTRUM SHOWING SULFUR IN THE PITS
TEST SAMPLES

COPPER TUBE EXPOSED TO CHINESE DRYWALL

COPPER TUBE EXPOSED TO DOMESTIC DRYWALL
TEST SAMPLES

LEFT – AS RECEIVED TUBE SURFACE (CHINESE DRYWALL)
NOTE MIXED COPPER OXIDE/SULFIDE (SULFATE?) CORROSION PRODUCTS

RIGHT AS-RECEIVED TUBE SURFACE (DOMESTIC DRYWALL)
NOTE LACK OF CORROSION

LEFT – ACID ETCHED TUBE AFTER EXPOSURE TO CHINESE DRYWALL
NOTE PITTING

RIGHT – ACID ETCHED TUBE AFTER EXPOSURE TO DOMESTIC DRYWALL
NO SIGNIFICANT PITTING
COPPER FOIL TEST SPECIMEN EXPOSED TO CHINESE DRYWALL

TAPE LIFT REMOVAL OF COPPER SULFIDE CRYSTALS FROM THE FOIL SURFACE

FOIL SURFACE WITH COPPER SULFIDE CRYSTALS AND PITS SHOWING SULFUR WHEN ANALYZED
TUBING CONCLUSIONS:

- CHINESE DRYWALL EXAMINED WAS CAPABLE OF PROMOTING SULFUR INDUCED CORROSION
- CORROSION PRODUCTS WERE COMPLEX INCLUDING SULFIDES, OXIDES AND, PROBABLY, SULFATES/SULFITES ALONG WITH POTENTIALLY HYDRATED VERSIONS OF THESE PRODUCTS
- CORROSION PRODUCT INCLUDED SCALE AND EXTENSIVE PITTING
- PITTING PRESENTS POSSIBLE/PROBABLE LEAKAGE FAILURES IN TUBES
- DOMESTIC DRYWALL EXAMINED DID NOT PROMOTE SIMILAR CORROSION
OPTICAL MICROGRAPHS OF FIELD SAMPLE ELECTRICAL COMPONENTS REMOVED FROM A HOME WITH CHINESE DRYWALL
NOTE BLACKENED CORROSION PRODUCT
SECTION OF COPPER WIRE WITH ENERGY DISPERSIVE X-RAY SPECTRA FROM THE THREE ANNOTATED AREAS SHOWING A GENERAL COPPER SULFIDE ON THE WIRE SURFACE

CORROSION FLAKES REMOVED (TAPE LIFT) FROM THE BRASS CONTACT

NOTE THE MIXED COPPER SULFUR/OXYGEN COMPOSITION
COPPER WIRE WITH DOMESTIC DRYWALL EXPOSURE (NO SULFUR EMISSIONS)

UNDER TYPICAL HOME CONDITIONS, A THIN CORROSION RESISTANT COPPER OXIDE PASSIVATION FILM FORMS
MIXED COPPER SULFUR OXYGEN-SULFUR CORROSION PRODUCT BUILD-UP ON BRASS ELECTRICAL CONTACTS REMOVED FROM HOME WITH CHINESE DRYWALL EXPOSURE
ELECTRICAL COMPONENT CONCLUSIONS

- CHINESE DRYWALL EXAMINED WAS CAPABLE OF PROMOTING SULFUR INDUCED CORROSION ON COPPER AND BRASS ELECTRICAL COMPONENTS
- CORROSION PRODUCTS WERE COMPLEX INCLUDING SULFIDES, OXIDES AND, PROBABLY, SULFATES/SULFITES ALONG WITH POTENTIALLY HYDRATED VERSIONS OF THESE PRODUCTS
- CORROSION SCALE PRESENTS POSSIBLE/PROBABLE CHANGES IN ELECTRICAL CONTACT PROPERTIES
- DOMESTIC DRYWALL EXAMINED DID NOT PROMOTE SIMILAR CORROSION
OVERALL CONCLUSIONS:

- EXPOSURE OF COPPER-BASED COMPONENTS TO SOME CHINESE DRYWALL PRODUCTS RESULTS IN CORROSION SCALE GROWTH AND PITTING FAR IN EXCESS OF ANY SUCH CORROSION PROMOTED BY TYPICAL DOMESTIC DRYWALL

DISCUSSION:

- THE CORROSION PRODUCTS ENCOUNTERED WERE COMPLEX MIXTURES OF SULFIDES, OXIDES, SULFATES, ETC.
- LITERATURE SUGGESTS THAT CORROSION PRODUCTS FORMED ON METALS IN THE PRESENCE OF COPPER, SULFUR, OXYGEN AND MOISTURE FORM COMPLEX CORROSION PRODUCTS THAT VARY IN COMPOSITION DEPENDING ON WHERE THE PRODUCTS FORM (e.g., IN PITS, ON THE EXPOSED SURFACE, WITHIN POROUS CORROSION PRODUCT PREVIOUSLY FORMED, ETC.)
- THE PRESENCE OF SULFUR/SULFIDES (LIKE CHLORIDES) ACT AS AN AGENT TO PREVENT THE FORMATION OF PASSIVATING OXIDE LAYERS AND THEREBY PROMOTE CONTINUED CORROSION
- IT MAY BE THAT THE PRESENCE OF SULFUR/SULFIDES (LIKE CHLORIDES) ACT AS A AUTOCATALYST PROMOTING CONTINUED CORROSION EVEN WHEN THE INITIAL SOURCE OF SULFUR HAS BEEN REMOVED

SUGGESTED REFERENCES:


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