



DOW

®

Polyurethane Additives

**Lighter and more comfortable
bedding and furniture foams
with VORASURF™ innovation**

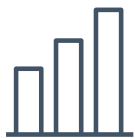
Felipe Nascimento
August 2022

VORASURF™
Silicone polyurethane additives by 

OUTLINE

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

THIS IS DOW



2021 NET SALES

\$55B



EMPLOYEES

~35,700



MANUFACTURING SITES

104 sites

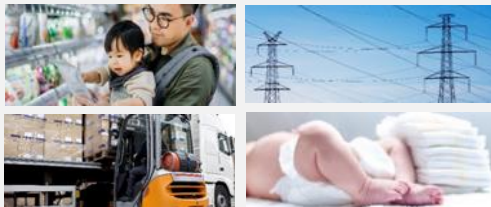


GLOBAL REACH

31 countries

in which Dow manufactures products

PACKAGING & SPECIALTY PLASTICS



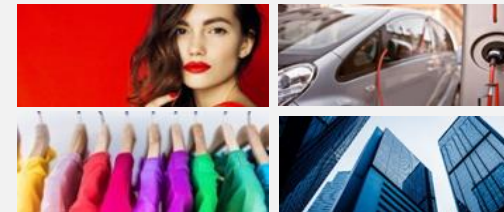
- Flexible and rigid packaging for food and consumer
- Health and hygiene
- Artificial turf
- Pressure pipe and power/telecom transmission applications

INDUSTRIAL INTERMEDIATES & INFRASTRUCTURE



- Insulation
- **Furniture and bedding**
- Footwear
- Infrastructure applications
- Solvents
- Lubricants
- Surfactants
- Heat transfer fluids
- Energy
- Life sciences
- Consumer applications

PERFORMANCE MATERIALS & COATINGS



- Personal & home care
- Mobility and transportation
- Building and infrastructure
- Consumer and electronics
- **Industrial & chemical processing**
- Interior and exterior architectural paints
- Traffic and road markings
- Industrial and protective coatings used in metal, wood, leather and paper applications

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

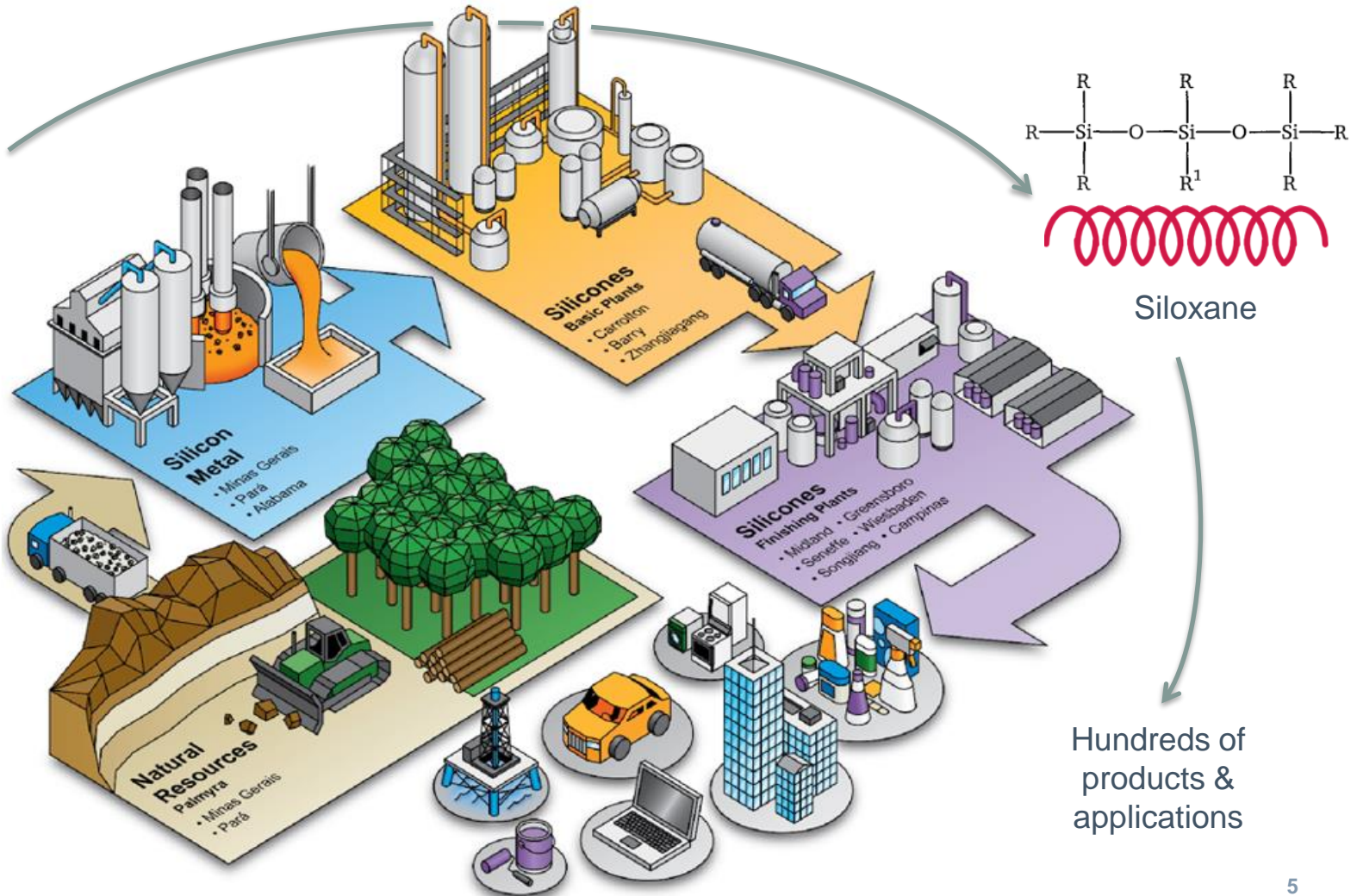
Si CHAIN



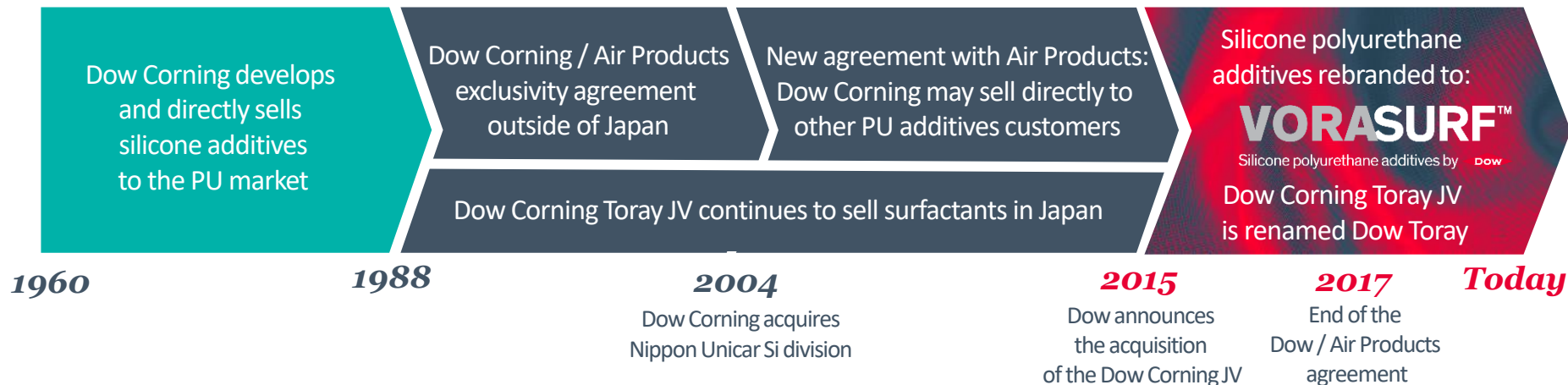
Silicon metal



Quartz



60 YEARS OF HISTORY IN SILICONE SURFACTANTS FOR POLYURETHANES



Industry standards

- VORASURF™ DC 198 Additive
- VORASURF™ DC 5906 Additive
- VORASURF™ DC 5986 Additive
- VORASURF™ DC 5933 Additive

All our silicone polyether offerings are hydrolytically stable

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

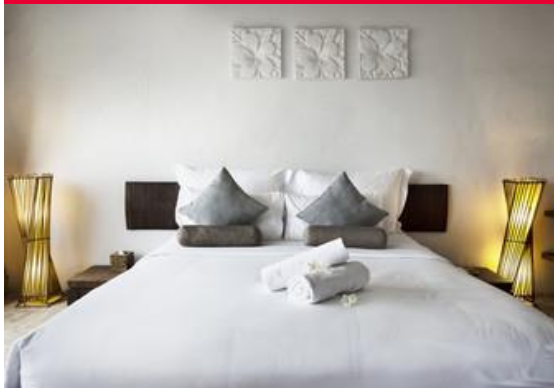
Minimize coalescence
and stabilization

KEY FOAM TYPES & INDUSTRY DRIVERS IN FLEXIBLE 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					

VORASURF™ FLEXIBLE POLYURETHANE FOAM ADDITIVES

Bedding and Furniture



Surfactant	Properties
VORASURF™ FF 5955	Versatile surfactant, low- medium density foam, VE foam, Hyper soft foam, CME
VORASURF™ FF 5959	Co-additive to enable finer cell size or to induce pneumaticity in foam
VORASURF™ DC 5188	Very low to low density continuous slabstock and box foam for furniture applications, particularly suitable for cost-driven markets

VORASURF™ FF 5955 ADDITIVE IN COMBUSTIBLE MODIFIED ETHER (CME) FOAM

- Density range: 22 – 100 kg/m³
- 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



These are typical properties, not to be construed as specifications

VORASURF™ FF 5955 ADDITIVE FOR TDI CONVENTIONAL CME FOAMS

Formulation Ingredients	<i>pphp</i>	
VORANOL™ WK 3138 Polyol	100	100
Flame Retardants	35	35
Additives	0.4	0.4
DI Water	4.4	4.4
VORASURF™ FF 5955 Additive		0.6
VORASURF™ DC 5950 Additive	0.5	
Catalysts	0.55	0.55
VORANATE™ T-80 Isocyanate	52.02	52.02
Index	100	100

Box foam lab results

VORASURF™ FF 5955 Additive offers

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

Property	DC 5950	FF 5955
Physical Property Testing		
Density (kg/m³) ISO 845-88	32.0	31.9
CFD @25 % (kPa) ISO 3386-1	3.44	3.37
Tensile strength (kPa) ISO 1798	101.7	95.90
Tear strength (N/m) ASTM 3574	366.7	380.0
Compression set 90% ISO 1856	12.5	10.8
Airflow (dm³/sec) ISO 7231	2.57	2.42
BS 5852 / Cribb 5 Testing Results		
Time to Extinguish (s)	260	275
Weight Loss (g)	32	40
CRIBB 5	PASS	PASS

VORASURF™ FF 5955 Additive enables to formulate foams with **comparable performance** to those formulated with VORASURF™ DC 5950LV

VORASURF™ FF 5955 ADDITIVE IN HYPER-SOFT (HS) FOAM

- Density range: 20 – 70 kg/m³
- 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



These are typical properties, not to be construed as specifications.

VORASURF™ FF 5955 ADDITIVE FOR TDI / MDI HYPER-SOFT FOAMS

	TDI, 24 kg/m ³	TDI, 28 kg/m ³	TDI, 42 kg/m ³	MDI, 32 kg/m ³
Formulation Ingredients				
EO Rich Polyol blend	100	100	100	100
DI Water	4.5	3.7	2.1	3.5
VORASURF™ FF 5955 Additive	2	2	2	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/m ³)	23.9	27.6	41.8	32.2
CFD @25 % (kPa)	1.35	1.36	1.11	-
Resilience (%)	38.5	45.9	52.7	49.6
Airflow (dm ³ /sec)	5.15	4.45	4.25	5.26
Compression Set @90% (%)	9.8	6.2	2.6	3.9
Foam feel (sensory panel)	Good	Good	Good	Good



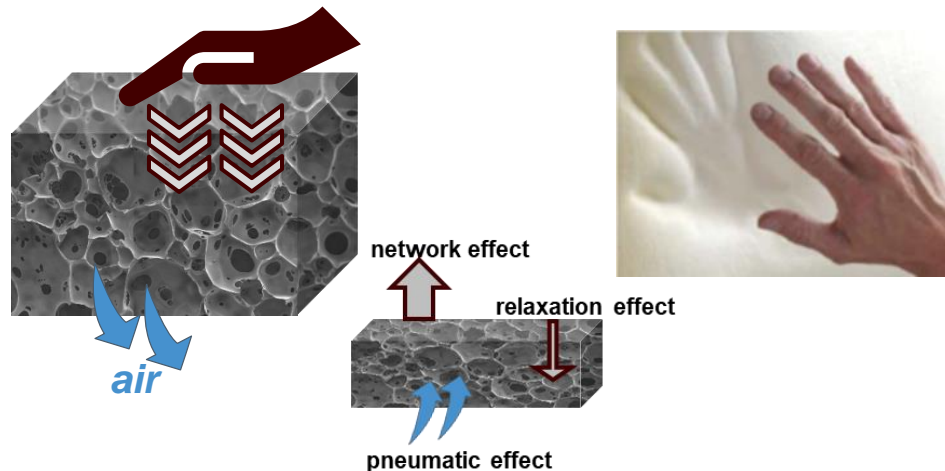
Box foam lab results

VORASURF™ FF 5955 Additive enables:

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

VORASURF™ FF 5955 + VORASURF™ FF 5959 ADDITIVES IN 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 T_g benefits



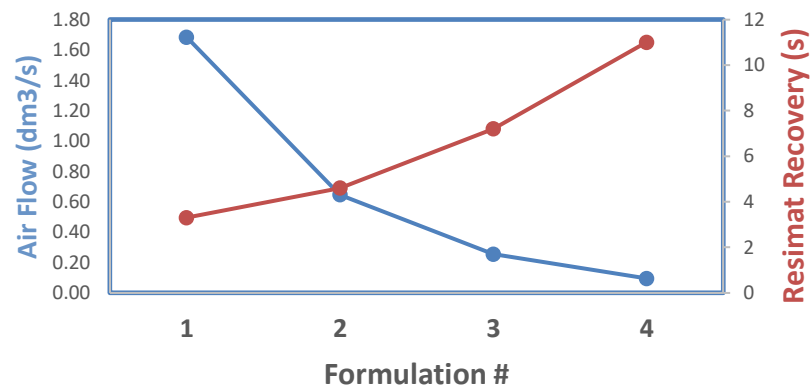
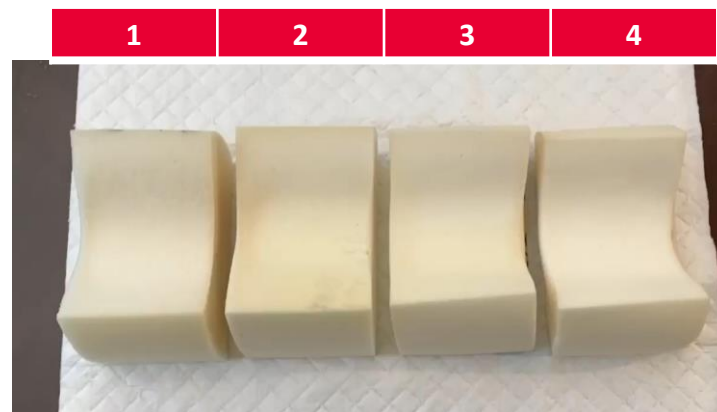
Chemical VE: slow recovery mainly caused by relaxation effect, that relies on the T_g. It is sensitive to environmental temperature: if $T_{ambient} < T_g$, polymer is stiffer.

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.

These are typical properties, not to be construed as specifications

VORASURF™ SURFACTANTS FOR MDI EO-RICH VE / PNEUMATIC VE (32 KG/M³)

	1	2	3	4
Formulation Ingredients				
MDI visco Polyol blend	100	100	100	100
DI Water	2.2	2.2	2.2	2.2
Auxiliary BA	7.0	7.0	7.0	7.0
VORASURF™ FF 5955	1.0	0.8	0.6	0.2
VORASURF™ FF 5959		0.2	0.4	0.8
Catalysts	0.25	0.25	0.25	0.25
PAPI™ 23	52.8	52.8	52.8	52.8
Index	82	82	82	82
Properties				
Density (kg/m ³)	32.2	32.8	32.3	31.4
Airflow (dm ³ /sec)	1.73	0.65	0.25	0.09
Compression set 90%(%)	2.51	2.8	2.58	2.57
Resimat Recovery (s)	3.3	4.6	7.2	11.0



VORASURF™ SURFACTANTS FOR TDI EO-RICH VE / PNEUMATIC VE (35 kg/m³)

	1	2	3	4	5
Formulation Ingredients					
TDI visco Polyol blend	100	100	100	100	100
DI Water	3.0	3.0	3.0	3.0	3.0
VORASURF™ DC 198	3.0				3.0
VORASURF™ FF 5955		1.5	2.0		
VORASURF™ FF 5951				3.0	
VORASURF™ FF 5959			1.0	1.0	1.0
VORANATE™ T-80 Isocyanate	47.0	47.0	47.0	47.0	47.0
Index	95	95	95	95	95
Properties					
Foam feel*	good	good	great	great	good
Airflow (dm ³ /sec)	0.184	0.355	0.035	0.199	0.112
Resimat max velocity [mm/s]	24.09	84.02	18.08	32.81	19.43

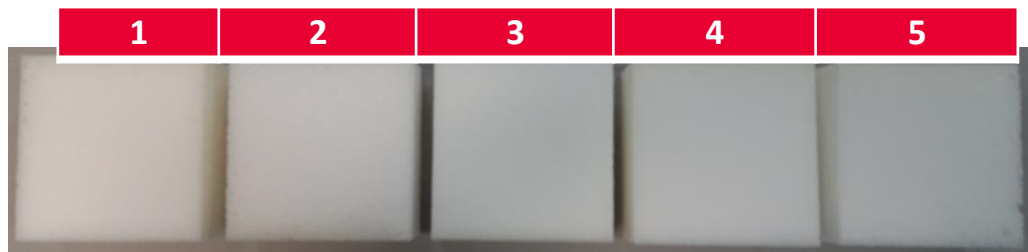
*Internal sensory panel

Box foam lab results

VORASURF™ DC 198, FF 5955 and FF 5959 Additives offer versatile performance in TDI VE EO-rich polyols

VORASURF™ FF 5959 Additive:

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



VORASURF™ DC 5188 ADDITIVE IN LOW AND VERY LOW DENSITY CONVENTIONAL FOAMS

- Density range: 8 – 15 kg/m³
- 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

These are typical properties, not to be construed as specifications



VORASURF™ DC 5188 ADDITIVE FOR TDI CONVENTIONAL LOW DENSITY BOX FOAM

Formulation Ingredients	Density 9.5 kg/m ³
VORANOL™ 3011 Polyol	100
Water	6.6
Methylene Chloride	28.4
VORASURF™ DC 5188	3.6
Tin catalyst	0.51
Amine catalyst	0.20
VORANATE™ T-80 Isocyanate	90.74
Index	121

Property	VORASURF™ DC 5188
Density (kg/m ³)	9.5
CLD @40% (kPa)	2.4
IFD @25 % (N)	130
IFD @40 % (N)	168
IFD @65 % (N)	256
Resiliency (%)	31
Airflow (dm ³ /s)	0.31
C. Set @90% (%)	15.5
Block height (m)	1.25



VORASURF™ DC 5188 has high efficiency to stabilize conventional formulations with low density, with **good block height**

PERFORMANCE, QUALITY, RELIABILITY AND PROFITABILITY

Surfactant	Conven- tional	Conventional with auxiliary blowing agents	Combustion modified CME	MDI Visco elastic	Hyper soft	TDI Visco elastic	Features
VORASURF™ FF 5955 Additive	✓	✓	✓	✓	✓	✓	Versatile surfactant, low- medium density foam, conventional with Auxiliary Blowing agent or vacuum, VE foam, Hyper soft foam and CME
VORASURF™ FF 5959 Additive				✓	✓	✓	Co-additive to enable finer cell size or to induce pneumaticity in foam
VORASURF™ DC 5188 Additive	✓	✓					Versatile surfactant, suitable fro low to very low density conventional foams

These are typical properties, not to be construed as specifications

✓ : 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

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