Urethanes TECHNOLOGY INTERNATIONAL

DOW®

Polyurethane Additives

Novel PU Surfactants For Bedding And Furniture Applications!

Dr. Sachit Goyal

November 19, 2020

VORASURF™

Silicone polyurethane additives by DOW

OUTLINE

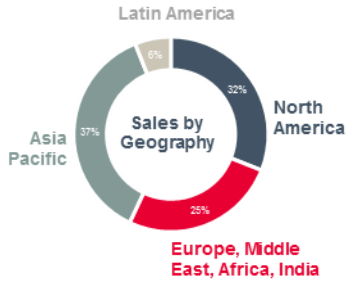
- Dow Background
- VORASURF™ polyurethane additives
- Dow's History in silicone manufacturing
- New VORASURF™ additives for flexible polyurethane foams
- Conclusions
- Questions and Answers

This is Dow

2019 NET SALES	EMPLOYEES	MANUFACTURING SITES	GLOBAL REACH
$43B	~36,500	109 sites	31 countries in which Dow manufactures products

Dow Consumer Solutions

2019 NET SALES	EMPLOYEES	MANUFACTURING SITES	GLOBAL REACH
$5.4B	~7,000	21 sites	12 countries in which Dow manufactures products



Innovation & manufacturing footprint across North America, Latin America, Europe and Asia

12 R&D locations

Broad portfolio of chemistries with high value innovation pipeline

Largest global silicones player[1] with 75+ years of industry leadership

Note: All data as of December 31, 2019

[1]*Largest global silicones player, based on annual sales*

Successful, Reliable, Safe and Effective Solutions for Industrial and Chemical Processing

- Foam control agents
- Coating resins & binders
- Performance additives
- Surface & material modifiers
- Processing aids
- Mold release agents
- Surfactants
- Formulation intermediates
- Silanes


Pulp Processing


PU Additives


Coatings


Food & Beverages


Plastic Additives


Textile Treatment


Agrochemicals


Automotive Care


Leather Finishing

Optimized manufacturing ***process***

Enhanced product ***properties***

Improved ***sustainability*** performance

VORASURF™
Silicone polyurethane additives by DOW

DOW

VORASURF™ ADDITIVES ENABLING VALUE CREATION IN POLYURETHANE FOAMS

polyol
+ isocyanate
+ catalyst
+ blowing Agent
+ *surfactant*
+ other additives

POLYURETHANE FOAM

Flexible molded

Flexible slab

Microcellular

Rigid

VORASURF™ Additives are
silicone surfactants
enabling formulators to
control essential properties of PU foams,
including performance, structure, breathability, moisture transport, flammability, and more.

Highly critical additives, used in almost every PU foam applications.

Support of mixing

Compatibility and dispersion

Stabilization of bubbles

Minimalize coalescence and stabilization

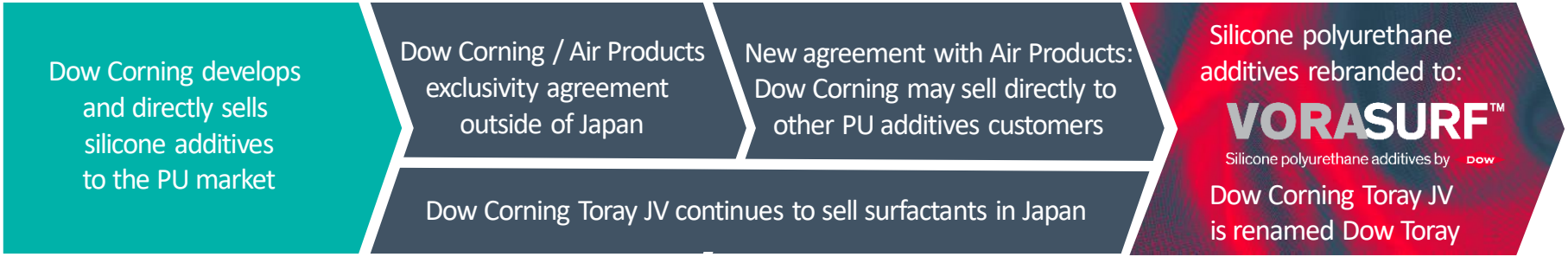
POLYURETHANE FLEXIBLE FOAM: WHAT ARE WE REFERRING TO?

Polyols and isocyanates react to form urethane foams for comfort and healthy living

Open cell structure:

- soft and flexible
- tunable compression and resilience

60 Years of History in Silicone Surfactants for Polyurethanes



Industry standards

- VORASURF™ DC 5986 Additive
- VORASURF™ DC 198 Additive
- VORASURF™ DC 5906 Additive
- VORASURF™ DC 5950 Additive

All our silicone polyether offerings are hydrolytically stable

VORASURF™ Polyurethane Additives: Quality, Global Alternative

60 years
of manufacturing expertise

Global PU foam generation and
testing capabilities

Over 200
distinct silicone surfactant products
>50 sold into PU segment
~150 sold into other industries

Leverage Dow's
back integration
in silicones and polyethers

Committed to **reliable, cost-effective solutions** and application support

KEY FOAM TYPES & INDUSTRY DRIVERS IN PLEXIBLE PU FOAM

Type of Foams	Conventional Foams	Combustible Modified Polyether (CME)	Viscoelastic (VE) foams	Hyper soft (HS) foams	High Resiliency (HR)	Flexible Molded
						
	Polyurethane Foam					

Main drivers	
	Durability and comfort: ergonomic, sensation, microclimate
	Health & Environment protection: low emissions and volatiles, regulations on hazardous additives, compulsory and voluntary certifications
	Circularity: circular economy, mattress recycling, recycling polyols

STANDARDS AND REGULATIONS

Regulations

- Global regulations on hazardous chemicals
- Global regulations to reduce emissions and limit volatile organic compounds (include cyclic siloxanes)

EU (ECHA)

In 2018, ECHA identified cyclic siloxanes D4, D5 and D6 as SVHCs: reporting threshold limit for these substances in silicone surfactants is now < 0.1% wt (for each). Dow SDS have been updated.

NFPA	U.S. CPSC Consumer product safety Commission	U.S. EPA	OSHA

Specifications & Certifications

Ecolabel	GreenGuard	OekoTex	LGA

IKEA

Effective June 2020, IOS-MAT-0010 includes requirements for cyclic siloxanes D4, D5, D6 in mattress and pillow foams

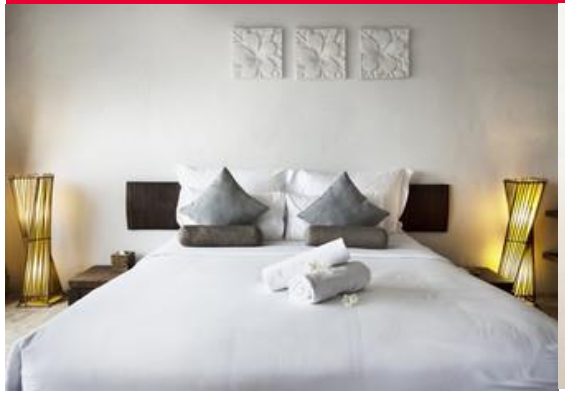
Level of total (D4 + D5 + D6) in the foam after 48 hours must be ≤ 30 µg/m³

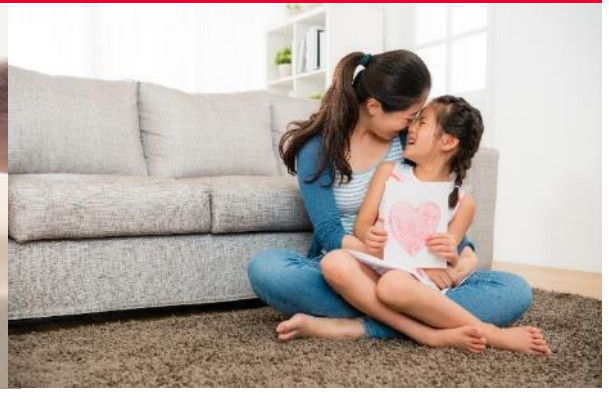
CertiPUR U.S.

Requires the Total VOC emissions in foams < 0.5 mg/m³ using ISO 16000

VORASURF™ FLEXIBLE POLYURETHANE FOAM ADDITIVES

Bedding and Furniture





VORASURF™ DC 5906LV	*Conventional med-high density foam, viscoelastic (VE) foam applications*	D4+D5+D6 < 500ppm
VORASURF™ DC 5950LV	*Conventional high-density, combustible modified polyether foam, VE foam*	D4+D5+D6 < 800ppm
VORASURF™ DC 198LV	*VE foam, molded flexible foam*	
VORASURF™ DC 5951LV	*Versatile surfactant, low- medium density foam, VE foam, Hyper soft foam*	
VORASURF™ FF 5959	*Co-additive to enable finer cell size or to induce pneumaticity in foam*	

New surfactants meeting stringent cyclic requirements to offer sustainability and offering improved foam performance and versatility to enable better control over foam properties

CONVENTIONAL FOAMS

- Density range: 10 – 100 kg/m^3
- Conventional and combustible modified polyether (CME) foams
- Hardness grades:
  - **Soft**: usually with cell openers or auxiliary blowing agents
  - **Hard**: with fillers or copolymeric polyol
- Almost exclusively produced with TDI

VORASURF™ DC 5906LV For TDI Conventional Foams

Formulation Ingredients	Density 22 kg/m³	Density 35 kg/m³
VORANOL™ 3322 Polyol	100	100
Water	4.4	2.6
VORASURF™ DC 5906LV	1	0.8
Catalysts	0.35	0.36
VORANATE™ T-80 isocyanate	56.2	36.9
Index	110	110

Box foam lab results

VORASURF™ DC 5906LV offers:

- processing of **multiple densities** of foams
- wide **processing latitude**,
- compatibility with **auxiliary blowing agents**,
- lower **viscosity**

Property	Density 22 kg/m³	Density 35 kg/m³
Density (kg/m³) ISO 845-88	23.1	35.2
CFD @25 % (kPa) ISO 3386-1	3.57	3.18
Tensile strength (kPa) ISO1798	124.4	132.8
Resiliency (%) ASTM 3574	34.5	46
Airflow (dm³/sec) ISO 7231	0.93	1.21
Compression Set (75%) % ISO 1856	9.4	3.6

VORASURF™ DC 5906LV enables to formulate **low VOC** foam with **comparable performance** to those formulated with VORASURF™ DC 5906

VORASURF™ DC 5951LV For TDI Conventional Foams

Formulation Ingredients	Density 22 kg/m³	Density 35 kg/m³
VORANOL™ 3322 Polyol	100	100
DI Water	4.4	2.6
VORASURF™ DC 5951LV	0.7	0.6
Catalysts	0.35	0.36
VORANATE™ T-80 isocyanate	56.2	36.9
Index	110	110

Property	Density 22 kg/m³	Density 35 kg/m³
Density (kg/m³) ISO 845-88	22.7	34.8
CFD @25 % (kPa) ISO 3386-1	3.5	3.22
Tensile strength (kPa) ISO1798	122.2	90.6
Resiliency (%) ASTM 3574	33.8	47.2
Airflow (dm³/sec) ISO 7231	0.7	0.8
Compression Set (75%) % ISO 1856	6.1	2.4

Box foam lab results

VORASURF™ DC 5951LV offers:

- processing of **multiple densities** of foams,
- compatibility with **auxiliary blowing agents** including CO_2 and vacuum

VORASURF™ DC 5951LV offer low VOC profiles, better density distribution and foam height, OH# = 0

VORASURF™ DC 5950LV FOR TDI CONVENTIONAL CME FOAMS

Formulation Ingredients	High FR	Low FR
VORANOL™ WK 3138 Polyol	100	100
Flame Retardants	35	28
Additives	0.4	0.4
DI Water	4.4	4.4
VORASURF™ DC 5950LV	0.5	0.5
Catalysts	0.55	0.55
VORANATE™ T-80 isocyanate	52.02	52.02
Index	100	100

Box foam lab results

VORASURF™ DC 5950LV offers

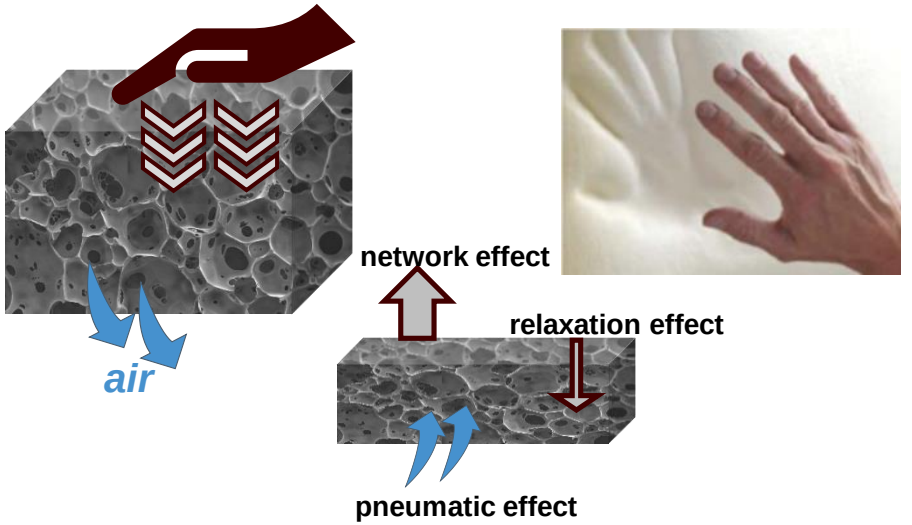
- Good flame retardant performance
- Excellent processing performance & final properties
- Suitable performance for high density TDI conventional and MDI visco-elastic foams

Property	High FR	Low FR
Physical Property Testing		
Density (kg/m^3) ISO 845-88	26.06	26.37
CFD @25 % (kPa) ISO 3386-1	1.86	1.76
Tensile strength (kPa) ISO1798	86.8	85.8
Tear strength (N/m) ASTM 3574	310.3	356.4
Resiliency (%) ASTM 3574	41	39.25
Airflow (dm^3/sec) ISO 7231	1.55	1.07
BS 5852 / Cribb 5 Testing Results		
Time to Extinguish (s)	261	265
Weight Loss (g)	51	57
CRIBB 5	PASS	PASS

VORASURF™ DC 5950LV enables to formulate **low VOC** foam with **comparable performance** to those formulated with VORASURF™ DC 5950

VISCOELASTIC (VE) FOAM

- Density range: 30 – 70 kg/m3
- Resilience < 15%
- Adapt to body shape and evenly distribute body weight on contact area
- Can be MDI or TDI based
- TDI VE typically used for better Tg benefits

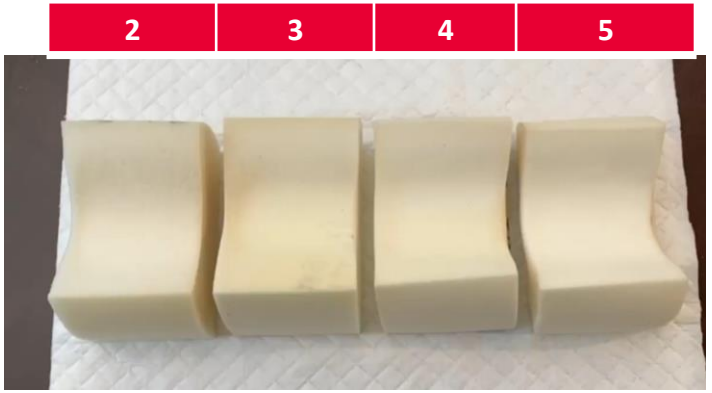


Chemical VE: slow recovery mainly caused by relaxation effect, that relies on the Tg. It is sensitive to environmental temperature: if $T_{ambient} < Tg$, polymer is stiffer.

Physical (pneumatic) VE: slow recovery mainly originated by the air that flows in and out of the cells. It does not depend on the temperature but on the cell openness – low airflow is required.

VORASURF™ SURFACTANTS FOR MDI VE / PNEUMATIC VE (45 KG/M^3)

	1	2	3	4	5
Formulation Ingredients					
MDI visco Polyol blend	100	100	100	100	100
DI Water	2.2	2.2	2.2	2.2	2.2
VORASURF™ DC 198LV	0.8				
VORASURF™ DC 5951LV		0.8	0.8	0.6	0.2
VORASURF™ FF 5959			0.2	0.4	0.8
Catalysts	0.25	0.25	0.25	0.25	0.25
PAPI™ 23 or Polymeric MDI isocyanate	49.6	49.6	49.6	49.6	49.6
Index	77	77	77	77	77
Properties					
Density (kg/m^3) ASTM D1622	43.36	43.68	44	44.8	44.96
IFD@25% (kPa) ASTM D3574	1.25	1.42	1.79	1.75	1.98
Airflow (dm^3/sec) ASTM D3574	1.27	1.55	0.42	0.24	0.05
Resimat Recovery (s)	2.7	2	4.8	7.2	13.8



Box foam lab results

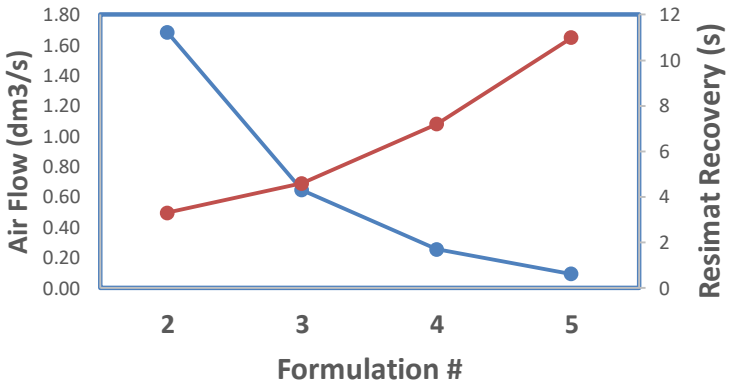
VORASURF™ DC 5951LV and DC 198LV offer versatile performance in MDI VE

VORASURF™ FF 5959:

- helps control cell size and tune pneumaticity in VE foams
- can be combined with other VE surfactants, including VORASURF™ DC 5906LV

VORASURF™ SURFACTANTS FOR MDI VE / PNEUMATIC VE (32 KG/M^3)

	1	2	3	4	5
Formulation Ingredients					
MDI VE Polyol blend	100	100	100	100	100
DI Water	2.2	2.2	2.2	2.2	2.2
Methylene Chloride	7	7	7	7	7
VORASURF™ DC 198LV	0.8				
VORASURF™ DC 5951LV		0.8	0.8	0.6	0.2
VORASURF™ FF 5959			0.2	0.4	0.8
Catalysts	0.25	0.25	0.25	0.25	0.25
PAPI™ 23 or Polymeric MDI isocyanate	52.8	52.8	52.8	52.8	52.8
Index	82	82	82	82	82
Property					
Density (kg/m3) ASTM D1622	30.08	32.16	32.8	32.32	31.36
IFD @25 % (kPa) ASTM D 3574	0.91	1.20	1.34	1.43	1.39
Tensile strength (kPa) ASTM 3574	38.1	44.8	40.0	42.7	42.2
Airflow (dm3/sec) ASTM D 3574	2.28	1.68	0.65	0.25	0.09
Resimat Recovery (s)	4.2	3.3	4.6	7.2	11



Box foam lab results

- VORASURF™ DC 5951LV and DC 198LV enable formulation with low density MDI VE
- VORASURF™ FF 5959 helps control cell size and tune pneumaticity in VE foams

HYPER-SOFT (HS) FOAM

- Density range: 20 – 70 kg/m^3
- Bedding, furniture and other comfort applications
- Extremely soft, used as top-layers
- Box foam or continuous machine
- Can be produced without auxiliary blowing agents using EO-rich polyols
- Almost exclusively produced with TDI but can be MDI

VORASURF™ DC 5951LV FOR TDI / MDI HYPER-SOFT FOAMS

	TDI, 22 kg/m³	TDI, 28 kg/m³	TDI, 40 kg/m³	MDI, 28 kg/m³
Formulation Ingredients				
EO Rich Polyol blend	100	100	100	100
DI Water	4.5	3.7	2.1	3.5
VORASURF™ DC 5951LV	1.5	1.5	1.5	2
Catalyst	0.25	0.25	0.25	0.3
VORANATE™ T-80 isocyanate	49	41.7	26.7	
PAPI™ 23 or Polymeric MDI isocyanate				53.2
Index	97	97	97	90
Properties				
Density (kg/m³) ISO 845-88	22.05	25.5	39.9	28.8
CFD @25 % (kPa) ISO 3386-1	1.08	1.13	1.02	
IFD@25 % (kPa) ASTM D 3574				1.7
Resiliency (%) ASTM 3574	37.7	41.8	42.2	25.8
Airflow (dm³/sec) ISO 7231	4.7	4.5	4.5	4.5
Compression Set @90% (%) ISO 1856	8.7	6.3	3.7	3.8
Foam feel	Good	Good	Good	Good

Box foam lab results

VORASURF™ DC 5951LV enables:

- processing of multiple densities hyper-soft foams
- formulation with both TDI and MDI

VORASURF™ DC 5951LV FOR TDI HYPER-SOFT FOAMS

	1	2	3
Formulation Ingredients			
EO Rich Polyol blend	100	100	100
DI Water	3.7	3.7	3.7
VORASURF™ DC 5951LV	1.4	2	2.6
Catalysts	0.3	0.3	0.3
VORANATE™ T-80 isocyanate	42.2	42.2	42.2
Index	100	100	100
Properties			
Density (kg/m^3) ISO 845-88	24.3	24.5	24.3
CFD @25 % (kPa) ISO 3386-1	1.49	1.53	1.58
Compression Set @90% (%) ISO 1856	5.5	5.9	5.6
Airflow (dm^3/sec) ISO 7231	5.1	5.0	5.0

Semi continuous machine run

VORASURF™ DC 5951LV shows wide processing latitude with TDI hyper-soft formulations at semi-continuous scale

PERFORMANCE, QUALITY, RELIABILITY AND PROFITABILITY

Surfactant	Conven-tional	Conventional with auxiliary blowing agents	Combustion modified CME	MDI Visco elastic	Hyper soft	Flex molded	Salient features
VORASURF™ DC 5950LV	✓		✓	✓			Conventional high-density foam, combustible modified polyether foam, VE foam
VORASURF™ DC 5906LV	✓	✓	✓	✓			Conventional med-high density foam, conventional with auxiliary blowing agent, VE foam applications, high filler content foam
VORASURF™ DC 198LV	✓		✓	✓		✓	Versatile surfactant, VE foam, molded flexible foam, foamed adhesives, one component foams
VORASURF™ DC 5951LV	✓	✓	✓	✓	✓	✓	Versatile surfactant, low- medium density foam, conventional with Auxiliary Blowing agent or vacuum, VE foam, Hyper soft foam
VORASURF™ FF 5959				✓	✓	✓	Co-additive to enable finer cell size or to induce pneumaticity in foam

✓: Product is suitable. Relative effects of surfactants are based on studies in standard formulations. Formulation to formulation differences may vary.

Learn more and order samples:

www.dow.com/vorasurf

Contact our Technical Customer Service:

North America:
na.info@dow.com

Latin America:
latam.info@dow.com

Europe, Middle-East and Africa:
europe.info@dow.com

India:
info.india@dow.com

South Korea:
korea.info@dow.com

Japan:
japan.info@dow.com

China:
china.info@dow.com

South East Asia & Pacific:
aanz.info@dow.com