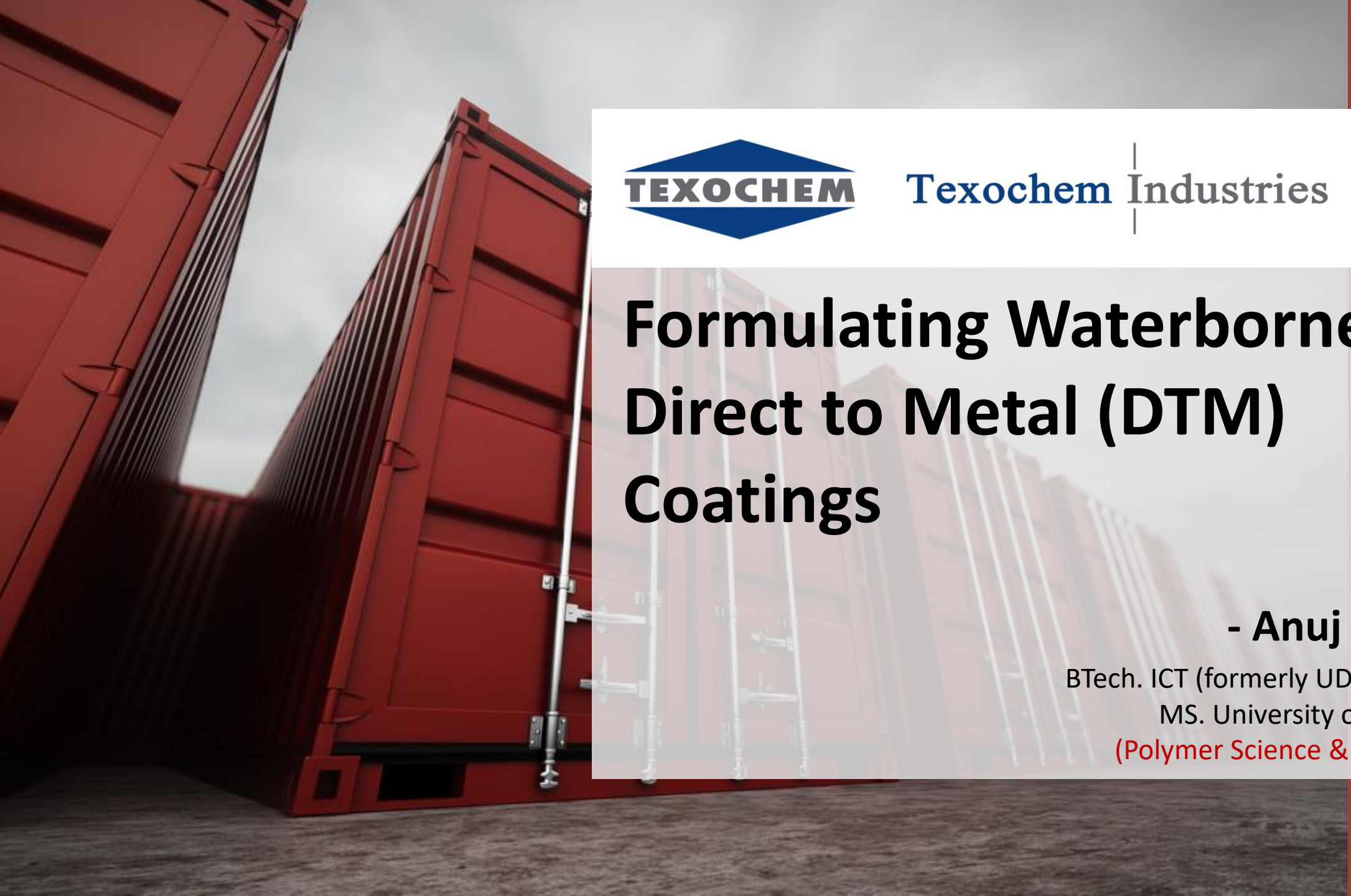


Texochem Industries

Formulating Waterborne Direct to Metal (DTM) Coatings

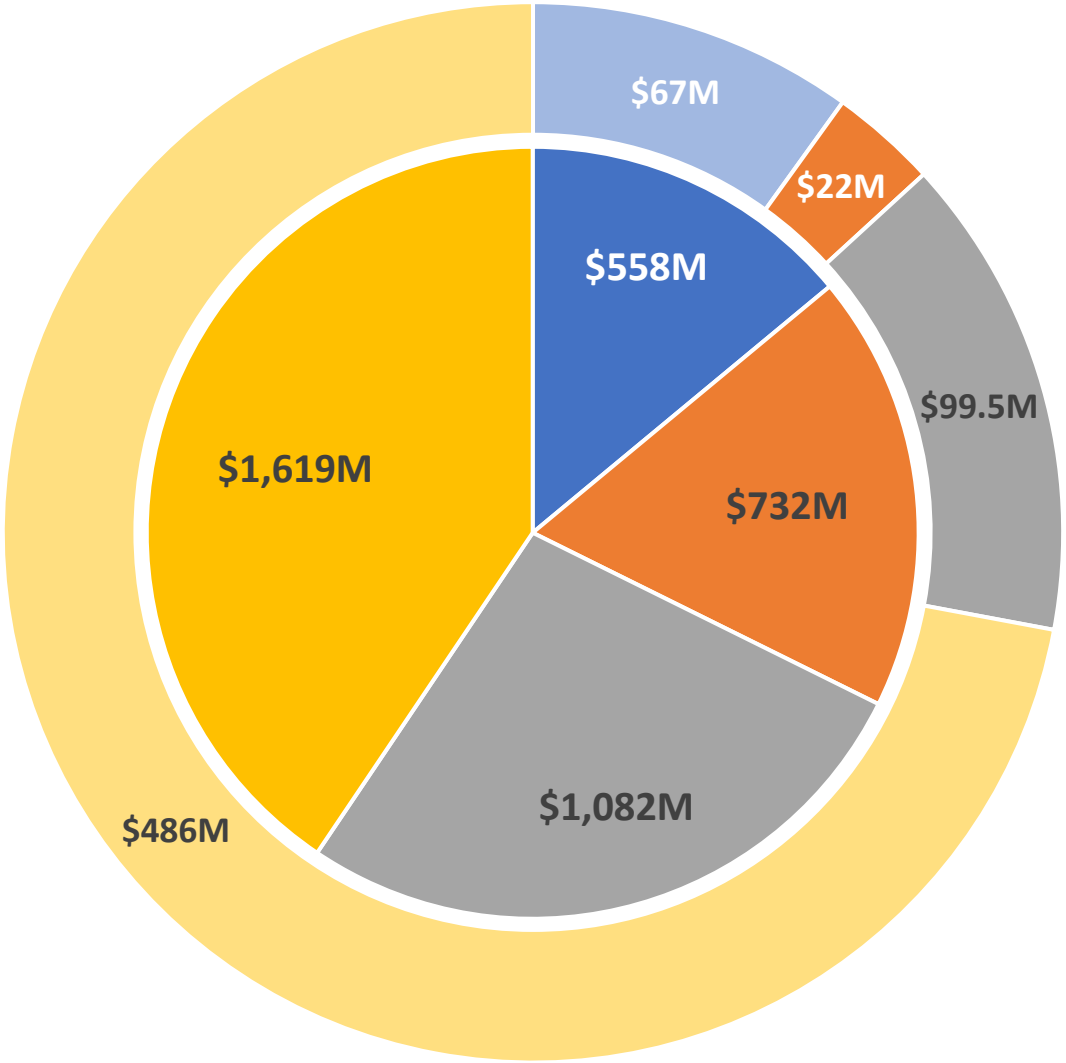
- Anuj Agrawal

BTech. ICT (formerly UDCT), Mumbai

MS. University of Akron, USA

(Polymer Science & Engineering)

Trends Impacting Waterborne DTM Innovation



- Metal Packaging
- Coil
- General Metal
- Industrial Maintenance

Inner Chart
Total Coatings Market

Outer Chart
Waterborne Coatings Market

Ref: 1

Trends Impacting Waterborne DTM Innovation

Get your Paint IGBC Certified

Shri Narendra Modi,
Hon'ble Prime Minister of India

Shared Message in the IGBC Publication
Green Built Environment

प्रधान मंत्री
Prime Minister

MESSAGE

It is a pleasure to learn that Indian Green Building Council (IGBC) is bringing out Volume IV of its Coffee Table Book series on the occasion of the online 18th Green Building Congress. The title of the Coffee Table Book - 'Green Built-Environment-Champions Redefining India's Sustainability Landscape' encapsulates India's comprehensive efforts in this realm.

Sustainable practices and lifestyle have always been an integral part of our socio-cultural setting. Our Government's policies and measures have been carrying forward such rich traditions.

India does not choose between environment and development. We firmly believe these two are not contrary but complementary to each other, and together make development process holistic, sustainable and resilient.

With green built environment as an underlying basis, we are striving to enhance our construction capabilities for affordable housing and building houses as per varied geographical conditions of different parts of the country.

We remain firmly committed to enhance the quality of our technological and infrastructural landscape, amalgamating them with the best sustainable designs and practices into the construction of buildings.

The construction of 'Green buildings' with the vision of 'Net Zero Energy' is the one India accords top priority. Our efforts towards energy efficiency through utilisation of solar energy, natural lighting, water recycling and water harvesting have been making a positive impact on the people's health and wellness as well as the environment.

The role of institutions such as IGBC in the construction and certification of 'Green Buildings', at par with global standards, acquires a critical importance in reducing our carbon footprint.

I am sure that the Coffee Table Book being published will share the best practices and experiences in the field of sustainable built-environment.

May the online 18th Building Congress and the publication being brought out be a huge success.

(Narendra Modi)

New Delhi
कार्तिक 05, शक संवत्, 1942
27th October, 2020

Shri Sameer Sinha
Chairman, IGBC Coffee Table Book &
IGBC Ahmedabad Chapter

Narendra Modi Stadium, Ahmedabad
IGBC Platinum

GIFT City, Gujarat
IGBC Green Cities Platinum

Dr. B. R. Ambedkar Telangana State Secretariat
IGBC Green New Building Gold

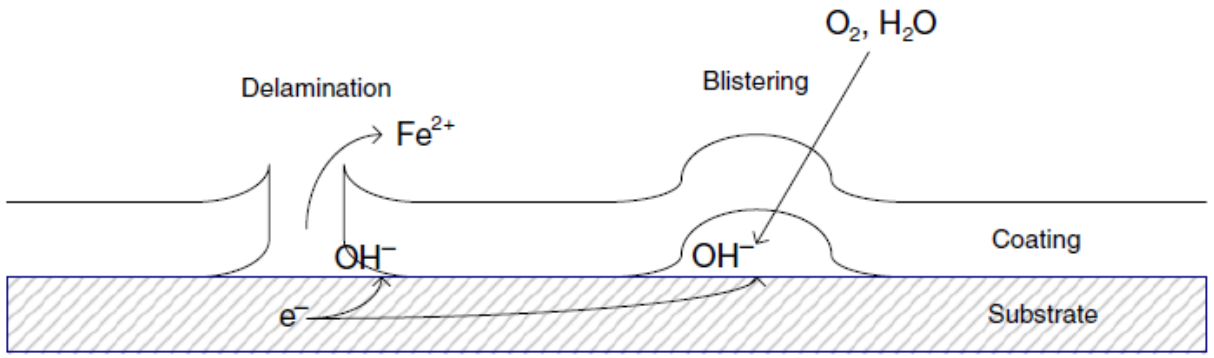
Ref: 2

Focus Areas for DTM Technologies

ISO 12944 Classification	Corrosiveness of atmosphere	Typical Environment
C1	**Negligible**	Air-conditioned rooms with low humidity
C2	**Low**	Dry climate with cold conditions
C3	**Moderate**	Moderate climate and moderate pollution
C4	**Heavy**	Sites with frequent condensation such as swimming pools
C5-M	**Very Heavy**	Marine and coastal areas with high salt content
C5-I		Industrial with high solid particles in air

Ref: 3

Coating Defects in DTM Applications

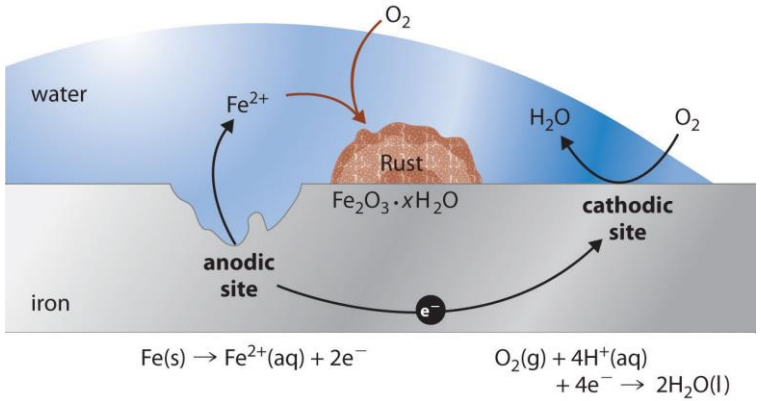


Delamination occurs when water molecules penetrate inside, disrupting the attractive force between the substrate and coating.

Blistering of coatings can be attributed to expansion due to swelling, gas inclusion, and osmotic processes.

Corrosion occurs when the coating has:

- Poor moisture and water resistance
- Soft surface prone to abrasion




Delamination


Blistering


Corrosion

Ref: 4,5,6

Analyzing Waterborne (WB) DTM Coatings

Advantages

- Water used as thinner and for cleaning
- Low VOC and environment friendly
- Low odor
- Good chemical resistance
- Fast recoating times
- Low dirt pickup
- High degree of flexibility
- Low flammability

Disadvantages

- Flash Rust
- Expensive raw materials
- Influence of RH on evaporation of water
- Unable to endure freeze thaw cycles
- Prone to edge marks
- Short open time
- Foaming
- Fungus and bacteria attack

Formulating WB-DTM Coatings

1. Binder/Emulsion

- Provides adhesion to metal
- Typically, self crosslinking and Tg > 20C
- Provide water and alkali resistance

2. Coalescent/ Co-solvents

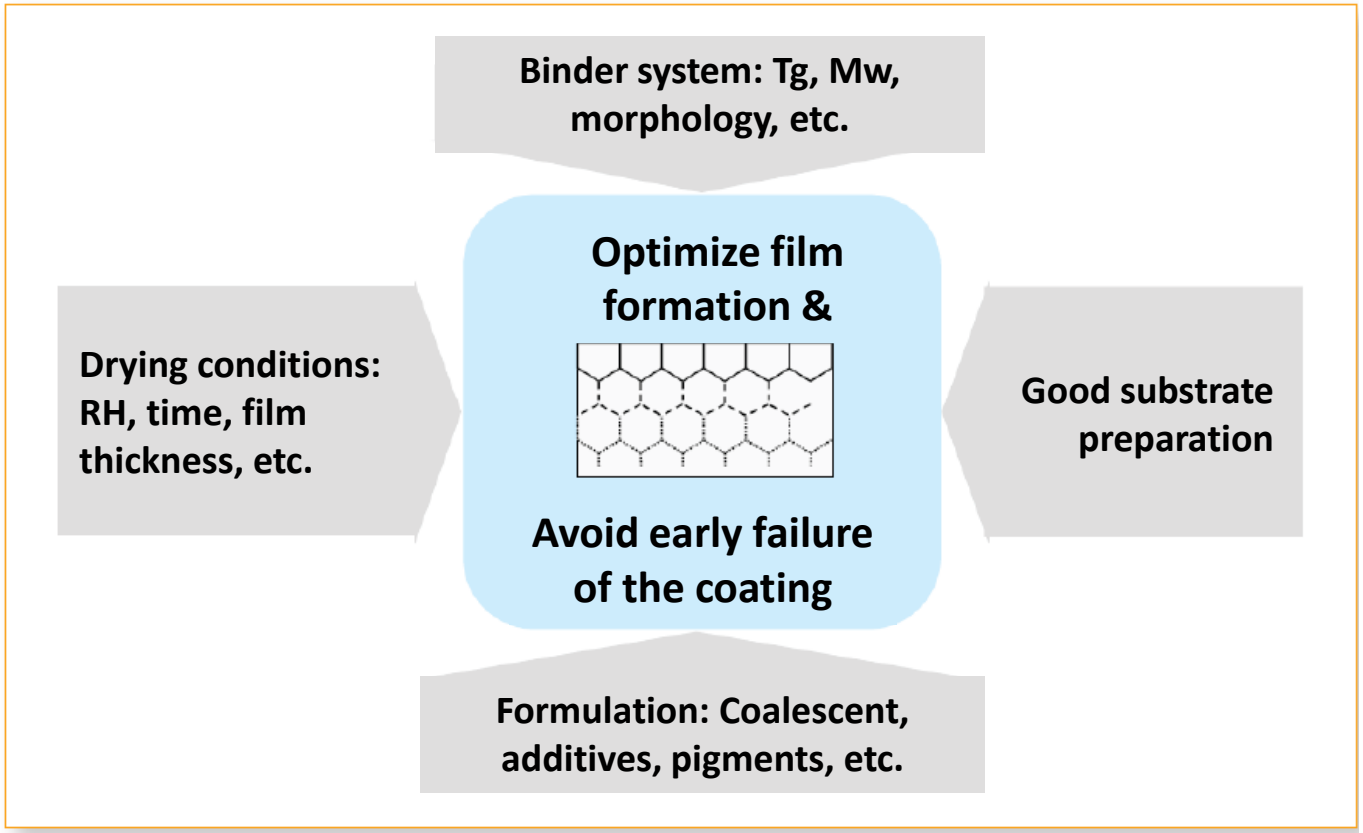
- Improve film formation by reducing MFFT
- Combination of hydrophilic (e.g. butyl glycol) and hydrophobic (e.g. DPnB) are typically used

3. Active Pigments/ Anticorrosion additives

- E.g. Zinc phosphate to improve corrosion resistance
- TiO2, Iron Oxide & fillers improves barrier properties

4. Conventional Additives

- Dispersing agents, rheology modifiers, biocides, UV stabilizers, defoamers, wetting agents, adhesion promoters, etc.



Formulating WB-DTM Coatings

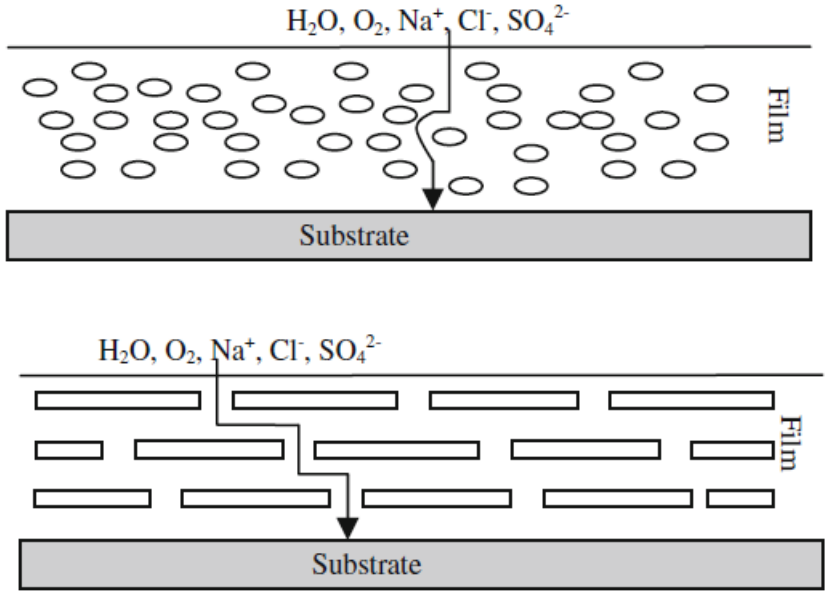
Selecting Fillers & Pigments

Pigment	Shape
Titanium dioxide	Spherical
Calcium carbonate	Spherical
Baryte	Irregular
Glass flakes	Lamellar
Talc (Magnesium silicate)	Lamellar
Iron Oxide	Lamellar
Kaolin	Lamellar
Mica, Aluminum	Lamellar

Key Point: Large spherical particles tend to offer lower anticorrosive protection than small spherical particles.

Effect of Pigment particle shape

In coatings pigmented with spherical pigments, the aggressive species can migrate almost straight through the coating. **When the coating is pigmented with lamellar pigments, the aggressive species are provided a tortuous path of diffusion.**



Formulating WB-DTM Coatings

Selecting Fillers & Pigments

Pigment	Shape
Titanium dioxide	Spherical
Calcium carbonate	Spherical
Baryte	Irregular
Glass flakes	Lamellar
Talc (Magnesium silicate)	Lamellar
Iron Oxide	Lamellar
Kaolin	Lamellar
Mica, Aluminum	Lamellar

Alkalinity of $CaCO_3$ is good for in can corrosion protection, but limits exterior use due to sensitivity to acidic ions

Chemically inert and easy to disperse

Because of high particle size, they can only be used in very thick coatings

Hydrophilic in nature – not preferred for anticorrosive coatings

Mica improves barrier protection, UV resistance, binder reinforcement and intercoat adhesion

Non-leafing aluminum pigments have a more random orientation in the coating and are very effective in barrier coatings compared to leafing pigments

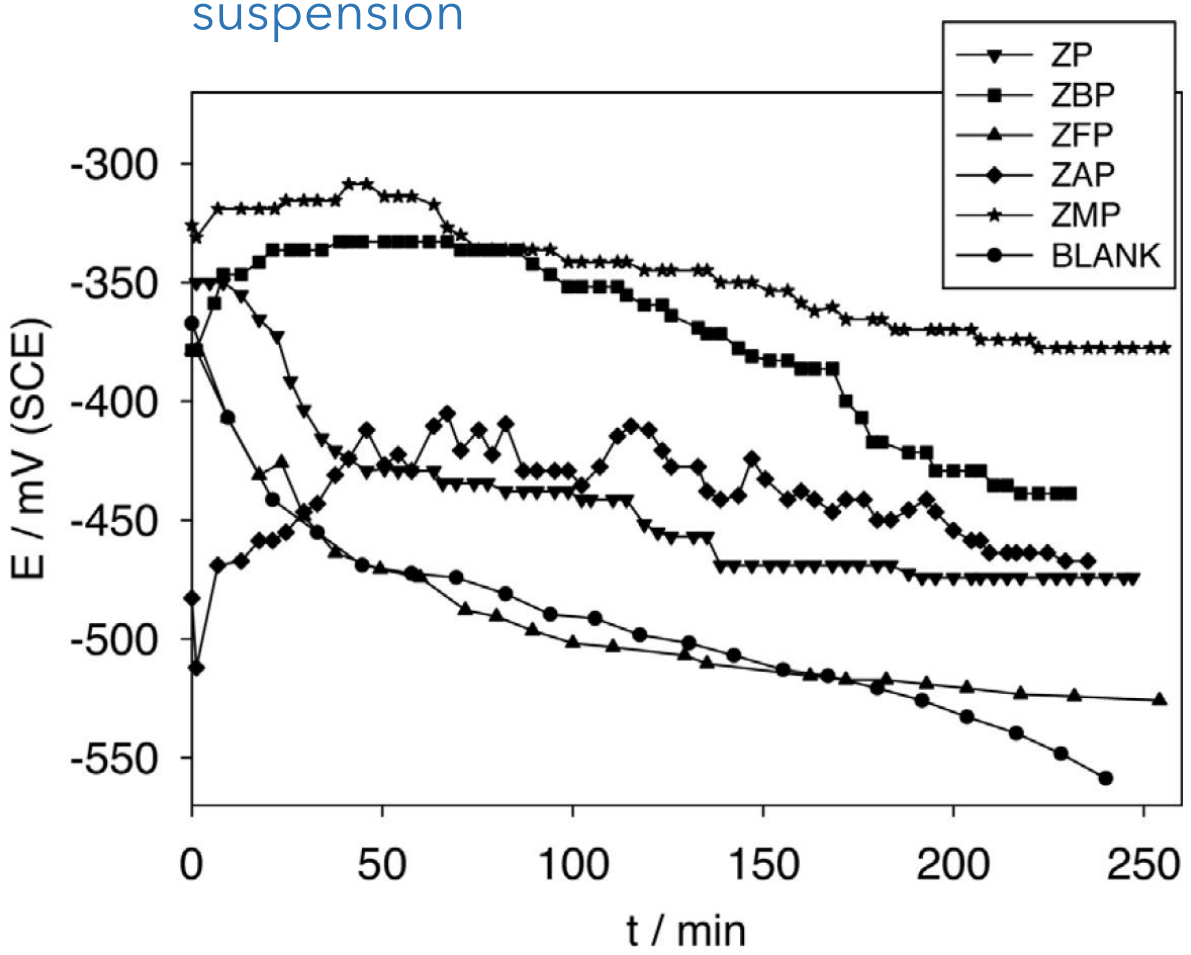
Formulating WB-DTM Coatings

Selecting Active Pigments

Pigment	Icorr (uA/cm2)
Zinc Phosphate (ZP)	3.44
Zinc and Iron Phosphate (ZFP)	7.75
Zinc and aluminum phosphate (ZAP)	24.5
Zinc molybdenum phosphate (ZMP)	2.6
Zinc basic phosphate (ZBP)	3.27

- Phosphates help in metal passivation by plugging pores and defects of the oxide layer on metal.
- Anticorrosive performance of pigments:
  ZMP > ZBP > ZP > ZFP >>> ZAP
- Corrosion reduction with ZMP was 25 times that of blank steel

Steel corrosion potential as a function of the immersion time in pigments suspension



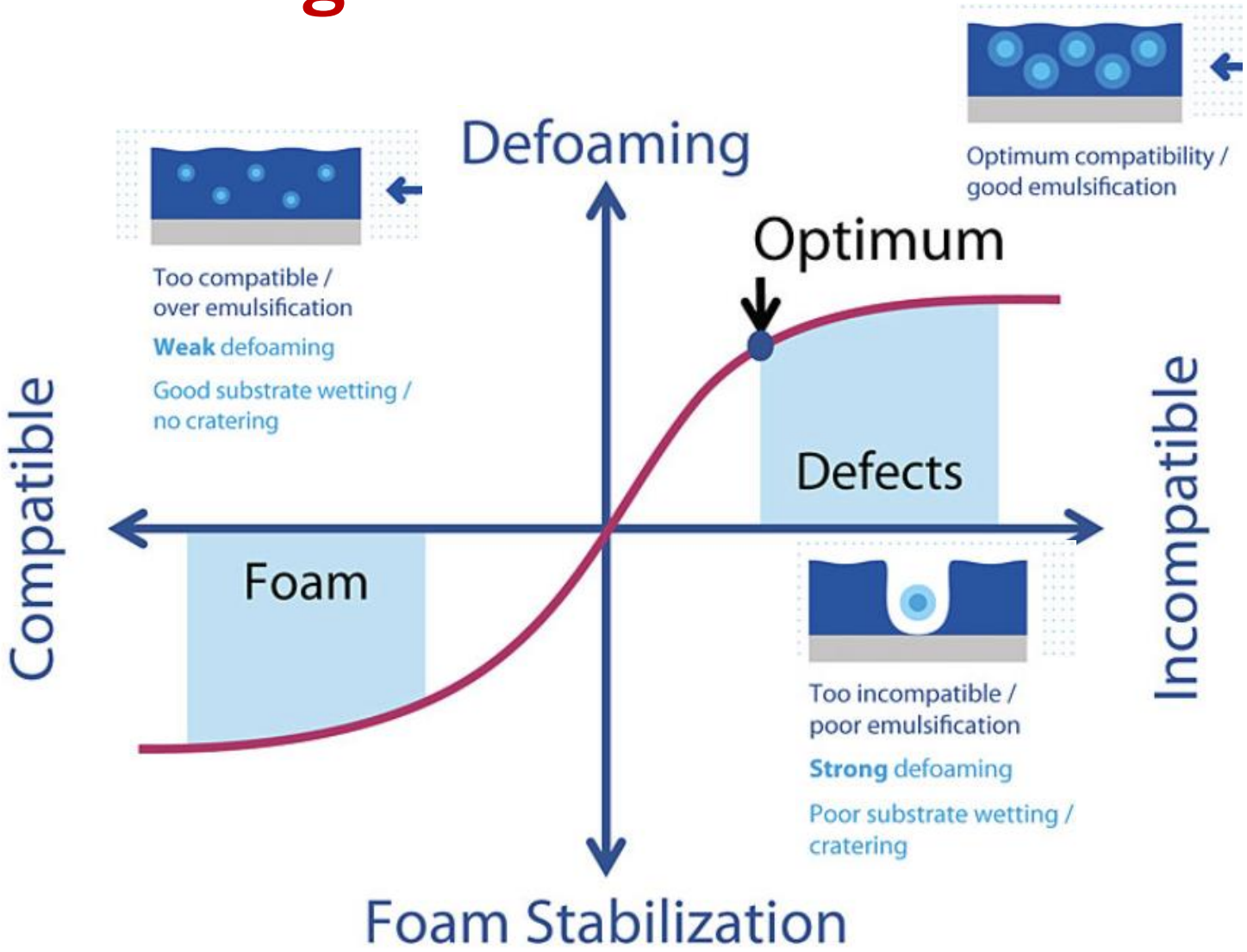
Formulating WB-DTM Coatings

Selecting the Right Defoamer

Unfortunately, there is no single defoamer for all systems. However, it is generally accepted that a defoamer should possess the following:

1. Controlled incompatibility (insoluble in system)
2. Low surface tension
3. De-wetting characteristics

System	Defoamer Hydrophobicity
Acrylic Emulsion	Low to moderate
Styrene Acrylic	Moderate to very strong
Vinyl Acetate	Moderate to strong
Polyurethane Disp.	Low



Formulating WB-DTM Coatings

Selecting Dispersing Agents

- A very good dispersion of pigments is necessary to avoid agglomeration – resulting in film defects causing water penetration.
- More hydrophobic the dispersant, the better.

1. Conventional Dispersing Agents

Based on **polyesters, polyamides, polyglycols and fatty acid chemistry (FAME).**
General Characteristics:

- **Mol wt. = 500 – 2000 g/mol**
- Good compatibility with the media
- Provide mainly electrostatic stabilization.

2. Polymeric Dispersing Agents

Mainly **polyacrylates, polyester, polyether, or polyurethane-based systems**
General Characteristics:

- **Mol wt. = 5000 – 50,000 g/mol**
- Very effective for long term stabilization
- Provide mainly steric stabilization.

3. Ionic and Non-Ionic Dispersing Agents

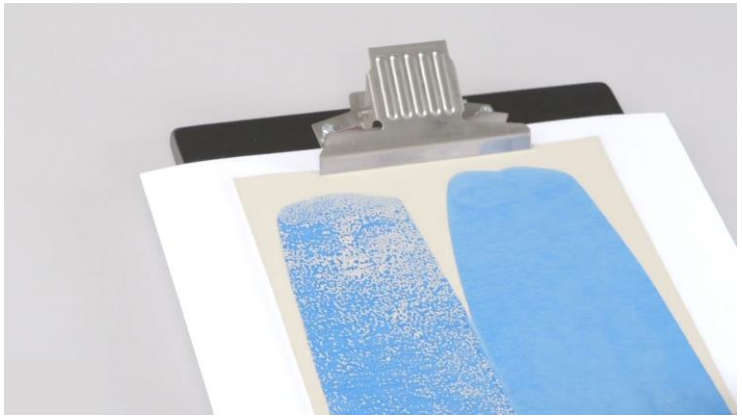
Mainly **alkyl phenol ethoxylate and more precisely nonyl phenol ethoxylate**
General Characteristics:

- **Mol wt. = 300 – 1,000 g/mol**
- Good wetting property
- Provide mainly electrostatic stabilization.

Formulating WB-DTM Coatings

Selecting Substrate Wetting Agents

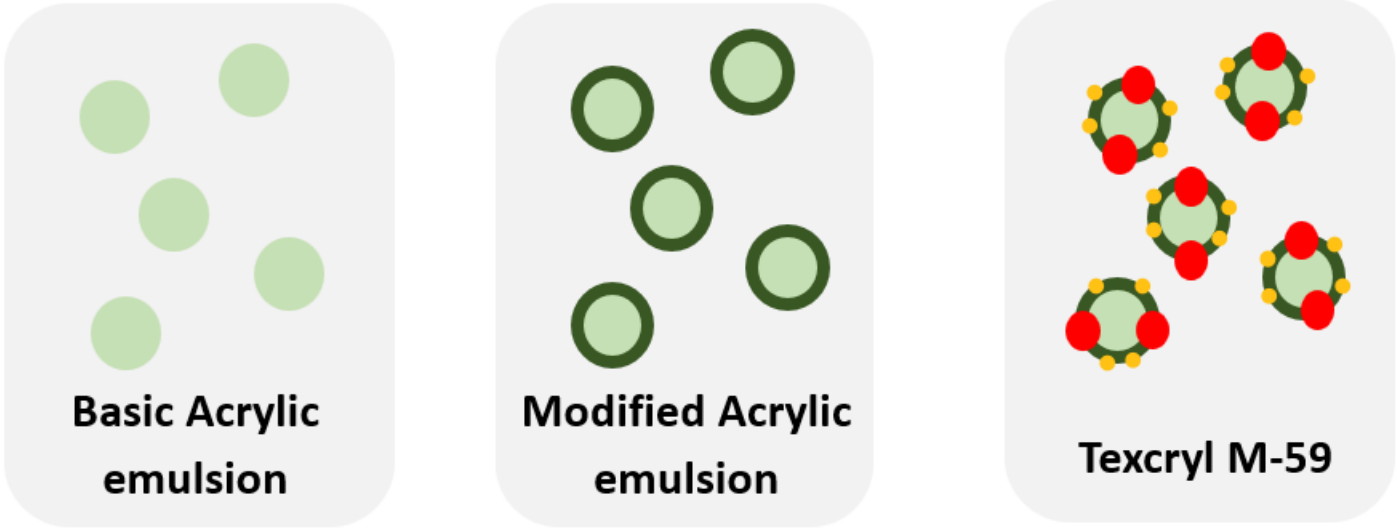
Additive	Reduction in static surface tension	Reduction in dynamic surface tension	Foaming tendency	Price
Sulfosuccinate	Medium – good	Good	Strong	Low
Alcohol alkoxylate	Low	Very good	Low	Medium
Polyether modified siloxane	Good	Medium	Medium	Medium – high
Fluorosurfactant	Very good	Low	Very Strong	High
Acetylenediol and derivatives	Medium – good	Very good	Low	Very high



Liquid	Surface tension (mN/m)
Water	73
Butyl Glycol	32
Xylene	29 – 30
Butyl acetate	25
Butanol	23
Hexane	18

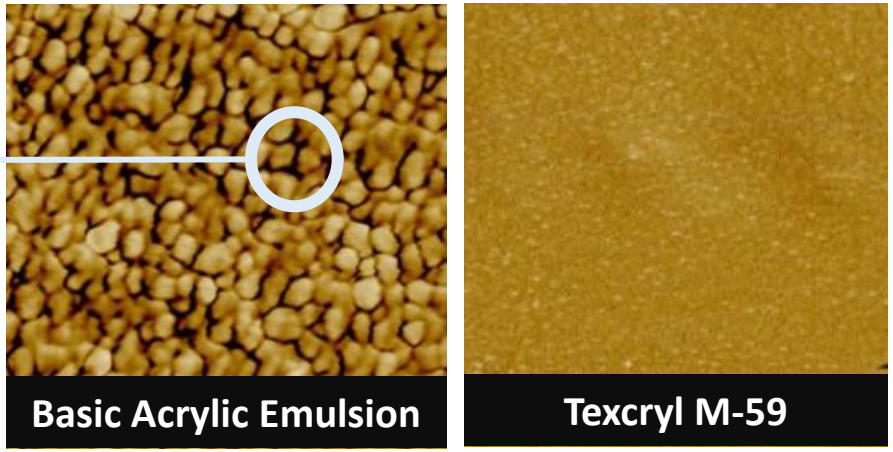
Substrate	Surface tension (mN/m)
Glass	73
Phosphated Steel	43 – 46
Tin plated steel	35
Aluminum	33 – 35
Untreated Steel	29

Texcryl M-59 DTM Emulsion



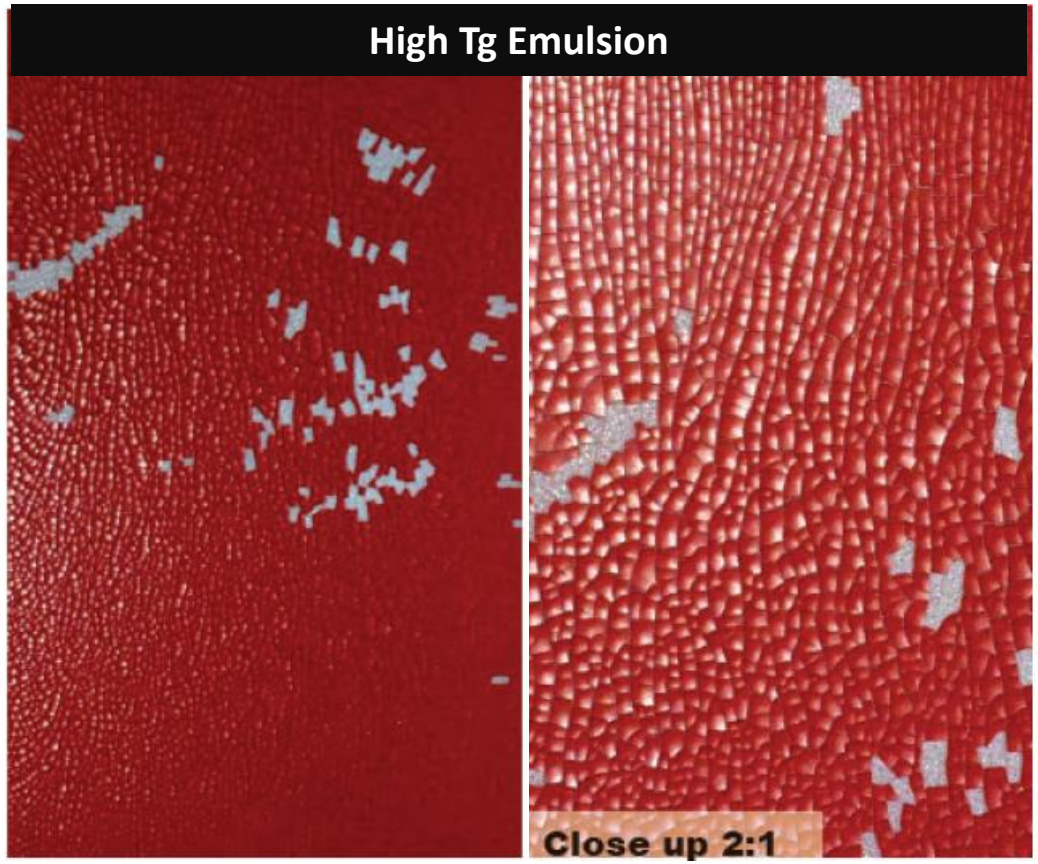
- Emulsion have added anchorage sites. (without addition of adhesion promoters)
- Good continuous film formation. (without addition of cosolvents)
- Emulsion is hydrophobic and provides moisture barrier. (without addition of surface modifying additives)
- Emulsion when dried is non-conductive in nature.

Moisture penetration site

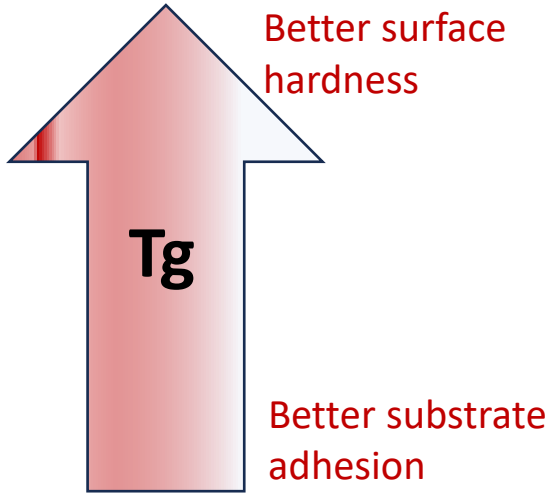


Microscopic Lens

Texcryl M-59 DTM Emulsion



Glass Transition temperature (Tg) of the emulsion is well optimized



Ref: 7

Benefits of Texcryl M-59 DTM Emulsion

HEAVY-METAL FREE

IMPROVE FILM WATER-RESISTANCE

AVOID FILM BLISTERING

SUITABLE FOR CLEAR-COATINGS

SUITABLE FOR VARIOUS METAL NATURES

IMPROVE PAINT ADHESION ON METALS

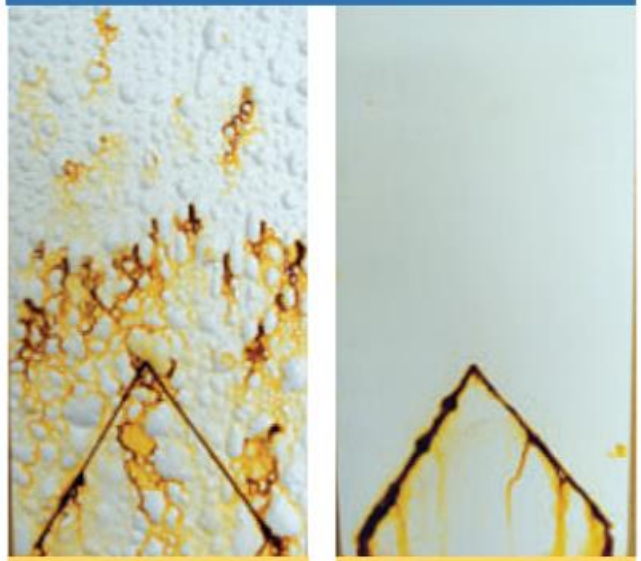
Performance Parameters for DTM Coatings

Humidity test
Duration: 45 days, 45°C
Dry film Thickness: 70 micron

Conventional Styrene Acrylic

Texcryl M-59

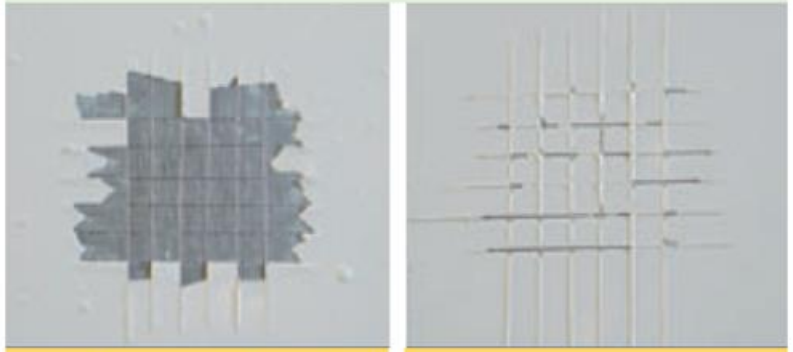
Salt Spray ASTM B117
Duration: 500 hrs.
Dry film Thickness: 60 micron



Conventional Styrene Acrylic

Texcryl M-59

Adhesion Test
Duration: 100 hrs. humidity exposure
Dry film Thickness: 125 micron



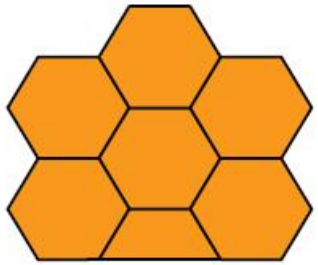
Conventional Styrene Acrylic

Texcryl M-59

Ref: 8

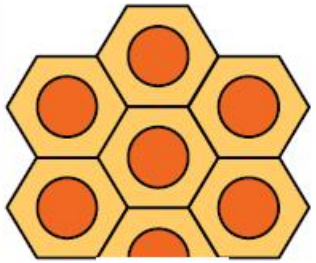
Performance Parameters for DTM Coatings

Coating based on regular emulsion structure



A

Coating based on Texcryl M-59

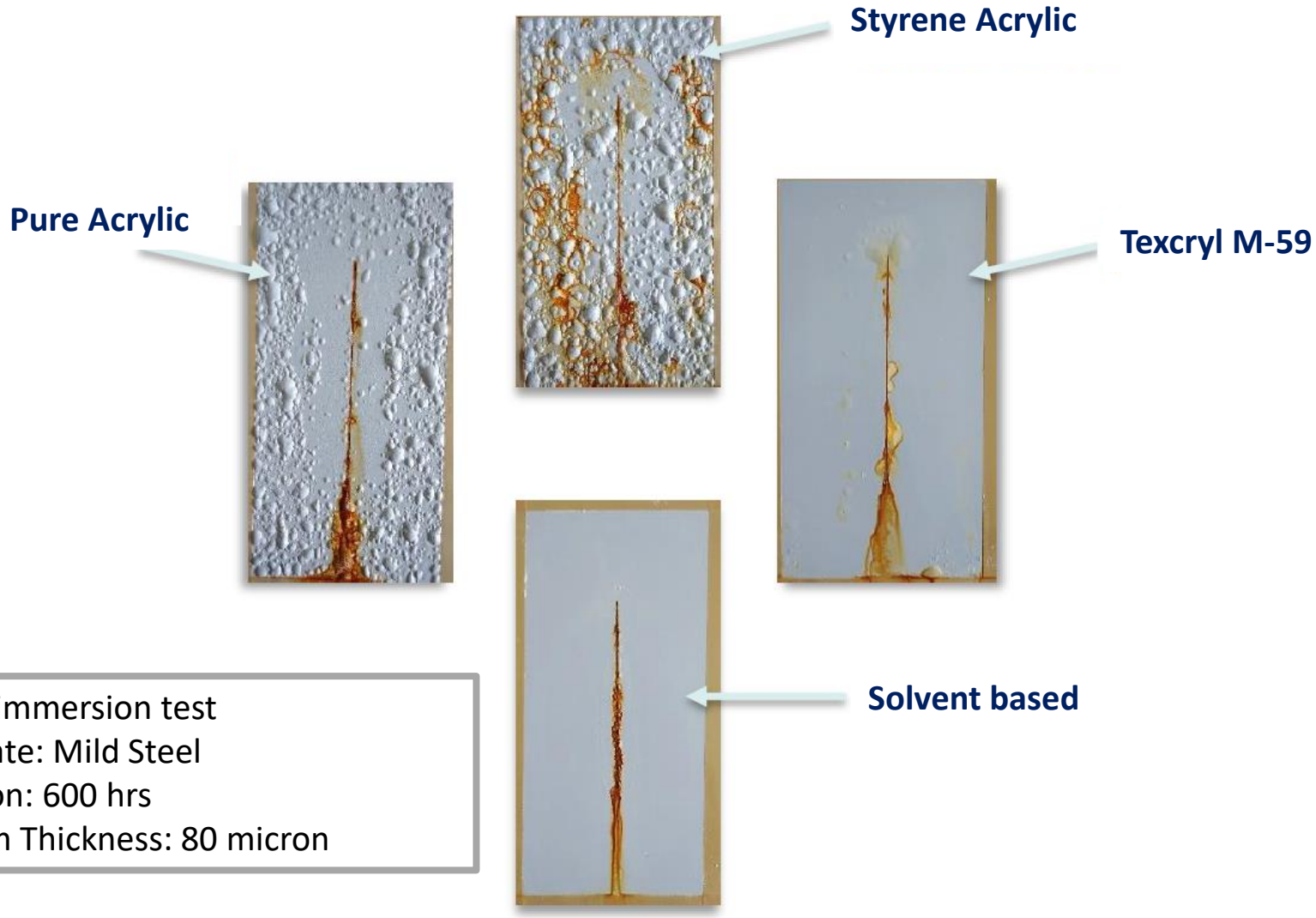


B

Salt Spray Test 400 hours
Substrate: Cold Rolled Steel
Duration: 600 hrs
Dry film Thickness: 80 micron

Performance Parameters for DTM Coatings

Comparing performance with solvent based coating systems



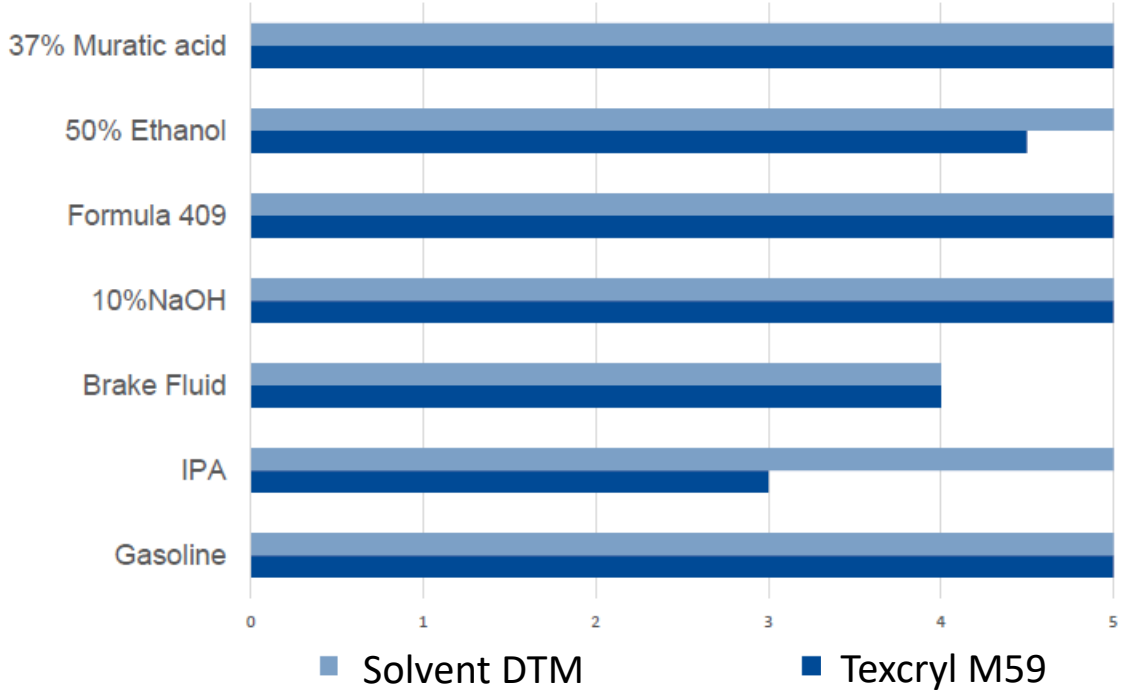
Water immersion test
Substrate: Mild Steel
Duration: 600 hrs
Dry film Thickness: 80 micron

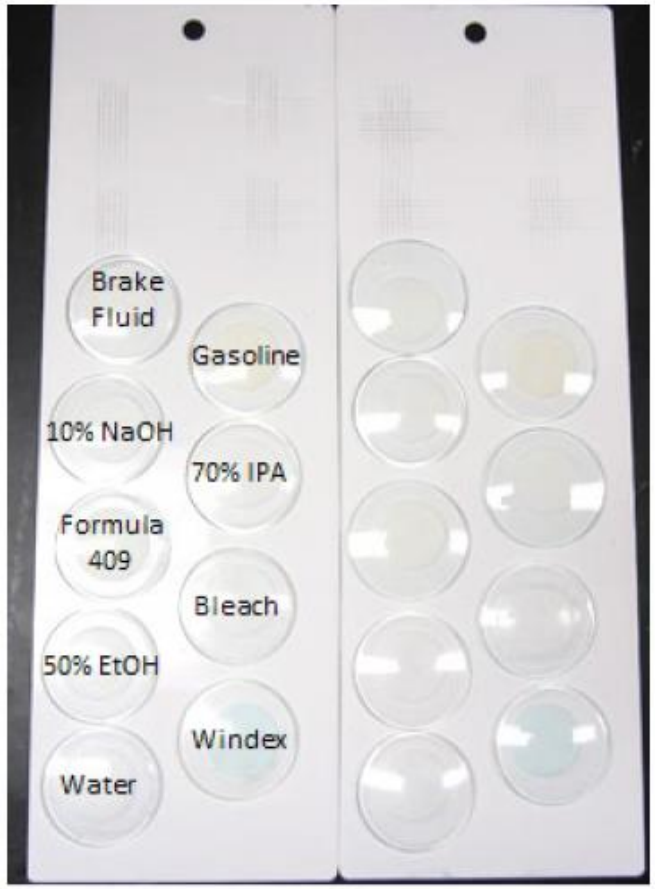
Ref: 8

Performance Parameters for DTM Coatings

Chemical Resistance

Spot Test (1hour)



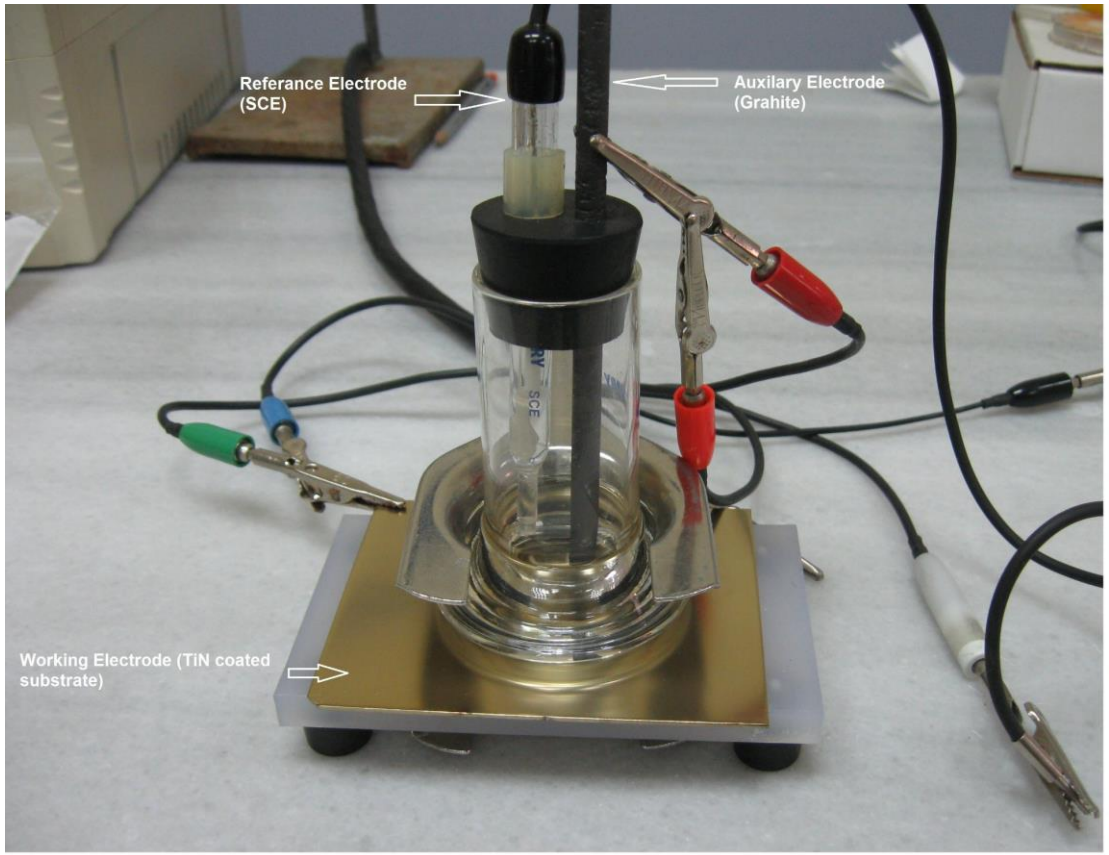


Performance Parameters for DTM Coatings

Potentiodynamic Polarization Study

Time	Sample	Corrosion Rate (mmpy)
0 Days	Texcryl M-59	0.00245
	Market WB-DTM	0.0481
3 Days	Texcryl M-59	0.00328
	Market WB-DTM	0.0754
10 Days	Texcryl M-59	0.0144
	Market WB-DTM	0.73
30 Days	Texcryl M-59	0.34
	Market WB-DTM	1.15

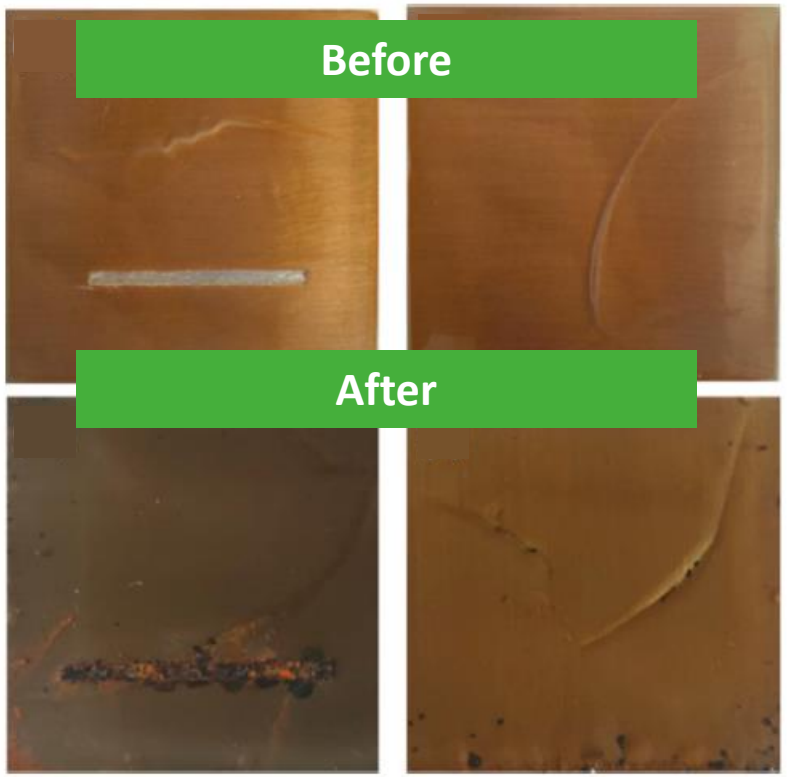
Coated on carbon steel.
DFT: 80 micron
Immersion solution: 3.5wt% NaCl soln



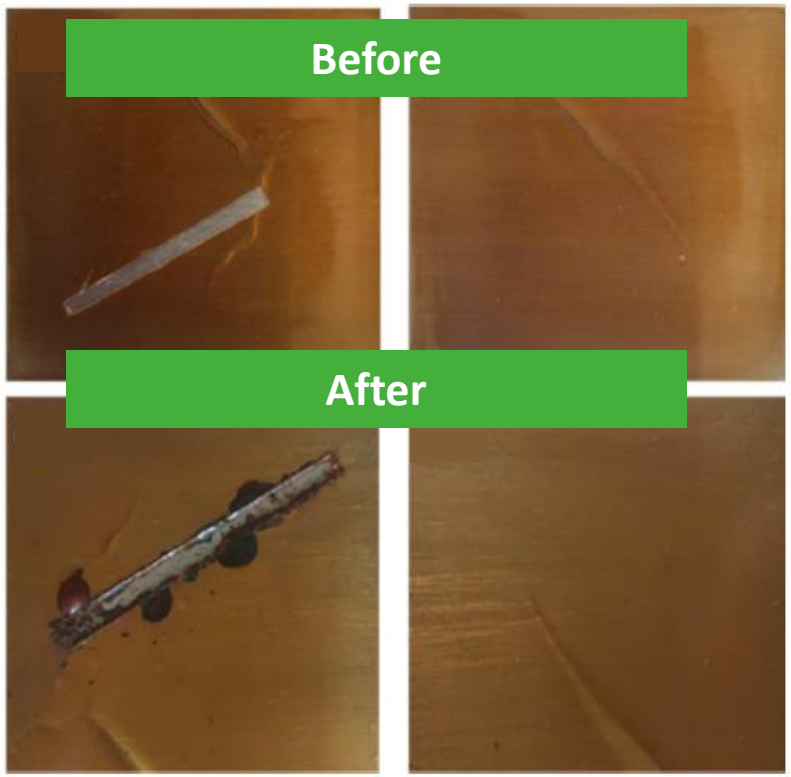
Performance Parameters for DTM Coatings

Salt Spray Test Comparison of only Emulsion

Market WB-DTM



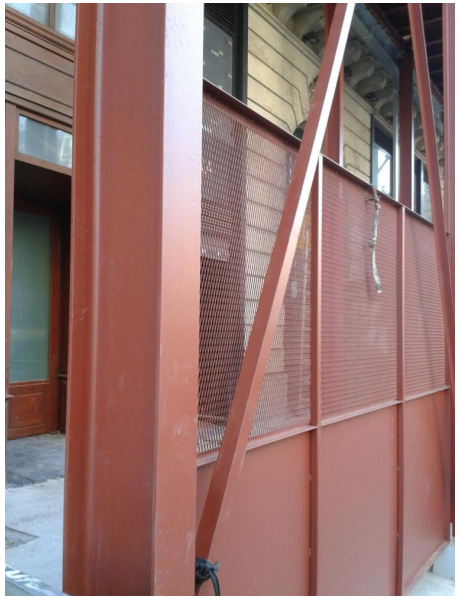
Texcryl M-59



Salt Spray ASTM B117
Substrate: CRS
Duration: 400 hrs
Dry film Thickness: 80 micron

Guideline Formulations

Red Oxide DTM Primer

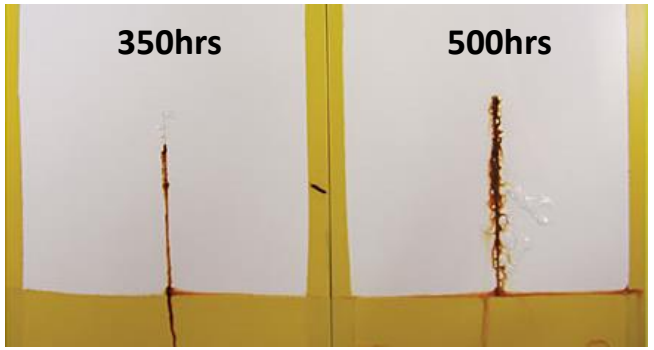


Raw Material	Function	Manufacturer	Wt. %
Deionized Water			17
2% HEC soln	Core Building		0.2
Ammonia	Neutralizer		0.2
Biocide			0.2
UnoWet 9459 N	Wetting agent	Uno Chemie	0.2
Texcryl D-50	Dispersing Agent	Texochem Industries	0.2
Red Oxide Paste	Pigment		20 – 25
Diethylene Glycol	Cosolvent		4
Calcium Carbonate	Filler		14
Zinc Phosphate	Corrosion Inhibitor		2
Texcryl M-59	DTM Emulsion	Texochem Industries	40
Sodium Nitrite	Flash rust Inhibitor		0.5
Texcryl MT-30	HASE Thickener	Texochem Industries	0.5 – 1.0
Ammonia	Neutralizer		0.2
Texcryl DF-02	Defoamer	Texochem Industries	0.2

TEXOCHEM Texochem Industries

Guideline Formulations

Waterborne White DTM Paint



Salt Spray Performance
Cold rolled steel
75micron dry

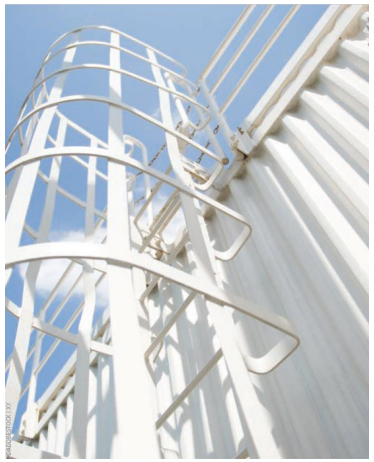
PVC: 23 - 25%
Gloss: 35 - 40 (60 deg)

Raw Material	Function	Manufacturer	Wt. %	Procedure
Deionized Water			5 - 7	Prepare the **mill base** under high shear for 10-15min. Add the components in order. Set the mill base aside.
Texcryl D50	Dispersing Agent	Texochem Industries	0.5 – 0.8	
Ammonia	Neutralizer		0.2 – 0.4	
Texcryl DF-02	Defoamer	Texochem Industries	0.1 – 0.2	
UnoWet 9459 N	Wetting agent	Uno Chemie	0.2 – 0.5	
Texcryl MT30	Thickener	Texochem Industries	0.3 – 0.6	
Titanium dioxide	Pigment		18 - 20	
Calcium carbonate	Filler		7 - 10	
Texcryl M59	DTM Emulsion	Texochem Industries	50 - 60	Add the components in continuous stirring.
Deionized water			5 - 7	
Texcryl DF-02	Defoamer	Texochem Industries	0.1 – 0.2	
Ascotran H10	Flash rust Inhibitor	Ascotec	0.5 – 1.0	
Asconium 142DA	Corrosion Inhibitor	Ascotec	2 - 3	
Texanol	Cosolvent	Eastman	1.5 – 2.5	
Mill base				
Biocide			0.2 – 0.3	

TEXOCHEM Texochem Industries

Guideline Formulations

Waterborne White DTM **Semi Gloss** Paint



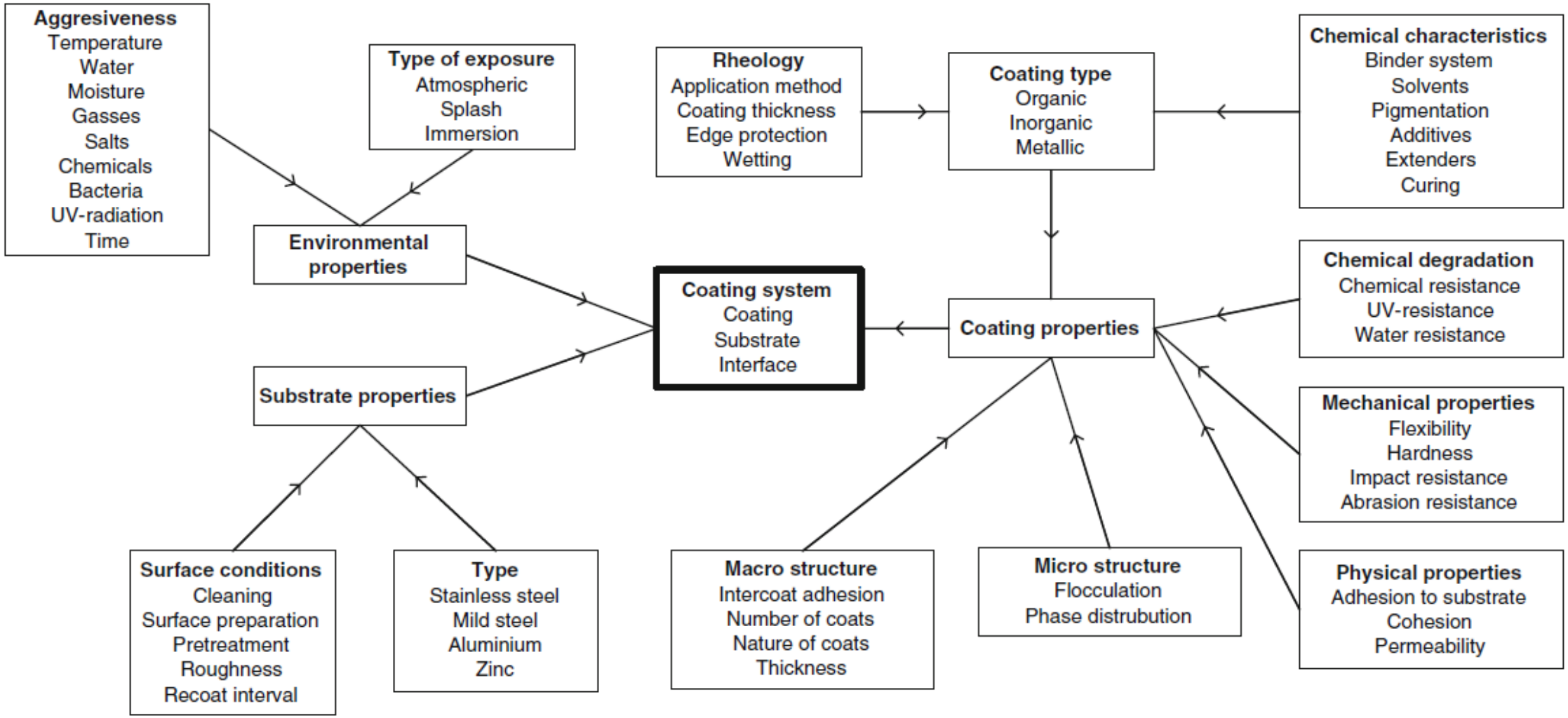
Salt Spray Performance
Cold rolled steel
75micron dry
Duration: 650 hours

PVC: 10 - 12%
Gloss: 55 - 60 (60 deg)

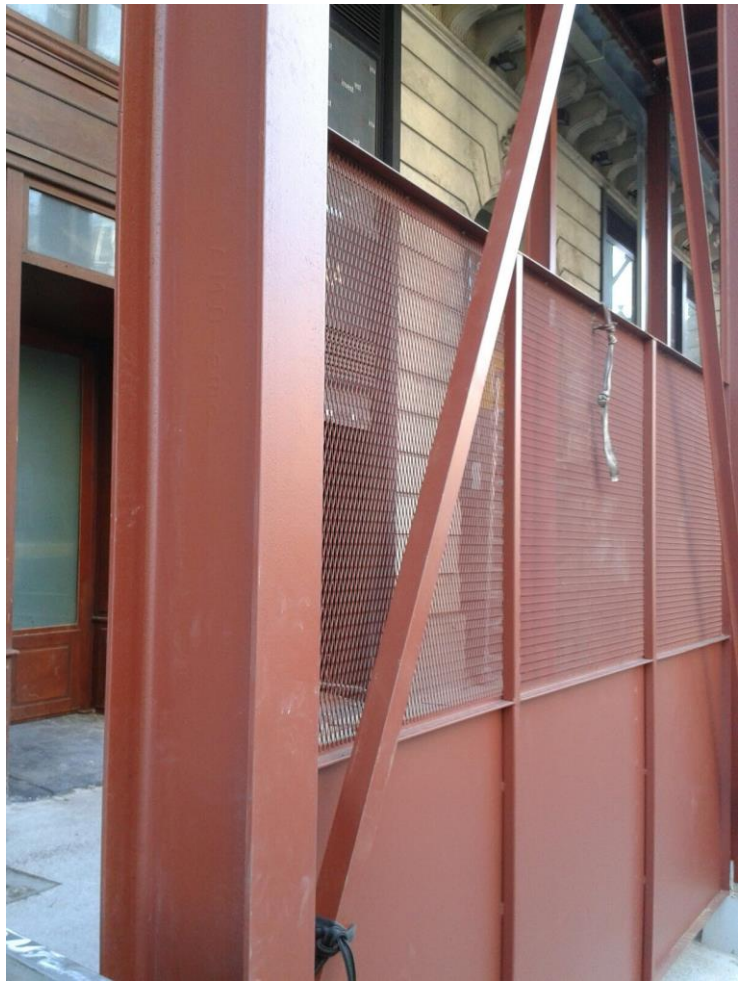
Raw Material	Function	Manufacturer	Wt. %	Procedure
Deionized Water			5 - 7	Prepare the **mill base** under high shear for 10-15min. Add the components in order. Set the mill base aside.
Texcryl D50	Dispersing Agent	Texochem Industries	0.5 – 0.8	
Ammonia	Neutralizer		0.2 – 0.4	
Texcryl DF-02	Defoamer	Texochem Industries	0.1 – 0.2	
UnoWet 9459 N	Wetting agent	Uno Chemie	0.2 – 0.5	
Texcryl MT30	Thickener	Texochem Industries	0.3 – 0.6	
Titanium dioxide	Pigment		18 - 20	
Texcryl M59	DTM Emulsion	Texochem Industries	57 - 70	Add the components in continuous stirring.
Deionized water			5 - 7	
Texcryl DF-02	Defoamer	Texochem Industries	0.1 – 0.2	
Ascotran H10	Flash rust Inhibitor	Ascotec	0.5 – 1.0	
Asconium 142DA	Corrosion Inhibitor	Ascotec	2 - 3	
Texanol	Cosolvent	Eastman	1.5 – 2.5	
Mill base				
Biocide			0.2 – 0.3	

TEXOCHEM Texochem Industries

Factors affecting durability of DTM coatings



Texcryl M59 current application examples



Texochem Industries

About Us

At Texochem, we thrive on innovation, crafting solutions that tackle today's challenges and pioneer the products of the future. With a dedicated focus on sustainability and relentless research, we're shaping tomorrow's possibilities.

Innovation

We are constantly developing new products and enhancing existing ones to provide our customers a technological edge.

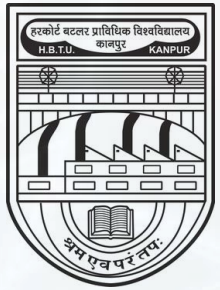
Sustainability

For us, sustainability is not just a word but a way of doing business – ensuring environmentally responsible future.

Customized solutions

We believe in long term partnerships and collective growth, by providing our research services on an individual level.

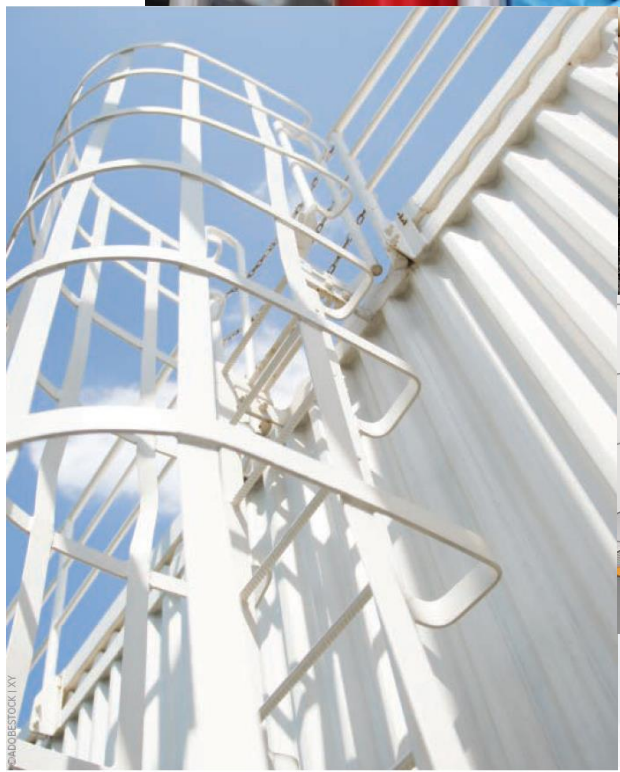
Our Technology Partners



NC STATE UNIVERSITY

Product Overview

- Styrene Acrylic & Pure Acrylic Emulsions
- Polyurethane Dispersions
- Dampproof Emulsions
- DTM Emulsions
- Waterproofing Coatings
- Polymer Seal Coats
- Acrylic Thickeners
- HASE Thickeners
- PU Thickeners
- Ammonia Polyacrylate Thickeners
- Dispersing Agents
- Wetting & Dispersing Agents



Contacts

Please don’t hesitate to contact us for more information. If you would like samples or if you would like to have any other conversation, we would be happy to help.

Contact	Company	Email	Mobile
Anuj Agrawal	Texochem Industries	anuj@texochem.com	+91 88280 27395

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