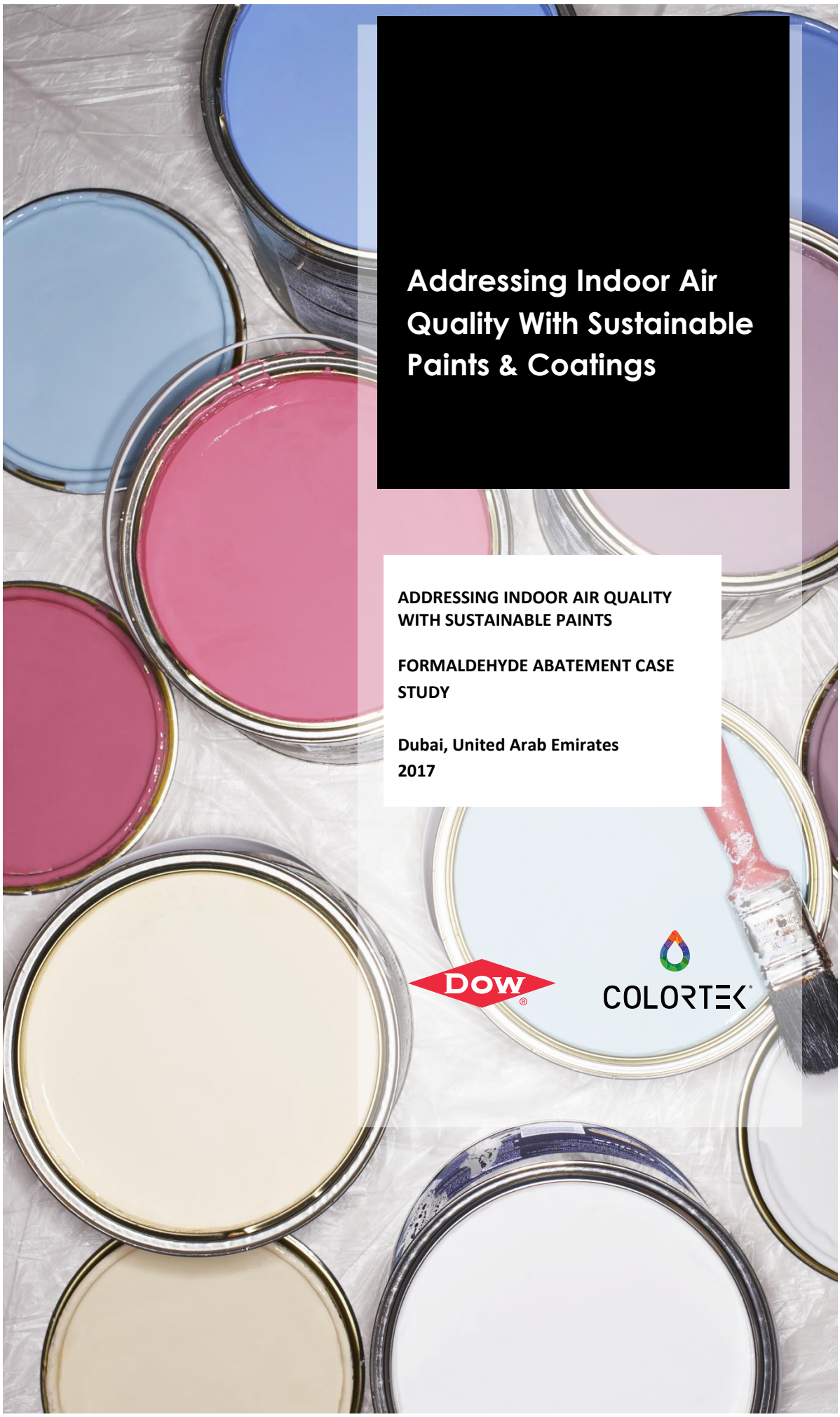

Addressing Indoor Air Quality With Sustainable Paints & Coatings

ADDRESSING INDOOR AIR QUALITY WITH SUSTAINABLE PAINTS

FORMALDEHYDE ABATEMENT CASE STUDY

Dubai, United Arab Emirates
2017

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EXECUTIVE SUMMARY

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. Understanding and controlling common pollutants indoors can help reduce your risk of indoor health concerns. [Environmental Protection Agency, 2017]

The study presented hereafter revolves around actively reducing major indoor air pollutants known as Volatile Organic Compounds ("VOCs"), through advanced paint systems. There is a wide range of VOCs emitted as gases from certain solid or liquid materials; these materials can be natural or artificial. Critical pollutants are often man-made VOCs. One of the most prevalent and most dangerous VOCs is formaldehyde, a known carcinogen (IARC Class 1), which primarily affects people with weak immunity systems and/or with breathing problems.

The Dow Chemical Company (hereafter "Dow"), and as part of Dow's ongoing commitment to innovations that support more sustainable solutions, introduced "FORMASHIELD™" Polymers as a novel technology used as a backbone of water based paint which enable active reduction of formaldehyde from indoor air, hence creating a healthier building environment.

FORMASHIELD™ Technology has been successfully applied in a local college located in Dubai, United Arab Emirates with Dow's partner, COLORTEK®[1]. COLORTEK®[1] is one of the leading paint manufacturers in the region with a proven track record for sustainability and green building solutions commitments. This paper gives a close and in-depth real life analysis of the paint functionality, under Respisafe®[2]brand from COLORTEK®[1], where it proves paint effectiveness in actively abating formaldehyde in classrooms' indoor air.

Respisafe®[2] is a brand from COLORTEK®[1] https://www.colortek.eu/

INDOOR AIR QUALITY ("IAQ")

In indoor environments, different indoor sources of pollutants that release gases or particles into the air are the primary cause of indoor air quality problems. Inadequate ventilation can increase indoor air pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area. High temperature and humidity levels can also increase concentrations of some pollutants.

While air is essential for life, its purity is far from guaranteed. Outdoors the dangers are obvious – billowing smoke from chimneys, exhaust from automobiles, and the smog settling over cities all remind us that our air quality is being compromised.

Indoors however, the dangers are less obvious and few realize that indoor air can be up to 10 times as much polluted as outdoor air with impurities that can build to levels high enough to affect our health, the quality of our lives and the condition of the very homes we live in. This indoor air pollution is in part due to dangerous airborne chemicals called VOCs (abbreviation of Volatile Organic Compounds) that once inhaled cause a range of harmful health effects. Formaldehyde, a known carcinogenic chemical widely released from many products found in the home or by common household activities is one of the most common VOCs and as people spend 80% of their time in closed environments, there is a growing concern about formaldehyde buildup in our buildings and on its impact on our health.

Globally, more and more awareness and regulations are in place to adopt environmentally preferably paints by mandating VOCs content limits and VOCs emissions in indoor air. In some countries, regulatory and environmental agencies are closely monitoring the adoption and implementation of these regulations.

IAQ – Volatile Organic Compounds: Formaldehyde Sources & Exposure Risks

Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. It is also a by-product of combustion and certain other natural processes. [Environmental Protection Agency, 2017]

Sources of formaldehyde in the environment include, not limited to: manufactured wood products such as furniture, laminate flooring, cigarettes smoke, household products such as paints, detergents, etc. Everyone is exposed to small amounts of formaldehyde in the air. Exposure to low levels of formaldehyde can cause eyes, nose, throat or skin irritation. Higher levels of exposure may cause respiratory symptoms and some

types of cancers. People who may be sensitive to the effects of formaldehyde are the very young (infants, kids), the very old, and people with asthma and other breathing problems (refer figure 1).

Figure 1. Sources of Formaldehyde

IAQ – Volatile Organic Compounds: Low VOC Interior Paints & Coatings

In paints and coatings, VOCs are used as solvents or thinners that work with the resin — the part that binds together all the ingredients of the paint and sticks them onto the wall or surface — to achieve excellent performance and durability. These organic solvents facilitate the paint's application, drying, and the formation of a regular paint film. [*American Coating Association, 2017]*

Today's consumer paints and coatings preferences are shifted towards more environmentally friendly – low VOC- water based paint. These paints are having similar, if not better, performance than solvent borne, also known as "oil based" paints, particularly in the architectural coatings market, while complying with VOC limits mandated by local and regional regulatory authorities. Environmentally friendly paints on the market are specifically important for use around sensitive populations, such as in nurseries, schools and hospitals.

IAQ – Volatile Organic Compounds: Formaldehyde Abatement Paint

Using "low VOC" building materials, in particular paints and coatings, constitute a first preventative step for enhancing IAQ. These materials fall under controlled sources of VOCs. On the other hand, there are uncontrolled sources of VOCs which can pollute indoor air (i.e. air circulation systems).
Consequently, new market trends are merging and are geared more and more towards the need of smart solutions that can actively reduce VOC concentration in closed spaces, in particular for paints and coatings. Hence the classification of "Active Smart Paint" solutions.

Sustainable and environmentally friendly systems would constitute one aspect of the equation and should be complemented by additional active functionalities in the paint system. Smart Paints are paints that actively reduce certain types of VOCs via specific innovative functionalities. Dow's FORMASHIELD™ Polymers are a leading technology that serves as a backbone of a paint, and abates certain types of VOCs, specifically formaldehyde. Thus the designation "formaldehyde abatement paint".

Respisafe®2 is a brand from COLORTEK®1 https://www.colortek.eu/

THE CASE STUDY

Study Scope

Dow, in collaboration with COLORTEK®[1], conducted a large-scale real life demonstration for the FORMASHIELD™ Technology within a college campus premises located in Dubai, United Arab Emirates. Core Objectives of this study was to evaluate in a non-controlled environment the effectiveness of formaldehyde abatement paint, Respisafe™ from COLORTEK®[1] via real life measurements and close monitoring.

Measurement Schedule

1. **Area to be painted:**
   - **Two Floors area consisting of 1 AC Unit**
   - **Ground Floor - Tested area parameters:**
     - **Total area painted exc. ceilings: 1,220 sqm**
     - **Number of rooms (excluding corridors): 5**
     - **Volume (2.5m ceiling height): 3,050 m3**
     - **Traffic type: Medium to high traffic rooms**
   - **First Floor - Tested area parameters:**
     - **Total area painted exc. ceilings: 1,160 sqm**
     - **Number of rooms (excluding corridors): 10**
     - **Volume (2.5m ceiling height): 2,900 m3**
     - **Traffic type: Medium to high traffic rooms**

2. **Possible sources of formaldehyde:**
   - **Enamel skirting**
   - **Vinyl glue on the walls bottom**
   - **Tables and Chairs**
   - **Wooden Doors**
   - **False Ceiling**
   - **Lab equipment & tools**

3. **Measurement Tool**
   - **Formaldemeter- htV from PPM Technology**
   - **Type: interchangeable digital CMOSens®[3].**

CMOSens®[3]is a brand from Sensirion www.sensirion.com

Respisafe®[2] is a brand from COLORTEK®[1] https://www.colortek.eu/

- **Range: -40 to + 128 °C, 0-100%RH**
- **Target Gas: Formaldehyde (HCHO) in air**
- **Response Time: 60 seconds in high accuracy mode**
- **Range: 0 – 10 ppm as standard**
- **Resolution: 0.001 ppm**

4. **Measurement Process**
   - **Two random rooms measurements per floor**
   - **Two measurements per day: 8am and 4pm**
   - **Corridor HCHO was measured once daily**
   - **Duration: 3 weeks**

5. **Measurement Results**

   Formaldehyde concentration was reduced by around 40% within non-controlled environment

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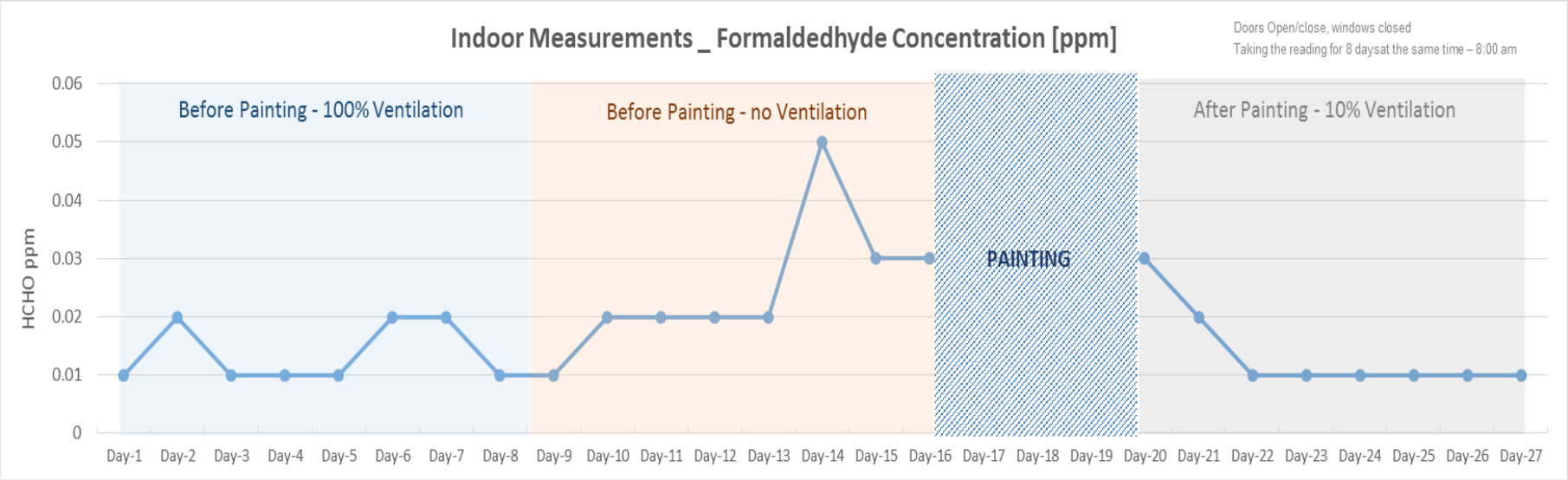

Source: Real life Measurements, 2017

Appendix I

About Dow

The Dow Chemical Company (Dow) combines science and technology knowledge to develop premier materials science solutions that are essential to human progress. Dow has one of the strongest and broadest toolkits in the industry, with robust technology, asset integration, scale and competitive capabilities that enable it to address complex global issues. Dow's market-driven, industry-leading portfolio of advanced materials, industrial intermediates, and plastics businesses deliver a broad range of differentiated technology-based products and solutions for customers in high-growth markets such as packaging, infrastructure, and consumer care. Dow is a subsidiary of DowDuPont (NYSE: DWDP), a holding company comprised of Dow and DuPont with the intent to form three strong, independent, publicly traded companies in agriculture, materials science and specialty sectors. More information can be found at www.dow.com.

Dow FORMASHIELD™ Technology

http://coatings.dow.com/en/products/formashield

Appendix II

About COLORTEK®

Respisafe®2 is a brand from COLORTEK®1 https://www.colortek.eu/

About COLORTEK®

COLORTEK® is an international producer of decorative, architectural and industrial coatings with a franchised retail concept conceived as a designer space where customers can browse through a wide selection of wall and floor coating solutions within an inviting and clearly organized space.

Technologically advanced and sustainable products, manufactured following international safety and performance standards coupled with an extensive know-how in the sales and application of architectural, decorative and technical coatings place COLORTEK® at the forefront of the wall and floor finishes industry, allowing it to develop into a fast-growing paints brand with a retail network present in Morocco, KSA, Egypt, United Arab Emirates, Qatar, Bahrain, Lebanon and France.

Respisafe™

Respisafe™ is a smart paint specifically developed in response to growing concern over the health effects of formaldehyde exposure in homes, schools and other indoor settings. It contains anti-formaldehyde technology that reacts with dangerous chemical present in the air, capturing formaldehyde and transforming it to harmless vapor. As such, Respisafe effectively clean the air we are breathing indoor just like a tree would clean the oxygen outside. Going beyond safety, Respisafe™ combines formaldehyde abetment with high-performance technologies such as burnish resistance, crack-bridging, stain-resistance and anti-bacterial properties to produce a revolutionary 5 in 1 coating that can make you rethink what paint can do for your interiors and your health without compromise on color selection.

Respisafe®[2] is a brand from COLORTEK®[1] https://www.colortek.eu/

Disclaimer

Real-life testing of the formaldehyde abatement technology is complex. There are many factors to be controlled and many variables that may be hidden. The cases and results reported herein are based on local causes, conditions, circumstances and assumptions. These are subject to normal experimental variability and errors. Should these facts, circumstances or assumptions be different, the results might be different. Thus, while this information is provided in good faith, no representations or warranties are made by The Dow Chemical Company or Colortek with regards to its completeness, accuracy or applicability beyond the local conditions and situations herein. No liability will be accepted for damages of any nature whatsoever resulting from the use of or reliance on the information.