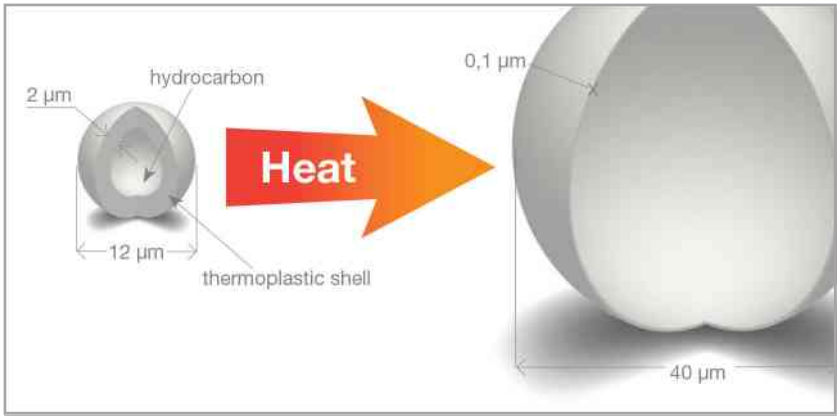
Expancel® Microspheres

application guide - Paints and Coatings

Boud Minerals

Introduction to Expancel® Microspheres

Expancel® microspheres are small spherical plastic particles. The microspheres consist of a polymer shell encapsulating a gas. When heated, the internal pressure from the gas increases and the thermoplastic shell softens, resulting in a dramatic increase of the volume of the microspheres. The gas remains inside the sphere.



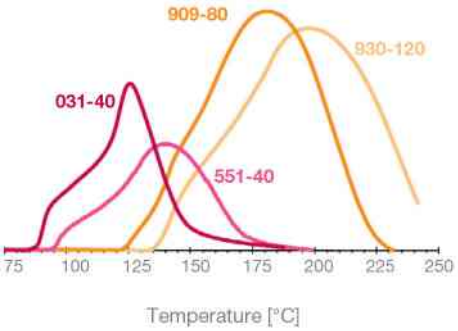
Expansion of Expancel microspheres. This results in a dramatic decrease of the density. Typical values are from 1000 down to 30 kg/m³ (8.35 to 0.25 lbs/gal).

Properties of Expancel® Microspheres

Thermomechanical properties

Expancel is available with expansion temperatures in the range of 80 - 190°C (175 - 375°F).

Expancel can normally be stored for a long time at room temperature without negative effects on the properties; very high temperatures should be avoided.



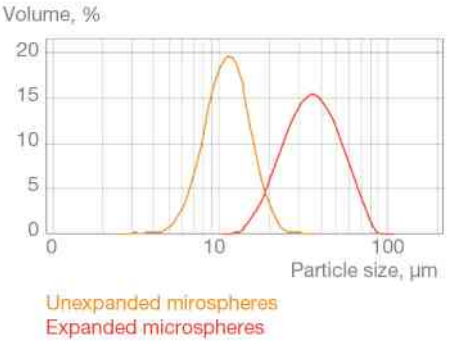
Expansion curves for some Expancel grades.

Elasticity

Expancel microspheres regain their original volume when the pressure is released. Expancel can withstand several cycles of loading / unloading without breaking.

This is very important when the microspheres are used in shock absorbent materials but also when pumping the microspheres; alone or in various mixtures.

Illustration of what happens when Expancel DE is first put under pressure and later returned to ambient pressure.



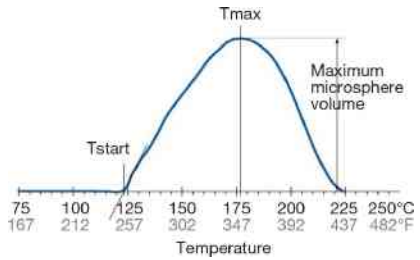
Expansion

The expansion characteristics are measured using Thermo Mechanical Analysis (TMA). The sample is heated at a constant rate (in our analysis 20°C/min, 36°F/min) and the volume of the sample is measured. A graph representing the expansion characteristics of the sample is recorded (figure 1). From this graph, the values are calculated. Typical TMA-graphs of a few grades are shown in figure 2.

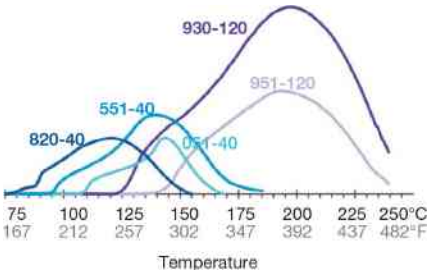
It is important to remember that if T_{max} is 140°C (284°F) this does not necessarily mean that the process temperature should be 140°C.

The expansion process is a delicate balance. The relationship between the softening of the shell, gas tightness of the shell and pressure increase from the gas inside the microsphere are important. The balance is affected by a number of factors such as:

- Polymer composition of the shell
- Type of gas inside the microspheres
- Chemicals in contact with the shell
- Outer pressure
- Free expansion or in a matrix
- Type of matrix
- Heating rate



The graph from a typical TMA analysis.



Typical graphs of some Expancel grades.

The polymer composition of the shell is important as it determines the glass transition temperature and the gas permeability of the shell. The gas inside the microspheres determines the pressure inside the shell at a given temperature.

Contact with chemicals can decrease the glass transition temperatures and thereby lower T-start of the microspheres. Chemicals might also influence the barrier properties and increase the gas permeability leading to the smaller density reduction.

Inside the matrix the gas permeability can be improved due to its barrier properties. If the microspheres are under pressure from the outside the decrease in pressure between the inside and the outside of the shell can result in a higher T-start and smaller density reduction.

A cross-linking matrix, eg rubber or thermoset, can also prevent some of the possible maximum pressure expansion of the spheres.

Thermal Stability

The thermal stability of different grades of pre-expanded microspheres shows a clear difference. The different thermomechanical behaviour of various Expancel grades makes it possible to choose an optimal grade for each process and application.

Expancel Grade		Particle Size	
820	Low	20	Low
642		40	
551		80	
461		100	
920		120	
009		140	High
930	High		

Ranking of thermal stability.

Particle Size

Expancel microspheres are available in different sizes between 20 and 120 microns after expansion.

The size of Expancel is measured by laser diffraction, Low Angle Laser Light Scattering (LALLS). The microspheres in any given sample are not all the same size. There is a particle size distribution.

All spheres in this sample have approximately the same relation between diameter and shell thickness. This means that the large microsphere has greater shell thickness - and hence a lower gas permeability - and therefore it will expand slightly better than a smaller microsphere in the same sample. This means that the particle size distribution that is rather narrow for unexpanded microspheres will increase after expansion.

The density of the microspheres has an influence on the particle size. For instance, size 40 microspheres at density 30 kg/m^3 (0.25 lbs / gallon) has about the same size as size 80 microspheres at a density of >100 kg/m^3 (0.83 lbs / gallon).

Chemical Resistance

Expancel can be used in contact with many chemicals, including solvents, without discoloration or negative effects on expansion or other properties.

High Pressure

Expancel DU has a good resistance to high pressure. The ability of Expancel DE to withstand high pressure varies considerably with density and particle size. Larger microspheres and microspheres with higher density lead to better high pressure resistance.

Closed Cells

Expancel microspheres are closed cells, which is an important property in many applications.

In a waterborne coating, such as paint, this means that the microspheres have a low water absorption but the coating will have a high water permeability. This is caused by the interface between the microspheres and the surrounding matrix.

In this interface, the moisture transport is quick compared with the moisture transport in the film itself. This allows moisture in the substrate to evaporate.

Gas Tightness

The polymer shell of Expancel microspheres has been carefully designed to have low gas permeability. This is important in many applications since it keeps the microspheres from leaking gas into the matrix.

Gas leakage into the matrix can produce pinholes in the matrix and an increased density. The degree of gas tightness varies with the grade.

Mechanical Strength

Expancel microspheres are able to withstand many cycles of loading / unloading without breaking. However as the density of the microspheres decreases this ability will decrease as well.

Some chemicals may also affect the elasticity and mechanical strength.

Surface Modification

Expancel microspheres can be used to achieve a nice velvet-like surface by adding a small amount to a coating. This can be done on metal, paper, fabrics, etc.

Insulation

Gas-filled closed cells are beneficial in both electrical and thermal insulation applications.

Expancel microspheres are used in cable filling compounds. In Petrolatum, the relative permittivity was reduced from 2.2 to 1.6 by adding 4% of Expancel DE.

The density was reduced from 900 to 450kg/m^3 (7.5 to 3.8 lbs /gallon).

The thermal conductivity of thermoplastics has been reduced from 0.2 to 0.06 W/m*K (1.4 to 0.4 Btu*ft/h*ft2*^{o}F). The density was approximately 300 kg/m^3 (2.5 lbs/gallon).

Thermal conductivities of 0.07 W/m*K (0.5 Btu*ft/(h*ft2*^{o}F) are reported on 1 to 1.5mm (0.4 to 0.6in) thick coatings.

Internal Pressure

Expancel microspheres can be added to produce an internal pressure in the finished product. This is used in many applications, for example printing blankets and pipe insulation for offshore applications.

Expancel microspheres are also used to improve the process. They can, for example, be mixed with a filler before adding a binder. Here the microspheres create a pressure in the mold and, together with the binder, fill all the voids between the filler particles.

Another example is injection molding where the pressure is used to counteract the shrinking that occurs when the product is cooled.

Dispersability

Expancel WU is easy to disperse uniformly in an aqueous dispersion, but care must be taken to choose the correct type of dispersing equipment. There are grades that are easier to disperse and there are others that are more difficult.

The grades that are more difficult to disperse may require a rotor / stator mixer like a Silverston mixer, while the grades that are more easily dispersed may only require a simple propeller stirrer for proper dispersion.

Expancel Grade		Particle Size	
642 WU	Difficult	20	Difficult
551 WU		40	
461 WU		80	
007 WUF	Easy	100	
054 WUF	Easy	120	
920 WUF	Easy	140	Easy

Ranking of Dispersability

Expancel DU can be easily dispersed using general dispersing equipment.

Expancel WE is fairly easy to disperse in an aqueous dispersion using proper equipment.

Expancel DE is very easy to disperse using general dispersing equipment. Care must be taken to avoid dusting because of the extremely low density.

Application Techniques

There are many different processes in which Expancel microspheres can be used:

Impregnation - a common technique for processing non-wovens

Lamination - Expancel in a core material will create a lightweight material with resilient properties

Coating - Expancel in a coating layer will add thickness and improve surface characteristics

Spraying - Spraying is possible

Molding - Expancel DE can be mixed with many thermoset materials to form a moulded product with low density

Matting and anti-slip - Expancel can be mixed in a coating to modify surface properties like gloss and anti-slip

Injection molding - Expancel DU or MB can be used in injection molding

Extrusion - Expancel DU or MB can be used in extrusion of profiles, cables and hoses

Designation

Every product has its own unique name depending on the composition of the shell, the particle size, the delivery form and, if the microspheres are expanded, the density of the microspheres.

The first three to four characters, the grade, are a code for the polymer type and type of hydrocarbon, eg FG = food grade.

The two to four letters indicate the delivery form, eg W = wet; D = dry; U = unexpanded; E = expanded; MB = masterbatch.

The two to three digits after the letter indicate the approximate particle size in microns after expansion.

The final d30 indicates that the true density of the dry product is 30 kg/m^3 (0.25 lbs/gallon). If the product is WE, the density value refers to the density as a dry product.

Delivery Forms

Expancel microspheres can be delivered in a wide variety of different forms.

Unexpanded products are used when the processing generates enough heat for the spheres to expand and the matrix allows an expansion.

Pre-expanded products are used in processes where no, or not sufficient, heat is generated during production or when, for example, the matrix is cross linking at temperatures lower than the expansion temperature of the microspheres.

Wet microspheres (WU, WUF, WE) are chosen for processes that contain water while the dry versions (DU, MB, DE / DET) are chosen when no water can be present.

The unexpanded microspheres act as foaming agents while the pre-expanded microspheres can be seen as lightweight fillers.

Variety	Description	Solid Content %	Density of Expancel kg / m^3	Density of Expancel lbs / gallon
WU	Wet, unexpanded	60 to 80	1000 to 1300	8.3 to 10.8
WUF	Wet, unexpanded	60 to 80	1000 to 1300	8.3 to 10.8
DU	Dry, unexpanded	>99	~1000	~8.3
DUT	Dry, treated, unexpanded	>99	~1000	~8.3
MB	Dry, unexpanded mixed with a matrix	62 to 65	1000	8.3
WE	Wet, expanded	15	~ 30	0.25
DE	Dry, expanded	>99	25 to 70	0.21 to 0.58
DET	Dry, treated expanded	>99	25	0.21

Delivery forms of Expancel

Storage

Expancel microspheres are very stable when stored in a place with normal temperatures.

Expancel WU(F) must be stored in a cool, well-ventilated area in a way that keeps the microspheres from drying.

If microspheres begin to dry because the bag in the drum is open or punctured, the dispersability will drop rapidly causing problems such as white spots or unevenness in the finished product.

Because of this, it is very important to close a bag when it is opened and only some of the content used.

Expancel DU(T) can be damaged by excessive heat during storage. This heat can cause leakage of the encapsulated hydrocarbon resulting in poor expansion.

Expancel MB must be stored in a cool, well-ventilated area away from direct sunlight.

Expancel WE must be stored in a cool, well-ventilated area in a way that keeps the microspheres from drying. Poor dispersability will result from allowing drying to take place.

Separation can also take place as a result of the large density difference between the microspheres and the surrounding water. This is best prevented by storing the bags lying down flat.

Expancel DE(T) must be stored in a dry, cool, well-ventilated area to control airborne particles.

Recommendations

Form	pH	Grade	Recommended Use
Unexpanded			
WU(F)	Acidic	820	
DU(T), MB	Acidic	642	
	Acidic	551	
	Acidic	461	Low temperature applications
	Acidic	051	
	Alkaline	920	Medium or high temperature applications
	Neutral	031	
	Neutral	007	Very good expansion capacity
Expanded			
WE, DE(T)	Acidic	461	Medium solvent resistance
	Alkaline	920	Excellent solvent resistance

Expancel® Microspheres recommended grades

Polyester Putties
461 DET 40 d25
920 DET 40 d25
461 DE 20 d70 (alternative grade)
461 DE 20 d60 (alternative grade)

Thermoset Materials
461 DET 40 d25
920 DET 40 d25 (alternative grade)
551 DU 40 (alternative grade)

Printing Inks Water
007 WUF 40

Tech Textiles & Non-Woven
551 WU 40
007 WUF 40

Paint
461 WE 40 d36
461 WE 20 d36 (alternative grade)
921 WE 40 d24 (alternative grade)
461 DE 20 d70 (alternative grade)

Cable Gel
461 DET 40 d25
920 DET 40 d25 (alternative grade)

Vinyl Foam
909 DU 80
051 DU 40 (alternative grade)
920 DU 40 (alternative grade)

Crack Filler
461 WE 40 d36

Cultured Marble
461 DET 40 d25
551 DE 40 d42 (alternative grade)

Model Making Board
461 DET 40 d25
551 DE 40 d42 (alternative grade)
920 DET 40 d25 (alternative grade)

Caulks and Sealants
461 DET 40 d25
920 DET 40 d25 (alternative grade)

UBC and Sealants
909 DU 80
930 DU 120

Thermoplastics
930 MB 120
951 MB 120
930 DU 120 (alternative grade)
951 DU 120 (alternative grade)

Lightweight Foam
551 DU 40
551 DE 40 d42
930 DU 120 (alternative grade)
951 DU 120 (alternative grade)

Silicon Rubber
053 DU 40
909 DU 80
920 DET 40 d25 (alternative grade)

Shoe Soles
093 DU 120
930 DU 120
951 DU 120
950 DU 80 (alternative grade)
930 MB 120 (alternative grade)

Leather Finishing
461 WE 20 d36
461 WE 40 d36
461 DET 40 d25 (alternative grade)

Artificial Leather
909 DU 80
920 DU 40
093 DU 120
051 DU 40 (alternative grade)

Wall and Roof Coating
461 WE 40 d36
461 DET 40 d25 (alternative grade)

Modelling Clay
461 DET 40 d25
461 WE 40 d36 (alternative grade)

Thermal Insulation Coating
461 WE 40 d36
921 WE 40 d24 (alternative grade)

Concrete
461 WE 40 d36
921 WE 40 d24 (alternative grade)

Expancel® Microspheres in Paint

Expancel gives advantages to paint:

● reduced density ● better applicability ● higher water vapor permeability ● lower water absorption ● better filling capacity ● lower material cost ● shorter drying time ● improved matting effect ● low emission of VOC

Waterborne Paints

As an additive to waterborne paints an Expancel WE grade is recommended. These are expanded to a very low density, the true density being 36 kg/m^3 (0.30 lbs/gal). They are available in three sizes, with a mean particle diameter of approximately 80, 40 and 20 µm respectively. The low density microspheres are moist, which makes handling easier. 921 WE 40 d24 is a chlorine-free alternative.

Expancel grades used in the paint industry:

Grade	461 WE 40 d36	461 WE 20 d36	921 WE 40 d24
Particle size weight average µm	30 - 50	20 - 30	35 - 55
True density (in air) kg/m^3 (lbs/gal)	36±3 (0.3 ± 0.025)	36±3 (0.3 ± 0.025)	24±3 (0.2 ± 0.025)
Solid content %	15±2	15±2	15 ±1.5

Properties of Paints with Expancel®

Reduced Weight

By using 0.5% Expancel, the weight of a 12 litre (3.17 gal) paint pot will be reduced from about 18kg (39.7lbs) to 14kg (30.9lbs).

The density of the paint decreases to 1.20kg/cm^3 (10 lbs/gal) and, thus, the volume per kg paint increases by 30%.

Application

The paint can easily be applied by roller or brush because of the spherical form of the particles. Spraying in airless spray guns is also possible. A lightweight paint containing Expancel, with equal viscosity as a conventional paint, does not splash to the same extent when using a roller. The expanded microspheres are highly elastic and withstand hard mechanical treatment without damage.

In textured coatings, Expancel makes it easier to get the structural filler more evenly distributed.

The drying time of a paint with Expancel will be shorter due to a higher solid content by volume.

Water Vapor Permeability

Paints with Expancel WE are more permeable than corresponding standard paints. Expancel WE can be used as an additive to regulate the water vapor permeability in light exterior paint films and primer coatings.

Water Absorption

Paints with Expancel WE are more hydrophobic than corresponding standard paints. One of the reasons for the degradation and destruction of a paint film is the water absorption. The addition of Expancel WE will decrease the water absorption causing a delay in the destruction and reduce the rate of destruction in paint.

Hiding Power - Opacity

One of the objectives when making a lightweight formulation with Expancel is to replace part of the heavy fillers with Expancel microspheres. It is then important to achieve a very high packing degree in order to improve the hiding power. Unfilled spaces between the particles are not to be recommended in this case as the microspheres themselves contribute with a lot of unfilled spaces in the film.

Surface Finish

Expancel microspheres can be used as a matting agent in paints with low gloss. The microspheres provide a matt fine structured finish to the surface.

Filling Capacity

A paint with Expancel has a better filling capacity, which means a higher capacity to cover cracks in the substrate. This is achieved by the increased solid content by volume. Another advantage is shorter drying time.

Viscosity

A suitable level of viscosity of a lightweight paint with Expancel can easily be obtained by using more or less thickener. A decrease in viscosity by adding water is not recommended since the opacity will be negatively affected.

If Expancel microspheres are added to a conventional formulation, or to a formulation not intended to contain any lightweight filler, the viscosity will increase considerably.

Material Cost

Expancel has a low binder demand because the oil absorption on a volume basis is very low. This makes it possible to increase the Pigment Volume Concentration without sacrificing quality. The raw material costs per litre paint will be lower with Expancel microspheres.

A standard formulation of an interior flat wall paint will show a cost saving of 3 - 5% per litre by using Expancel, while an exterior paint will show a cost saving of approximately 7%.

Storage Stability

The storage stability of the paint will not be affected when using Expancel microspheres as a lightweight filler. There is no risk of Expancel microspheres flotating at a viscosity suitable for painting. pH should be kept below 8.3 in order to avoid discolouration.

Health Aspects

Expancel microspheres in lightweight paints will not give the users any health or safety problems.

Preparation of Lightweight Paints with Expancel WE

Two things are of utmost importance concerning the preparation of Expancel. The addition of Expancel ought to take place just after dispersing the heavy fillers and the peripherical speed should be high enough to disperse Expancel WE microspheres completely.

The following dispersion programme is suitable to obtain completely dispersed particles at the manufacturing of a lightweight paint with Expancel WE.

Water
Dispersing agents
Preservative
Defoamer
Wetting agent
Pigment
Opacifying extender
Fillers

The mixture is dispersed for 10 minutes at a peripherical speed of at least 10 m/s (32.8 ft/s).

Expancel WE

Thickener
pH-buffer
Coalescent

Disperse for 5 minutes at a peripherical speed of at least 10 m/s (32.8 ft/s).

Binder

Disperse for 5 minutes at a lower peripherical speed eg 5 m/s (16.4 ft/s).

Defoamer
Water

The components are mixed together by means of a high speed dissolver. The ingredients are added in the order suggested. It is very important to achieve a mixture with no agglomerates.

Therefore, dispersion should take place in three steps during preparation:

1. for ten minutes after addition of the mineral filler.

2. for five minutes after addition of the thickeners to the mixtures (if cellulose thickener in powder form is used it must be dissolved and the mixture thickened before the dispersion of Expancel WE).

3. for five minutes after addition of the binder.

The peripherical speed of the dissolving disc should be at least 10 m/s (32.8 ft/s). A lower speed can result in incomplete dispersion of the microspheres. The air, which is often whipped into the paint during preparation, is removed by a special deaeration disc in laboratory scale.

If necessary, a smaller amount of a suitable anti-foaming agent can be helpful. In this phase the dissolver may work at a low speed to give the air bubbles a good chance to escape.

Please note that dispersion and deaeration might be more important for paints with Expancel WE than for paints without microspheres.

Expancel 461 WE 20 d36 is recommended due to its good dispersability.

Dispersability of Expancel DE

The dry Expancel DE grades can be sprayed with water to make the handling easier. The DE grades obtain a proper dispersion at lower agitation compared to the WE grades.

The wetting procedure is performed rapidly. The microspheres can be wetted directly in the bag.

Comments to the Guiding Formulations

The viscosity was measured with a Brookfield RVT Viscosimeter spindle 6. The rheology of the guiding formulation shows a pseudoplastic flow.

The viscosity was determined after three days of storage.

In order to keep the consumption of binder on a low level in a lightweight paint it is of great importance to calculate the right packing degree of the used fillers. In such cases, parts of the heavy fillers can easily be replaced by microspheres without additional binder.

When kept in metal containers it is necessary to add an antirust agent to the formulation, usually sodium nitrite and sodium benzoate.

To prevent the growth of fungi in places with high humidity a fungicide may be added to the formulation.

The guiding formulations are based on laboratory tests only. A prospective user should determine the suitability of the formulations before adopting them on a large scale.

Formulation no 1

Interior flat paint containing 2% (0.3% dry) Expancel 461 WE 40 d36 vs corresponding standard paint.

	Standard Paint	Modified with 2% Expancel 461 WE 40 d36
Water	400.0	409.0
Sodium tri polyphosphate, 10%	6.0	6.0
Pigment disperser A, 10%	6.0	6.0
Proxel GXL	2.0	2.0
Triton CF-10, 10%	20.0	20.0
Foamaster 8034	2.0	2.0
Tylose MHB 30000YP	3.0	3.0
Titaniumdioxide R-FD-1	120.0	120.0
Socal P2	60.0	90.0
Microdol Super	120.0	140.0
Omya BLP-2	118.0	50.0
Expancel 461 WE 40 d36, 15%	--	20.0
Acrylic binder emulsion, 60%	100.0	100.0
Texanol	10.0	10.0
Foamaster 0	2.0	2.0
Water	16.5	11.5
AMP 95	2.5	1.0
Acrysol TT-935, 30%	12.0	8.5
Total	**1000.0**	**1000.0**

Constants and properties

Specific Gravity	g/cc (lbs/gal)	1.40 (11.7)	1.22 (10.2)
Solid Content, weight	%	49.8	47.8
Solid Content, volume	%	26.9	34.7
Viscosity Brookfield #6, 50 rpm	mPa s	7900	5400
PVC	%	72.0	80.9
Hiding Power -			
Contrast ratio gap clearance	180 µm	98.8	97.5
Film thickness	75 µm dry	97.8	97.5
Brightness 457mm		89.5	90.5
Gloss 60°		2	2
pH		8.6	8.3
Cost saving (approx)	%	--	4.3

Formulation no 2 - 3 - 4

Interior flat paint containing Expancel 461 WE 20 d36 vs corresponding standard paint.

	Standard Paint	Modified with Expancel 461 WE 20 d36		
		2%	3%	4%
Water	245.0	255.0	255.0	275.0
Sodium tri polyphosphate, 10%	6.0	6.0	6.0	6.0
Pigment disperser A, 10%	6.0	6.0	6.0	6.0
Triton CF-10, 10%	10.0	10.0	10.0	10.0
Proxel GXL	1.0	1.0	1.0	1.0
Foamaster 8034	2.0	2.0	2.0	2.0
Tiona 388	60.0	60.0	60.0	60.0
Socal P2	100.0	130.0	145.0	160.0
Omya Violet D	170.0	140.0	140.0	140.0
Calcium carbonate 5 µm	160.0	105.0	75.0	50.0
Talcum M15	50.0	50.0	50.0	50.0
Expancel 461 WE 20 d36, 15%	--	20.0	30.0	40.0
Cellosize QP-30000 H, 3%	30.0	60.0	50.0	40.0
Collacral PU 85, 30%	10.0	10.0	10.0	10.0
Ropaque Ultra E, 37.5%	30.0	30.0	30.0	30.0
Texanol	6.0	6.0	6.0	6.0
Acronol 290 D, 50%	100.0	100.0	100.0	100.0
Foamaster 0	2.0	2.0	2.0	2.0
Water	12.0	7.0	22.0	12.0
Total	1000.0	1000.0	1000.0	1000.0

Constants and properties

Specific Gravity	g/cc (lbs/gal)	1.40 (12.9)	1.29 (10.8)	1.19 (9.9)	1.12 (9.3)
Solid Content, weight	%	61.2	56.1	55.3	54.7
Viscosity Brookfield #6, 50 rpm	mPa s	6000	5700	5400	5300
PVC	%	81.0	86.0	88.0	89.0
Hiding Power (contrast ratio gap clearance)	180 µm	99.4	99.0	99.0	98.6
Spreading rate (contrast ratio 98%)	m^2/l	10.3	9.5	9.6	9.8
Wet Film thickness (contrast ratio 98%)	µm	97.0	105.0	104.0	102.0
Brightness 457mm		86.2	86.8	86.8	86.9
Gloss 60°		2	2	2	2
Scrub resistance DIN 53778		ca2000	ca2000	ca2000	ca2000
Cost saving (approx)	%	--	4.6	5.1	5.7

Formulation no 5

Exterior house paint containing 2% (0.3% dry) Expancel 461 WE 20 d36 vs corresponding standard paint.

	Standard Paint	Modified with 2% Expancel 461 WE 20 d36
Water	186.2	166.5
Natrosol 250 HR	3.8	3.5
Oratan 731, 10%	20.0	20.0
Triton CF-10, 10%	20.0	20.0
Sodium tri polyphosphate 10%	10.0	10.0
Nopco 8034	2.0	2.0
Ethylene glycol	10.0	10.0
Titaniumdioxide RK-B2	200.0	200.0
Microtalc IT Extra	70.0	100.0
Syenex 10 Nepheline Syenite	110.0	80.0
Expancel 461 WE 20 d36 15%	--	20.0
Acrylic binder emulsion, 60%	330.0	330.0
Propylene glycol	10.0	10.0
Proxel GXL	3.0	3.0
Texanol	10.0	10.0
Nopco NXZ	2.0	2.0
Water	13.0	13.0
Total	1000.0	1000.0

Constants and properties

Specific Gravity	g/cc (lbs/gal)	1.39 (11.6)	1.23 (10.3)
Solid Content, weight	%	60.8	61.5
Solid Content, volume	%	41.0	49.0
PVC	%	39.0	56.0
Viscosity Brookfield #6, 50 rpm	mPa s	4900	5000
Storage Stability	14 days at 50°C	Pass	Pass
Hiding Power -			
Contrast ratio gap clearance	180 µm	98.7	98.3
Film thickness	75 µm dry	98.2	97.7
Brightness 457mm		89.1	89.1
Gloss 60°		5	2
pH		8.3	8.1
Cost saving (approx)	%	--	6.8

Formulation no 6

Texture coating containing 3% (0.45% dry) Expancel 461 WE 20 d36 vs corresponding standard paint.

	Standard Paint	Modified with 3% Expancel 461 WE 20 d36
Water	150.4	152.4
Proxel GXL	2.0	2.0
Potassium tri polyphosphate 10%	0.8	0.8
Oratan 731, 25%	6.0	6.0
Foamaster NXZ	0.8	0.8
Titaniumdioxide	50.0	50.0
Syenex 20 Nepheline Syenite	100.0	70.0
Calcium carbonate, 2 µm	200.0	210.0
Cellosize QP-15000 H	6.0	6.0
Acrylic binder emulsion, 60%	200.0	200.0
Expancel 461 WE 20 d36 15%	--	30.0
Bentone EW, 10%	4.0	2.0
Texanol	10.0	10.0
Ethylene glycol	10.0	10.0
Structure filler Quartz-sand 0.02-0.5mm	90.0	70.0
Structure filler Quartz-sand 0.02-0.5mm	170.0	180.0
Total	1000.0	1000.0

Constants and properties

Specific Gravity	g/cc (lbs/gal)	1.70 (14.2)	1.33 (11.1)
Solid Content, weight	%	74.2	71.5
Solid Content, volume	%	54.0	60.0
PVC	%	70.0	79.0
Cost saving (approx)	%	--	7.8

Expancel® Microspheres in Thermal Insulation Coatings

Adding Expancel to an insulation coating reduces conductivity, which can help to reduce power consumption.

Expanded thermoplastic Expancel microspheres with low density are often used as a lightweight filler. There are also a number of valuable properties that are technically improved when Expancel microspheres are incorporated.

When expanded microspheres are added to an acrylic coating, an essential increase in thermal insulation is achieved. This is caused by gas-filled voids in the coating that are created by the expanded microspheres.

The thermal insulation coating is based on a highly elastic aqueous polymer emulsion. The volume extent of expanded Expancel microspheres could be adjusted depending on the required insulation capacity of the coating.

What Grade is Best?

As the coating is cured without additional heat, wet pre-expanded Expancel microspheres are recommend to build up a foamed structure in the coating; eg Expancel 461 WE 40 d36 or Expancel 921 WE 40 d24. Dry pre-expanded grades are also available.

Preparation

The thermal insulation coating can be mixed and prepared with rotational devices like dissolver, butterfly mixer or planetary mixer. Expancel microspheres are easily dispersed and can be added to the mixture as the last component.

Application

Exterior roofs and walls of houses, buildings, industrial facilities and warehouses can be protected by thermal insulation coatings. It can be used on surfaces like concrete, wood and metal sheets.

It is recommended to apply a layer with a dry thickness of 1.0 to 1.5mm to achieve a sufficient insulation. The insulation coating is easy to apply with a roller, brush or by spraying.

High PVC-value

Expancel contributes with a large volume to the coating. The binder demand of Expancel is lower by volume compared to conventional mineral fillers. The specific surface of the round particles is small.

Thermal Conductivity and Thermal Insulation

The thermal conductivity and insulation are influenced by the addition of Expancel and the content of mineral filler.

A mineral filler like $CaCO_3$ will increase the thermal conductivity. Expancel, with the porous structure in the coating, will reduce the thermal conductivity and improve thermal insulation.

Further Properties

The expanded microspheres are closed cells.
This will improve the water resistance of a coating.

Paints with Expancel have a higher water vapour permeability than corresponding standard paints.

The UV crosslinking technology of the acrylic binder has been optimised to guarantee a low dirt pick-up performance. Due to the high volume solids of a coating with expanded microspheres, the drying time is shortened.

The high volume contribution from the microspheres will give a low density and a low VOC-emission (g/l) of the insulation coating.

Guiding formulation

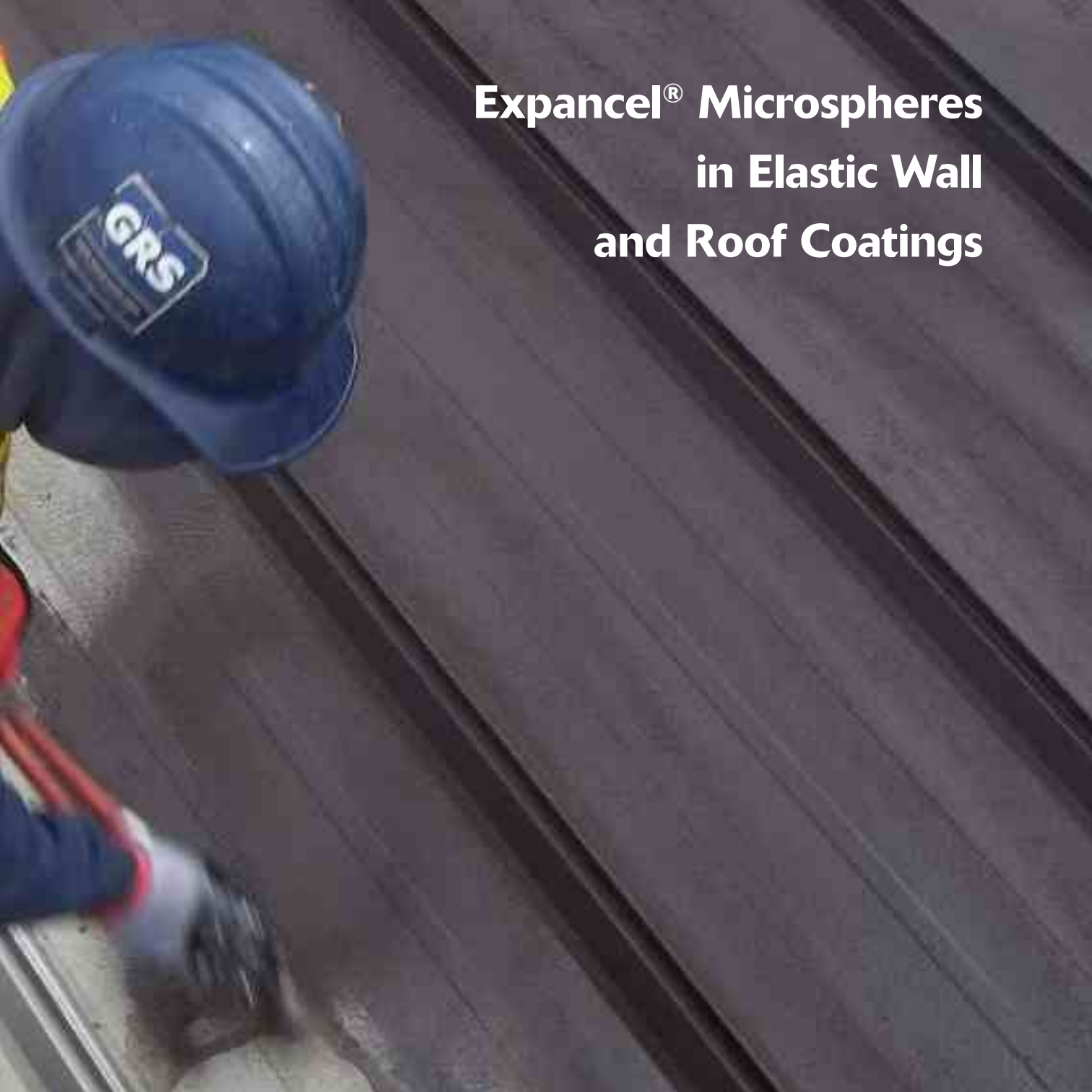
Base Coating		Weight		Volume	
		g	%	cc	%
Grind	Water	70.0	9.3	70.0	11.5
	Orotan 731A	10.7	1.4	9.7	1.6
	Triton DF-16	2.2	0.3	2.1	0.3
	Foamaster NXZ	3.0	0.4	3.3	0.6
	Propylene glycol	18.0	2.4	17.4	2.9
	Tioxide TR 92	80.0	10.7	20.0	3.3
	Durcal 5	100.0	13.3	36.4	5.9
Premix	Foamaster NXZ	3.5	0.5	3.9	0.7
	Water	13.0	1.7	13.0	2.1
Let down	Elastene 404	419.0	55.9	402.9	66.2
	Acrysol RM-8W	20.0	2.7	19.2	3.2
Premix	Water	4.6	0.6	4.6	0.8
	DMAE Dimetylaminoethanol	0.7	0.1	0.8	0.1
	Acrysol ASE-60	5.3	0.7	5.0	0.8
Totals		750.0	100.0	608.3	100.0

Addition of Expancel 921 WE 40 d24	Weight		Volume	
	g	%	cc	%
Base Coating	307.5	89.4	249.4	57.4
Expancel 921 WE 40 d24	36.5	10.6	184.9	42.6
Dry microspheres	3.7	1.1	152.1	35.0
Water from microspheres	32.9	9.5	32.9	7.6
Totals	344.0	100.0	434.3	100.0

Properties		%
Pigment volume concentration	%	63.7
Volume solids	%	67.7
Weight solids	%	60.0
Density	g/cm³	0.80
Viscosity (Brookfield, spindle 5/6 rpm)	mPa s	55000 - 60000
Viscosity (Brookfield, spindle 5/3 rpm)	mPa s	65000 - 70000

Addition of Expancel 920 DET 40 d25	Weight		Volume	
	g	%	cc	%
Base Coating	307.5	89.3	249.4	57.4
Expancel 920 DET 40 d25	3.8	1.1	152.0	35.0
Free Water	33.0	9.6	33.0	7.6
Totals	344.2	100.0	434.4	100.0

Properties		%
Pigment volume concentration	%	63.7
Volume solids	%	67.8
Weight solids	%	60.1
Density	g/cm³	0.80
Viscosity (Brookfield, spindle 5/6 rpm)	mPa s	50000 - 55000
Viscosity (Brookfield, spindle 5/3 rpm)	mPa s	60000 - 65000



Expancel® Microspheres in Elastic Wall and Roof Coatings

Elastic wall and roof coating is a highly flexible exterior coating used on cement, concrete and similar materials. It withstands water, which could otherwise cause cracking and freeze-thaw degradation in the substrate.

This coating should also be an effective barrier for carbon dioxide and other acid gases in the atmosphere that might otherwise neutralise the alkalinity of the substrate.

At the same time the coating should be permeable enough to equalise the differences in partial pressure of water vapor that appear between the substrate and the exterior. The coating should preserve the elasticity at low temperatures.

Suitable Expancel Products

Expancel microspheres are highly elastic, compressible particles with low specific surface, low binder demand and low water absorption by volume. They are gas-tight and retain their volume and spherical form during preparation.

Expancel 461 WE 40 d36 is recommmended as the primary grade for elastic wall and roof coating; followed by 461 DET 40 d25 - if not possible to add the water that 461 WE 40 d36 contains.

If a chlorine free grade is required, 920 DET 40 d25 or 921 WE 40 d24 is recommended.

Grade	461 WE 40 d36	461 DET 40 d25	921 WE 40 d25	920 DET 40 d25
Appearance	Moistened Powder	Dry Powder	Moistened Powder	Dry Powder
Particle size average µm	30 - 50	30 - 50	35 - 55	35 - 55
True density active MS, kg/m³ (lbs/gal)	36 ± 3 (0.3 ± 0.025)	25 ± 3 (0.21 ± 0.025)	24 ± 3 (0.2 ± 0.025)	25 ± 3 (0.21 ± 0.025)
Solid content (%)	15 ± 2	>99	10 ± 1.5	>99

Formulation of elastic wall and roof coating containing Expancel 461 WE 40 d36

The formulations below aim to be a guide on how the main properties of elastic wall and roof coatings change when Expancel 461 WE microspheres are included.

Add Expancel 461 WE 40 d36 and remove the same amount of mineral extender. This will give unchanged viscosity when adding 1% by weight of 461 WE 40 d36.

Further addition of 461 WE 40 d36 decreases the viscosity. To maintain the same viscosity level with 2% 461 WE 40 d36 included, a further small addition of primary thickener is necessary.

Incorporation of Expancel 461 DET 40 d25 to elastic wall and roof coatings will significantly

Water	Standard	Expancel 461 WE 40 d36 Content	
		1%	2%
	90	**90**	**88**
Orotan 731 25%	9	9	9
Triton CF-10	2	2	2
Nopco NXZ	3	3	3
Acrysol RM-8 36.8%	13	13	13
Propylene glocol	16	16	14
Tioxide RCR-2	76	76	76
Durcal 5	250	240	230
Expancel 461 WE 40 d36	--	10	20
Butyl carbitol	11	11	10
Skane M-8	2	2	2
Nopco NXZ	3	3	3
Acrylic copolymer emulsion, 46%	465	465	465
Acrysol ASE 60 / Water 1:1 pH 8	60	60	60
Constants and properties			
Density g/cm³ (lbs/gal)	1.30 (10.8)	1.22 (10.18)	1.14 (9.51)
Solid content, weight %	56.5	55.6	55.0
Solid content, volume %	41	44	46
PVC %	35	43	49

increase the viscosity and a more careful reformulation is necessary to achieve suitable consistency.

Elastic wall and roof coatings containing Expancel microspheres can be prepared by means of a closed low speed mixer or dissolver. Use vacuum for deaeration during the last part of the mixing.

The ingredients are to be added in the same order as the table shows.

Properties of elastic wall and roof coating containing Expancel 461 WE 40 d36

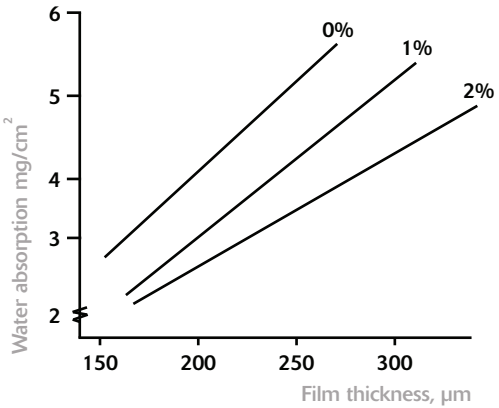
Water absorption

Expancel 461 WE 40 d36 can reduce the water aborption of elastic wall and roof coating. The water absorption (mg/cm^2) is plotted as the function of the film thickness at three different immersions

The positive effect is clearly shown. Coatings containing microspheres are more resistent to water compared to corresponding coating without microspheres. The difference in water absorption between standard coating and coating containing Expancel increases with increasing thickness.

This is important as elastic wall coatings are applied at a dry thickness of 1mm or more.

Water absorption of elastic wall and roof coating with addition of 0 to 2% Expancel 461 WE 40 d36, 1 day of immersion



Water vapor permeability

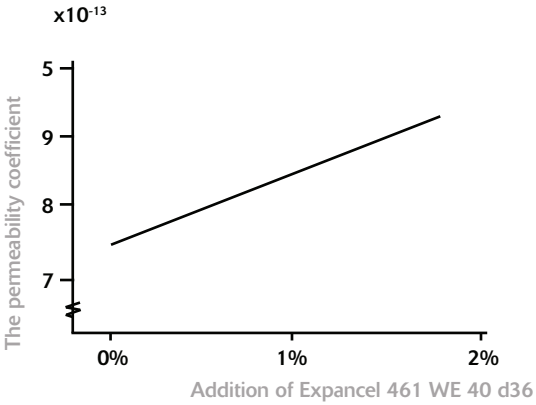
Studies have shown that coatings including Expancel 461 WE 40 d36 are more permeable than coatings without and the microspheres support the transportation of water vapour through the material. The test is performed by means of the cup method and the true permeability coefficients are calculated.

As the permeability coefficients vary with the film thickness and there are other significant resistances than the material in the system, the inverse of the permeability coefficients are plotted against the inverse of the thickness.

Extrapolation to infinite thickness will give the true permeability coefficient after inversion.

The influence of Expancel 461 WE 40 d36 on the water vapour permeability would probably be more advantageous during the ageing of the coating, as the transport mechanism of water vapour turns from activated diffusion to capillary flow.

True permeability coefficient kg ● m/s ● m^2 ● Pa of elastic wall and roof coating with addition of 0 to 2% Expancel 461 WE 40 d36



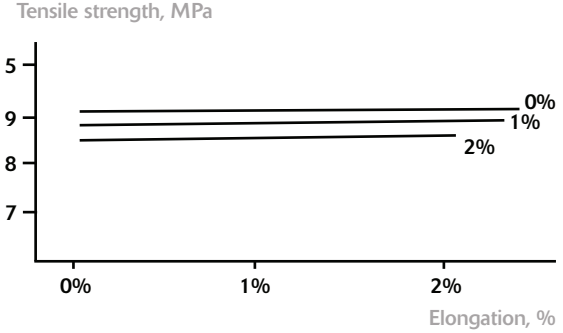
Low temperature flexibility
According to test method ASTM D-1043, the low temperature flexibility of elastic wall and roof coating is not affected by the addition of Expancel 461 WE 40 d36. The determined temperatures (-28°C to -29°C / -18.4°F to -20.2°F) are equal for standard coating and coatings containing Expancel.

Solid content by volume
Addition of Expancel 461 WE 40 d36 to elastic wall and roof coatings will increase the solid content by volume. That will help with the formation of thick layers to which these types of coatings are applied.

Tensile strength
The elongation at break of wall and roof coatings containing Expancel decreases only slightly compared to standard. The tensile strength also decreases somewhat when Expancel microspheres are added. The samples were stored for 10 weeks at room temperature before testing.

High PVC-values with addition of Expancel 461 WE 40 d36
The great volume contribution from microspheres will result in high PVC-values, which is quite misleading, as Expancel 461 WE 40 d36 consists of hollow tight particles with a large void volume that has no demand of binder.

Stain resistance
The elastic wall and roof coating is based on an acrylic co-polymer emulsion, which is reticulable on surface at the presence of natural light. The reticulation provides a high stain resistance, which is maintained when Expancel 461 WE 40 d36 is included.



Tensile strength of elastic wall and roof coating (ISO R-527 II) with addition of 0 - 2% Expancel 461 WE 40 d36.

Other Acrylic Emulsions

Expancel microspheres give moderate changes in the properties of a formulation including an acrylic co-polymer emulsion with solid content of 46%. Other more elastic acrylic emulsions with higher solid content are expected to give the same result. Binder emulsions suitable for this application are Primal LT-2949 and Primal EC-3848 ER.

Cost Savings

Addition of Expancel 461 WE 40 d36 to this type of coating will give possibilities for material cost savings by volme. By using 1% 461 WE 40 d36, an approximate cost saving would be 4 - 5%.

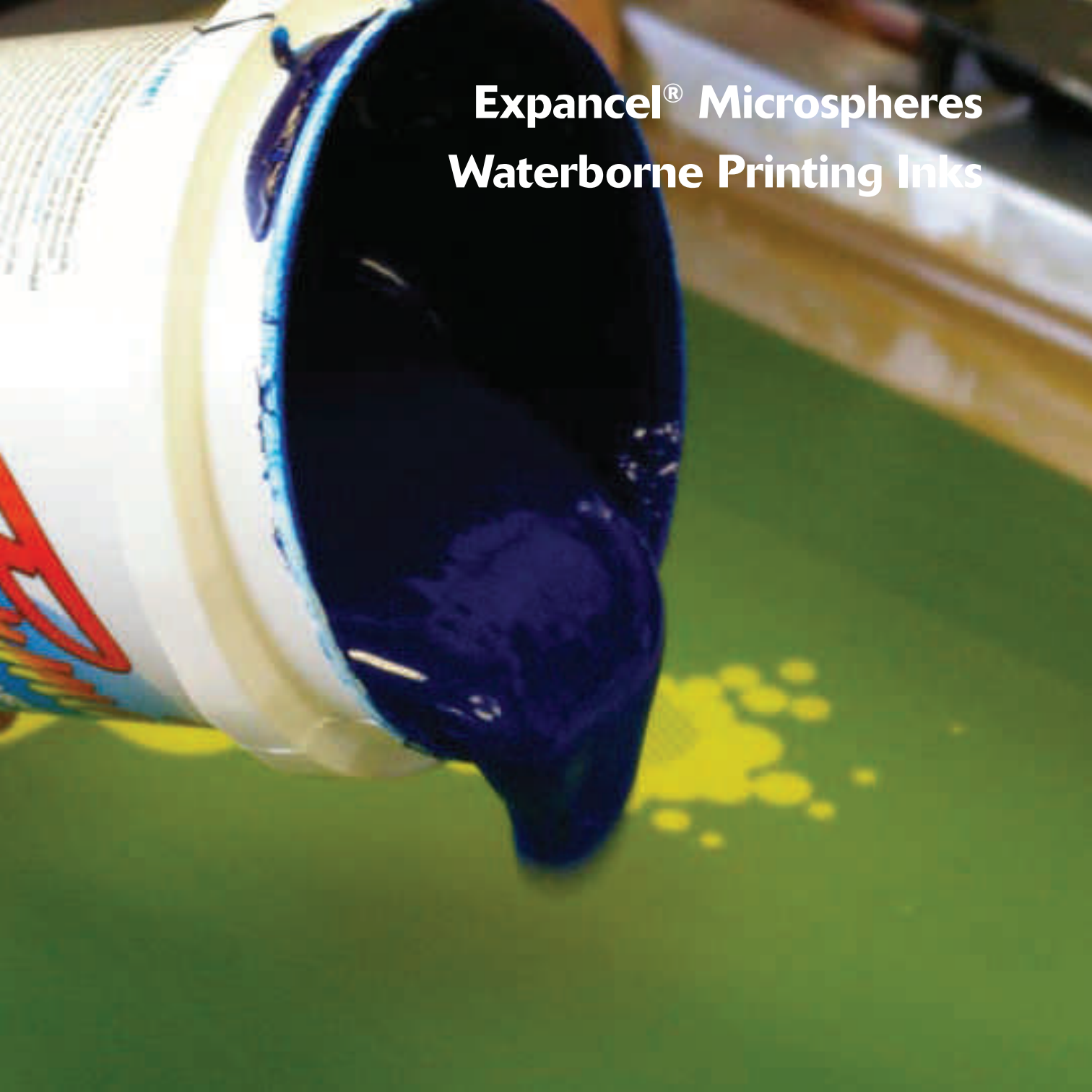
Corresponding approximate cost saving using 2% microspheres is 8 - 9%.

Properties

		Expancel Addition		
		1%	2%	3%
Water absorption mg/cm² 250µm dry film				
Days of immersion	1:	5.2	4.0	3.5
	5:	4.6	3.8	3.3
	15:	4.2	3.4	3.1
True permeability coefficient kg x m/m² • s • Pa:		$7.5\ 10^{13}$	$8.8\ 10^{13}$	$9.6\ 10^{13}$
Tensile strength MPA ISO R-537 II, +23°C (+73.4°F)				
At maximum stress		1.5	1.4	1.3
At break		1.4	1.3	1.1
Elongation %				
At maximum stress		240	200	200
At break		390	370	330
Elastic elongation		390	370	330

Raw material used in suggested starting formulation

Chemical	Description	Supplier
Orotan 731	Dispersant	Rohm & Haas
Triton CF-10	Surfactant	Rohm & Haas
Nopco NXZ	Defoamer	Henkel - Nopko
Acrysol RM-8	Thickener	Rohm & Haas
Tioxide RCR-2	Titanium dioxide	Tioxide
Durcal 5	Calcium carbonate	Omya
Butyl carbitol	Coalescent	Not specified
Skane M-8	Biocide	Rohm & Haas
Acrysol ASE 60	Thickener	Rohm & Haas
Acrylic copolymer emulsion	Binder	Rohm & Haas



Expancel® Microspheres
Waterborne Printing Inks

Printing inks containing Expancel microspheres are formulated to produce three-dimensional prints on textiles, wallpaper, paper, etc. It can also be used to achieve a velvet look or other surface effect.

The three-dimensional effect is achieved by heating the print to a temperature at which the microspheres expand and which causes the binder to crosslink.

Many of the commercially available printing inks are also suitable for expandable printing inks.

Formulation

Basic formulations, known by experienced printers and ink manufacturers, may need to be slightly adjusted due to the addition of microspheres to produce raised prints on various substrates.

A basic recipe could be:

Expancel (dry weight) 0 - 20 parts per hundred
Binder(s) 40 - 60 parts per hundred
Thickener 2 - 35 parts per hundred

As a guide, the amount of dry binder should be at least three times the amount of dry microspheres in order to give good resistance to abrasion.

However, the mechanical properties of the binder and also the expansion capacity of the grade of Expancel have an influence on the resistance to abrasion.

Mixing Equipment

No special mixing equipment is required.

Best results are achieved, however, with a homogenizer such as a Silverson mixer.

Pigmentation

Prints made from unpigmented ink have a white semi-opaque appearance.

By adding up to 10% by weight of titanium white, completely opaque white prints will be achieved.

For coloured printing, add up to 8% micro-pigment dispersions of non-ionic colours.

Textiles

In a printing ink for textiles, Expancel can help achieve effects such as a velvety look, puff effect and the resemblance of embroidery.

Components of the Printing Ink

Binder
The binder should be highly elastic, give a good adhesion to the fabric and have good wet tensile strength.

Microspheres
There are different grades of Expancel from which to choose depending on the heating conditions:

642 WU 40 - general purpose
031 WUF 40 - very good expansion at low temperatures, inert, white
007 WUF 40 - very good expansion at slightly higher temperatures, inert, white
920 WUF 40 - good expansion at very high temperatures, inert, white.

Typical dosage levels of microspheres are 10 - 17% (dry weight) of the total weight of the formulation. The greater the amount of microspheres the greater the loft of the print.

Expancel WUF grades are special grades which can be used in formulations where the rheological stability is a problem. Compared to other Expancel grades, the dosage of 031 WUF 40 and 007 WUF 40 can be reduced by 30 - 50%.

Thickener
The thickener should give a short buttery rheology. A suitable thickener is, for example, Printofix Thickern DS Liquid.

Auxiliary chemicals
Glycerine is a hygroscopic agent and is added to prevent skinning and clogging of screens. Foamaster ENA-515 is added as a defoamer. Water is added to compensate for the varying solid content of Expancel.

In the following formulation the amount of the binder (as solids) is 26% by weight. If this percentage is raised, an increase in strength and, possibly, in height will be gained but at the same time the ink dries faster, which may cause clogging of the screen.

Textile Formulation

	Amount in g
Primal ECO-8 (45.5%)	603.3
Expancel 642 WU 40 (65%)	154 - 261.5
Glycerine (100%)	40
Foamaster ENA-515 (50%)	5
H_2O	174.9 - 67.4
NH_3 (25%)	approx 3.5
Printofix Thick, DS Liquid	19.3
Total	**1000g**

The viscosity of the printing ink tends to increase when stored.

Procedure

All ingredients, except thickener and ammonia, are mixed using a homogeniser to attain a uniform mixture. Ammonia is added to adjust the mixture to a pH of approximately 8.5. The thickener is added to the mixture during stirring. Continue stirring until thickening is complete and a smooth mixture has been obtained.

Printing

Screen printing and gravure printing are suitable application techniques for expandable printing inks. The three-dimensional effects become most apparent with a heavy deposit.

Fixation

During fixation, the following processes take place:

- drying of the paint
- expansion of the microspheres
- crosslinking / curing of the binder

The fixation takes place in direct connection with the printing at 120 - 160°C (248 - 320°F). The temperature depends on microsphere grade, substrate, type of binder, degree of deposit and curing oven to be used.

Fixation takes 1 - 3 minutes, but could be prolonged if a complete drying / curing is not obtained within this time. The optimum drying / curing conditions may be tested by the printer.

In case of multi-colour printing the printed material is intermittently dried at room temperature or up to 80°C (176°F).

In the event of overheating and / or if a too long heating time is used, the microspheres may collapse and become discoloured.

An infrared dryer may be used instead of, or in combination with, a heating oven. A lower temperature and / or a shorter time is then required.

Wallpaper

Formulations suitable for printing on wallpaper have been developed to achieve 3D and matting effects.

Components of the Printing Ink

Binder
Important properties of the binder are adhesion and resistance to abrasion. A hard binder can give the desired resistance to abrasion while a very soft (and sticky) binder can improve the adhesion.

A suitable hard binder is Primal ECO-16 or equivalent. A suitable soft binder is Mowilith DM 105 or equivalent.

Microspheres
There are several grades of Expancel that are suitable for wallpapers:

642 WU 40 - general purpose
031 WUF 40 - very good expansion at low temperatures, inert, white
007 WUF 40 - very good expansion at slightly higher temperatures, inert, white
920 WUF 40 - good expansion at very high temperatures, inert, white

The amount of Expancel should be 1 - 15% (dry weight) of the total weight of the formulation. The greater the amount of microspheres the greater the loft of the print.

Expancel 031 WUF 40, 007 WUF 40 and 920 WUF 40 are special grades which can be used in formulations where the rheological stability is a problem. Compared to other Expancel grades, the dosage of 031 WUF 40 and 007 WUF 40 can be reduced by 30 - 50%.

Thickener
The thickener should give a pseudoplastic rheology. This will produce a low viscosity at high shear rates and will allow printing at high speeds. At the same time, the viscosity will be high at low shear rates, preventing the ink from flowing after printing.

A suitable thickener is Acrysol RM-8; Lyoprint PTXN is also suitable if a more pronounced pseudoplasticity is desired.

Hydroscoping Agent
Glycerine or propylene glycol can be used to prevent skinning and clogging of screens.

Defoamer
The defoamer prevents formation of foam during mixing. A suitable defoamer is Foamaster ENA-515 or equivalent.

Water
Water is added to compensate for the varying solid content of Expancel.

Preparation

Micropheres, binders, hygroscopic agent and defoamers are mixed. By means of a high speed mixer (homogeniser) the microspheres are completely dispersed in the mixture. Care must be taken, however, that the mixing does not take too long since developed heat at high shear rates may cause premature expansion of the microspheres.

The thickener is added while the mixture is being stirred. Continue agitation until a smooth mixture is obtained.

Water is added either as the last component or in the pre-mixture of microspheres, binders, hygroscopic agent and defoamer.

If pigments are added as a dry powder, they should be added and properly dispersed in, for example, the binders before the microspheres are added. The reason is that it is generally more difficult to disperse pigments than microspheres.

It might be necessary to add a dispersant in order to obtain good dispersion of the pigment.

If the pigment is added as a dispersion it can be added at any point.

Viscosity

The printing ink exhibits a pseudoplastic flow ie its viscosity decreases with increasing shear rates. Regulate viscosity by using more or less thickener in the formulation.

Pot Life

Storage durability of the above formulation is approximately four months when kept in closed containers. A preservative can be added in order to prevent the growth of bacteria and fungi.

Laboratory tests have been carried out with good results at the addition of 0.1 - 0.2% Acticide SPX.

Screen Printing

The three dimensional effects become most apparent with a heavy deposit. This is achieved by means of a coarse screen, 60 - 85 mesh (24 - 34 threads per cm). By using finer screens ie 100 - 125 (40 - 50 threads / cm) mesh, a lower deposit and, thereby, fine patterns and sharp contours, are obtained. It is recommended to filter the printing ink before application to prevent clogging of the screen.

Drying

Drying, expansion and curing are preferably done immediately after printing for 0.5 - 2 minutes. In case of multi-colour printing, the printed material is intermittently dried at 20 - 85°C (68 - 185°F).

If the print is dried before expansion this will produce prints with a smooth surface. If the print is expanded without drying this will produce prints with a rougher surface.

Expansion and Curing

The suitable temperature for expansion and curing depends on the microsphere grade as well as the weight of the substrate and the deposit and may be set at 120 - 180°C (248 - 356°F).

The prints that were used to produce the expansion curves presented were dried at room temperature before they were expanded in a hot air oven. These expansion curves might help in finding suitable expansion times and temperatures.

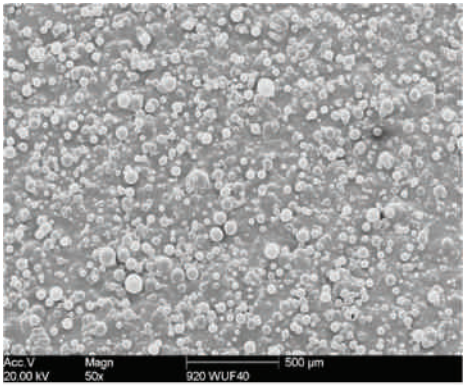
An infrared dryer may be used instead of or in combination with a heating oven. A lower temperature and / or a shorter time is then required.

In the event of overheating and / or using a too long heating time, the microspheres may collapse and become discoloured.

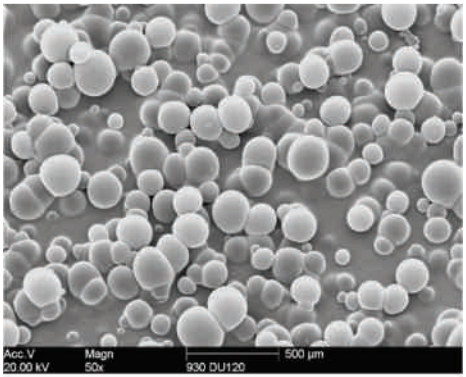
The recommended drying / curing conditions may be adjusted by the printer depending on substrate, degree of deposit and the curing oven to be used.

Surface Modification

By using microspheres with different particle sizes, the look and feel of the printed surface can be modified.



Expancel 920 WUF 40

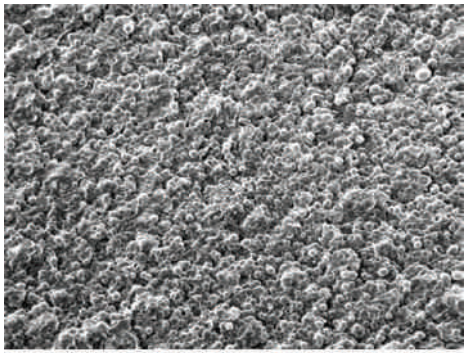


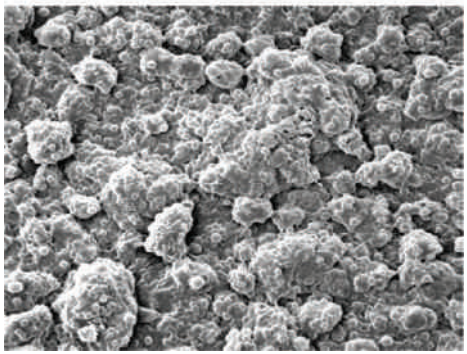
Expancel 930 DU 120

Effect on surface roughness when drying before expansion

The surface of a print that is heated and expanded immediately after printing may become somewhat rough because of water vapour.

On the other hand, if the print is first dried at a temperature which is too low to start the expansion the surface of the expanded print will be smoother.


Print dried before expansion, SEM 20x


Print not dried before expansion, SEM 20x

Wallpaper Formulations

Wallpaper formulation with Expancel 642 WU 40 using Mowilith DM 105 and Primal ECO-16 as binders and Lyoprint PTXN as thickener.

	Solids %	Amount (g)	(oz)
Mowilith DM 105	55.0	407.8	14.4
Primal ECO 16	45.5	335.6	11.8
Expancel 642 WU 40	67.5	88.9	3.13
Glycerine	100.0	50.0	1.76
Foamaster ENA-515	50.0	8.0	0.28
Lyoprint PTXN	90.0	10.0	0.35
Water	0.0	99.7	3.52
Total	50.0	1000.0	35.3

Part of non-volatiles being binders: 75.4%
Part of non-volatiles being microspheres: 12%
Binder / microspheres (solids / solids): 6.28

Suppliers of Chemicals

Chemical	Agent	Supplier
Primal ECO-8	Acrylic emulsion binder	Rohm and Haas
Primal ECO-16	Methylmethacrylate / ethlyacrylat emulsion binder	Rohm and Haas
Mowilith DM 105	Vinylacetate / ethylene copolymer dispersion binder	Celanese Emulsions
Printofix Thickener DS Liquid	Synthetic thickener based on ammonium polyacrylate	Clariant
Lyoprint PT-XN	Acrylic polymer dispersion	Huntsman
Acrysol RM-8	Polyurethane thickener	Rohm and Haas
Foamaster ENA-515	Mineral oil based defoamer	Cognis
Acticide SPX	Preservative	Thor Chemicals

Specification

Product Specification for Expancel® microspheres

Expancel DE

Dry Expanded Microspheres

Expancel	Particle Size µm D(0.5)	True Density kg/m³	Solvent Resistance
551 DE 40 d42	30 - 50	42 ± 4	3
461 DE 20 d70	15 - 25	70 ± 6	4
461 DE 40 d60	20 - 40	60 ± 5	4
461 DET 40 d25	35 - 55	25 ± 3	4
920 DE 40 d30	35 - 55	30 ± 3	5
920 DET 40 d25	35 - 55	25 ± 3	5

Expancel WE

Wet Expanded Microspheres

Expancel	Est. Particle Size µm D(0.5)	Solid Content	True Density kg/m³	True Volume	Solvent Resistance
461 WE 20 d36	20 - 30	15 ± 2	36 ± 4	4.2 ± 0.45	3
461 WE 40 d36	30 - 50	15 ± 2	36 ± 4	4.2 ± 0.45	3
921 WE 40 d24	35 - 55	10 ± 1.5	24 ± 3	4.2 ± 0.45	5

Expancel DU

Dry Unexpanded Microspheres

Expancel	Particle Size µm D(0.5)	Thermomechanical Analysis Tstart °C	Tmax °C	Density kg/m³	Solvent Resistance
551 DU 40	10 - 16	95 - 100	139 - 147	≤ 17	3
461 DU 20	6 - 9	100 - 106	137 - 145	≤ 30	4
461 DU 40	9 - 15	98 - 104	142 - 150	≤ 20	4
051 DU 40	9 - 15	108 - 113	142 - 151	≤ 25	4
031 DU 40	10 - 16	80 - 95	120 - 135	≤ 12	3
053 DU 40	10 - 16	96 - 103	138 - 146	≤ 20	3
093 DU 120	28 - 38	120 - 130	188 - 203	≤ 6.5	5
909 DU 80	18 - 24	120 - 130	175 - 190	≤ 10	5
920 DU 40	10 - 16	123 - 133	168 - 178	≤ 17	5
920 DU 80	18 - 24	123 - 133	180 - 195	≤ 14	5
920 DU 120	28 - 38	122 - 132	194 - 206	≤ 14	5
930 DU 120	28 - 38	122 - 132	191 - 204	≤ 6.5	5
950 DU 80	18 - 24	138 - 148	188 - 200	≤ 12	5
951 DU 120	28 - 38	133 - 143	190 - 205	≤ 9	5

Expancel FG92 DUX 120

Dry Unexpanded Microspheres

Particle Size D(0.5):	28 - 38µm

Thermomechanical Analysis:	
Tstart	122 - 132 °C
Tmax	194 - 206 °C
TMA-density	≤ 14 kg/m³

Residual Substances:	
Acrylonitrile	≤ 30 mg/kg
Methacrylonitrile	≤ 100 mg/kg
Sodium 2-cyanoethanesulfonate	≤ 200 mg/kg
Sulfite	≤ 2000 mg/kg

Expancel MB

Masterbatch with Unexpanded Microspheres

Expancel	Grade	Concentration	Carrier	Height of Foaming (mm)	Bulk Density (g/l)
920 MB 120	920 - 120	65 ± 1	EVA*	90 - 140 (200 °C)	400 - 500
930 MB 120	930 - 120	65 ± 1	EVA*	100 - 150 (200 °C)	400 - 500
950 MB 80	950 - 80	65 ± 1	EVA*	90 - 130 (210 °C)	400 - 500
951 MB 120	951 - 120	65 ± 1	EVA*	100 - 150 (210 °C)	400 - 500

EVA* - Co-polymer of ethylene vinylacetate

Expancel WU

Wet Unexpanded Microspheres

Expancel	Dry Content %	Particle Size µm D(0.5)	Thermomechanical Analysis Tstart °C	Tmax °C	Density kg/m³
551 WU 40	71 ± 2.5	10 - 16	95 - 100	139 - 147	≤ 17
461 WU 20	68 ± 2.5	6 - 9	100 - 106	137 - 145	≤ 30
461 WU 40	68 ± 2.5	9 - 15	98 - 104	142 - 150	≤ 20
007 WU 40	71 ± 2.5	10 - 16	91 - 99	138 - 143	≤ 15
031 WUF 40	76 ± 2.5	10 - 16	80 - 95	120 - 135	≤ 12
053 WU 40	71 ± 2.5	10 - 16	96 - 103	138 - 146	≤ 20
920 WUF 40	71 ± 2.5	10 - 16	123 - 133	170 - 180	≤ 17

Boud Minerals Limited
West Bank
Sutton Bridge
Lincolnshire PE12 9UR
UK
Tel: +44 (0)1406 351988
Fax: +44 (0)1406 350897
Web: www.boud.com
Email: sales@boud.com

Boud Minerals AB
Håkantorpsvägen 109
SE-26391 Höganäs
Sweden
Tel: +46 42 333741
Fax: +46 42 333829
Web: www.boud.com
Email: sweden@boud.com