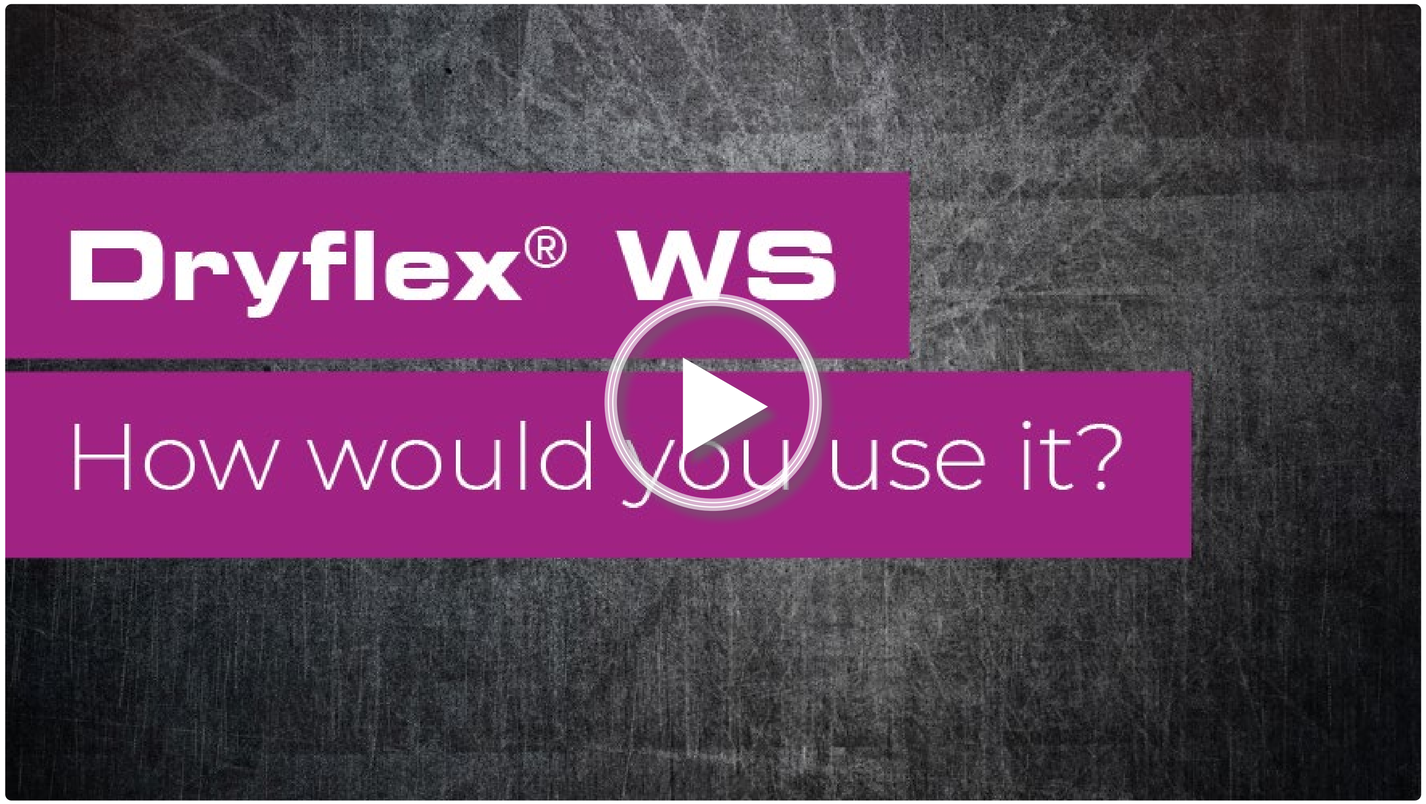
A Material Difference

Dryflex® WS

Hydrophilic TPE

HEXPOL® TPE

Movie Time...



Click to watch a video of the Dryflex WS materials **working their magic**

Contents

Introduction

With the **Dryflex WS** range we have turned the usual water-resistant properties of thermoplastic elastomers (TPE) on their head to create materials that **swell when immersed in water**. These materials were developed to expand after contact with aqueous solutions to form a positive **seal** and **prevent the ingress or exit of water.**

We've developed a range of materials with different swell levels. When there is **no longer water present they shrink back** to their original size, a process of expansion and contraction that can be repeated. The materials have **solid structural integrity**; unlike many of the equivalent clay based products which can erode and shatter over time.

Compounded in any colour, the water swellable TPE is recyclable in production and can be processed using conventional plastics processing methods, including **extrusion** and **injection moulding.**

Please use this guide as an introduction to the **Dryflex WS** range of TPEs and **contact us** to discuss your specific requirements.

Dryflex® WS+

Even More Swellable...

We've further expanded the possibilities with the development of the **Dryflex WS+** grades.

These materials are designed for applications in **high saline environments**, such as sea walls, defences and water-stop construction.

For example, in **8% saline solution** at 23°C **Dryflex WS+ 51446** achieved **double the volume swell** of Dryflex WS 25E950 after 21 days.

Dryflex WS+ 51446 had a volume swell around **300%** compared to 150% for Dryflex WS 25E950.

How Does it Work?

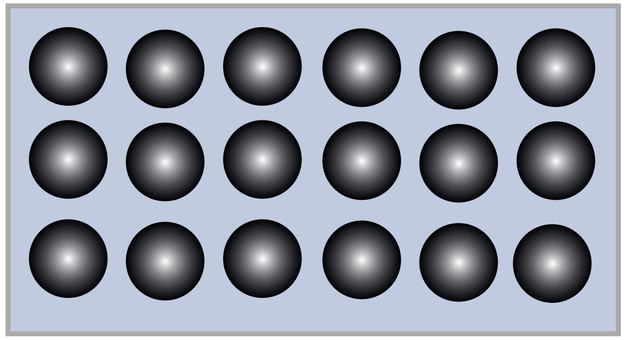


Fig 1 : The hydrophilic additive is added to the TPE compound at the time of manufacture

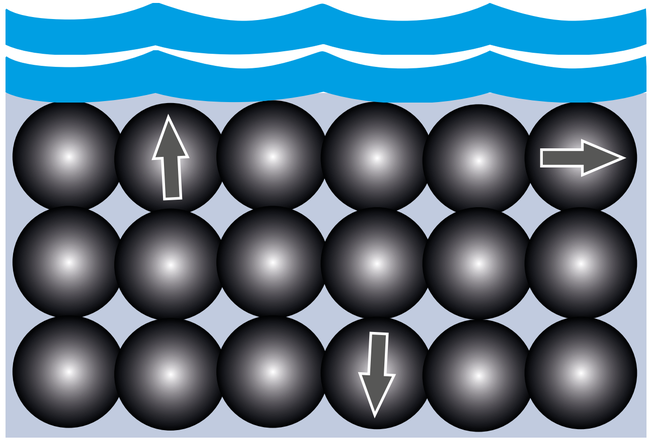


Fig 2 : After immersion in water, the TPE will expand uniformly, at a controlled rate and percentage

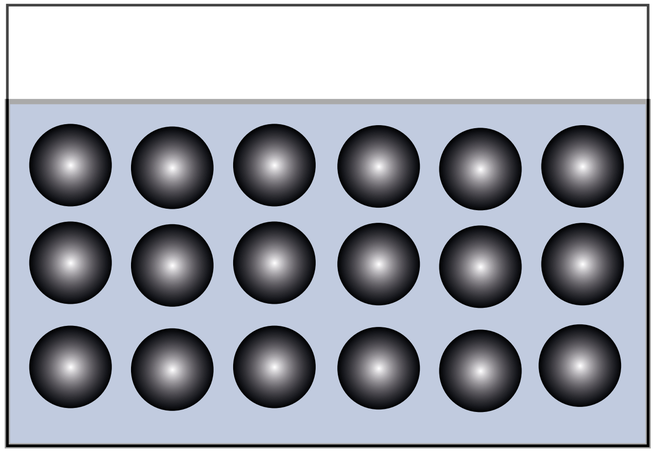


Fig 3 : When there is no longer water present the TPE compound shrinks back to its original size

How Much Does It Swell & How Quickly?

We have developed a range of materials that offer swell levels from **350%** to **1000%** in de-ionised water. The **Dryflex WS+** grades are designed to offer superior swelling in high saline environments.

We can also **customise the swell level** to meet the requirements of a specific application.

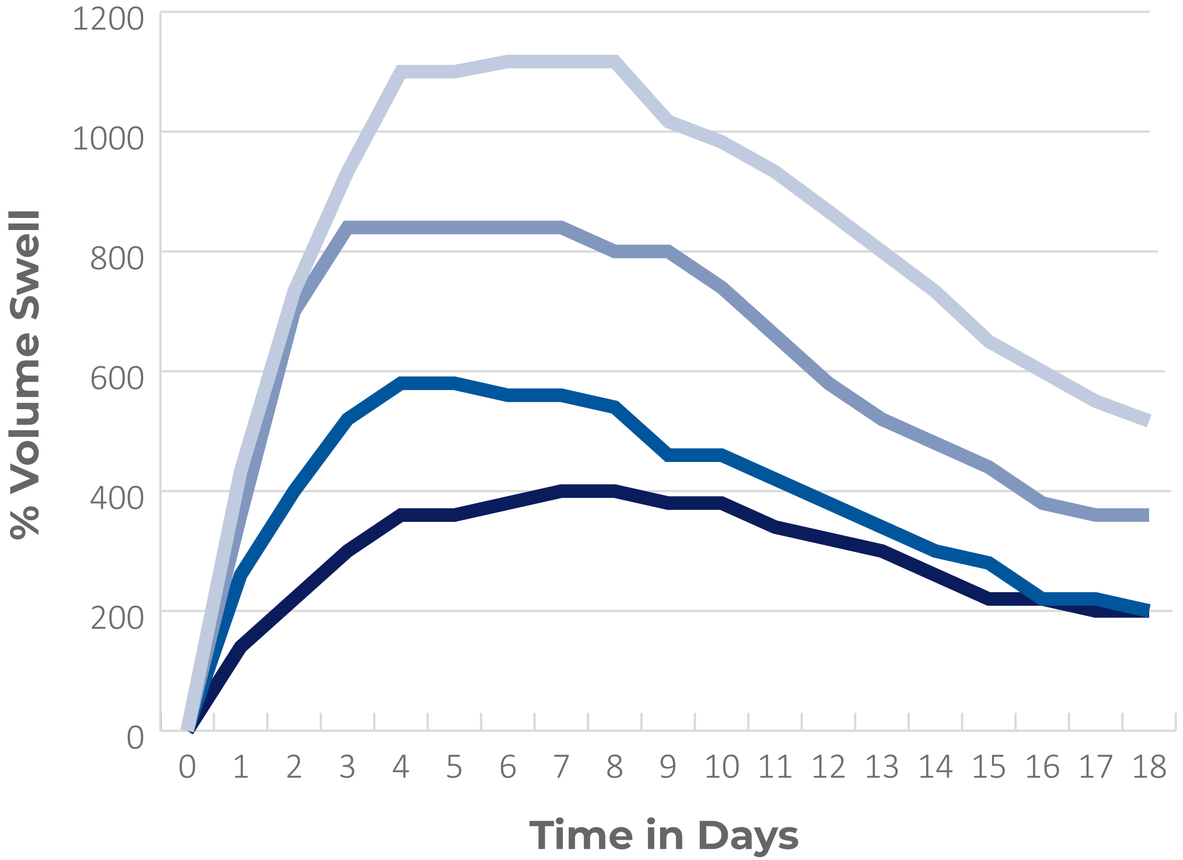
The swelling is not instant, under recommended conditions most Dryflex WS grades will swell to optimum levels within 7 days. All grades will reach quoted swell levels within 21 days under recommended conditions and testing procedures *(please see grade specific information for recommendations)*.

After reaching optimum swell levels, the system will relax and establish equilibrium.

Grades Across The Dryflex WS Range Swell At Various Rates, Dependent On The Following Factors:

- Hardness
- The formulated level of swell additive
- Environmental conditions *(for example temperature and water conditions)*
- Profile geometry
- Compression of material at the die
- Surface finish and potential sealing of the material from water penetration

Dryflex WS % Volume Swell



Dryflex WS 25E950

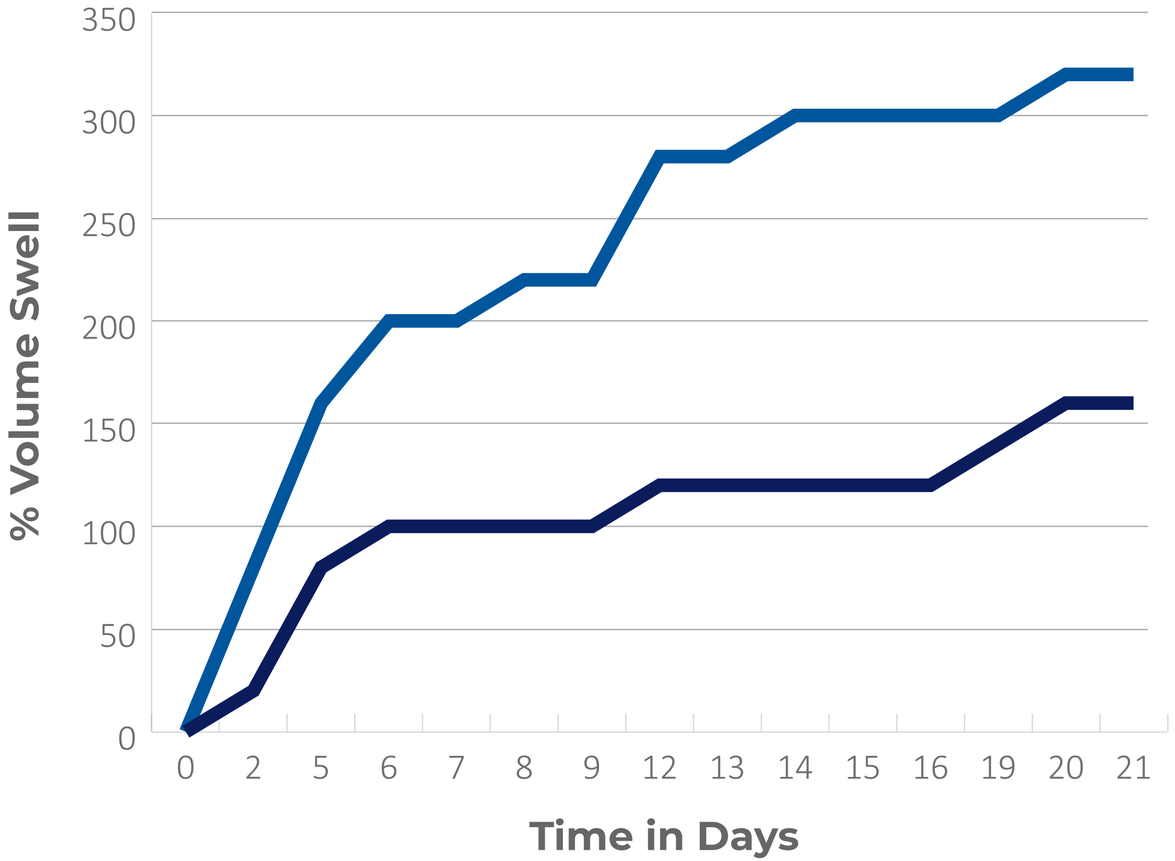
Dryflex WS 40E850

Dryflex WS 35E550

Dryflex WS 40E350

The swell level is calculated on a percentage volume basis. In order to standardise the testing process, samples are evaluated in **de-ionised water at 23°C**.

Dryflex WS+ % Volume Swell



Dryflex WS+ 51446

Dryflex WS 25E950

The swell level is calculated on a percentage volume basis. In order to standardise the testing process, samples are evaluated in **8% saline solution at 23°C**.

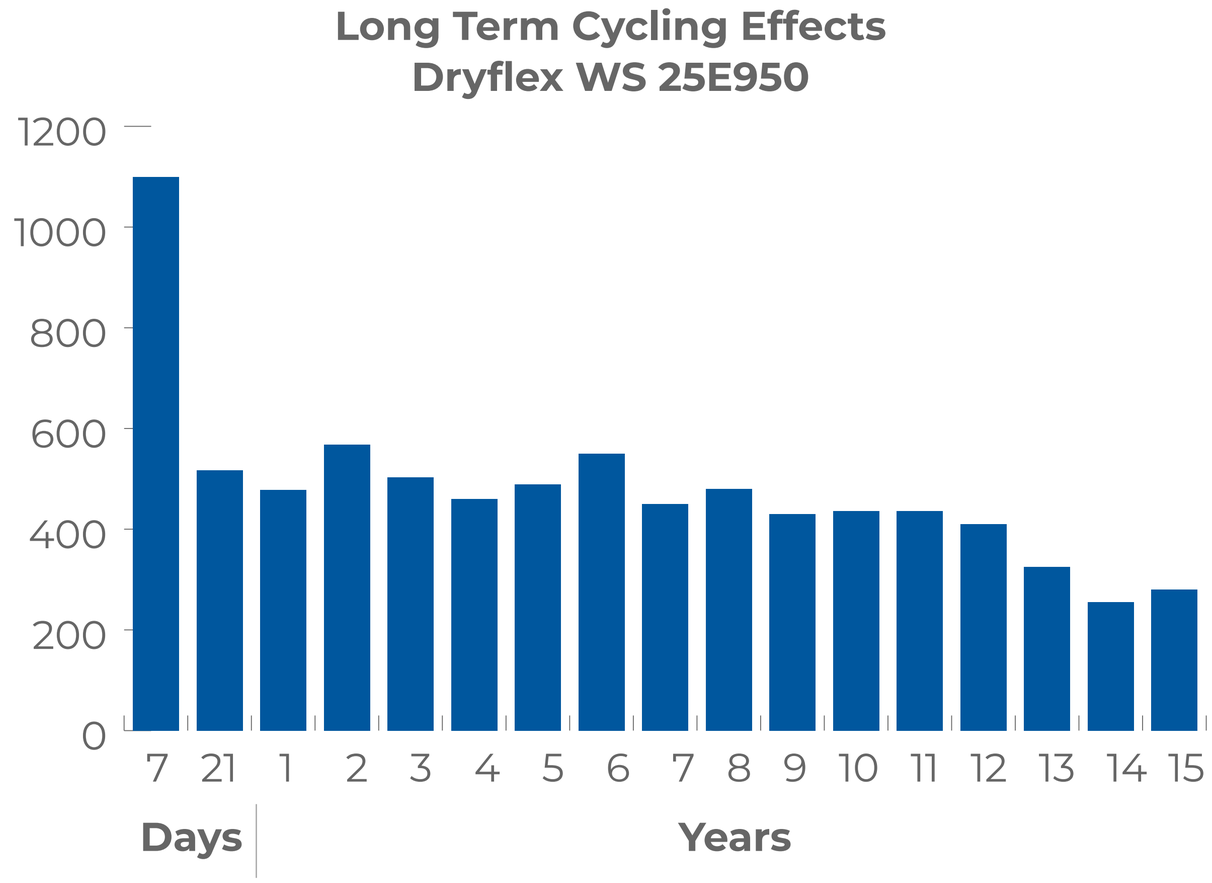
Does It Return To Its Original Size When There Is No Longer Water Present?

Yes, this is **one of the strengths of Dryflex WS TPEs.** Their structural integrity means they can withstand longterm cycling from wet to dry.

Profiles produced from Dryflex WS exhibit **excellent retention of properties** during repeated cycling.

The chart shows the optimum swell level of a typical Dryflex WS grade **exposed to repeated cycling** and measured on an annual basis.

The sample is fully immersed in de-ionised water for 7 days, then removed and allowed to fully dry for a further 7 days. **This process is repeated, giving 26 wet / dry cycles per year.**



Why A Hardness Range?

Dryflex WS grades are typically available in a hardness range of between **25 and 40 Shore A.**

A hardness range enables the production of profiles, or moulded components, with **varying degrees of flexibility**.

The benefits of a softer, more flexible profile can be seen both in terms of the manufacturing process and installation techniques. For example, the softer grades offer **improved drapability**, required for waterstop applications where the profiles may be **coiled or need to be fitted around complex structures.**

Softer versions of Dryflex WS also benefit from **lower processing temperatures**, which in turn allow for **shorter cooling times**. A process for which air cooling, rather than water, is recommended.

How Are They Affected By Environmental Conditions?

The **rate** and **swell level** is affected by environmental conditions such as **temperature**, **pH** and **salinity of the water**, as shown in the graphs on the following pages.

Grade Selection:

Grades should be selected based on the **hardness** of the material and the **environmental conditions** to which the product will be exposed.

In general, extremes of pH and salinity require WS grades with higher levels of optimum swell in de-ionised water. **We recommend that products produced from Dryflex WS are fully evaluated under expected service environments.** This also includes the impact of variations experienced during the moulding or extrusion process.

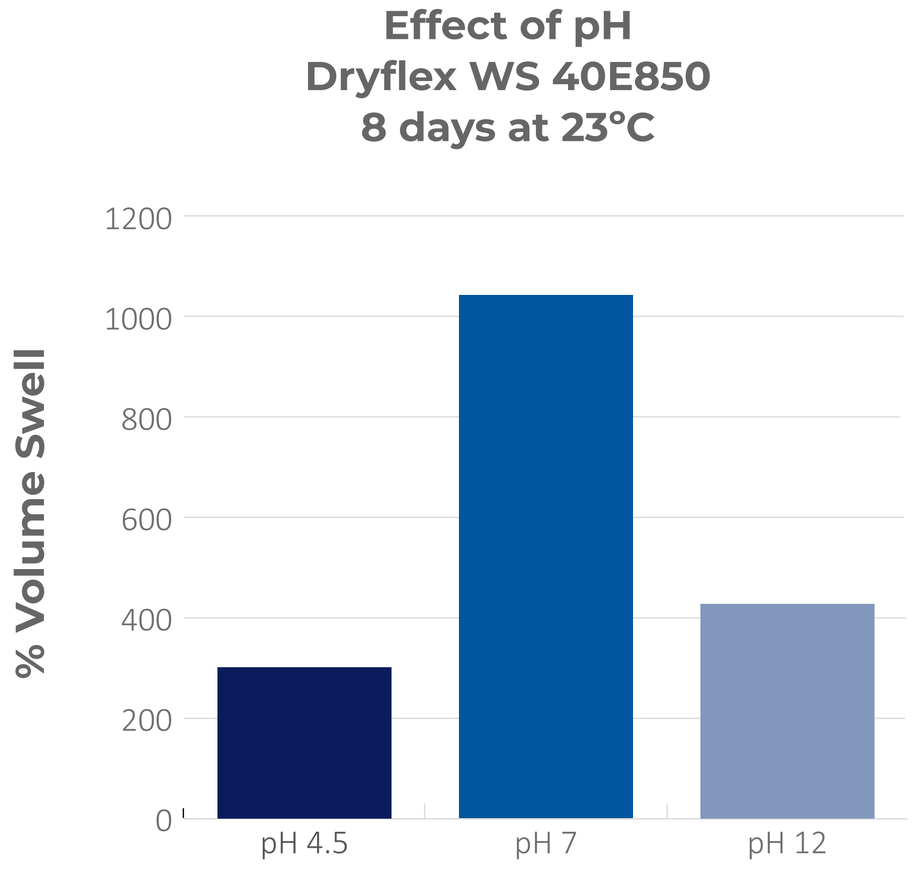
Effect of pH

Both acidic and alkaline conditions can affect the level and rate of swell.

The presence of various ion types across the pH range reduces the hydrogen bonding interactions and impacts on the hydrophilic nature of the product.

Swell levels will change as we move from a neutral pH to higher or lower pH values.

Optimum swelling occurs in the 6 to 8 pH band.



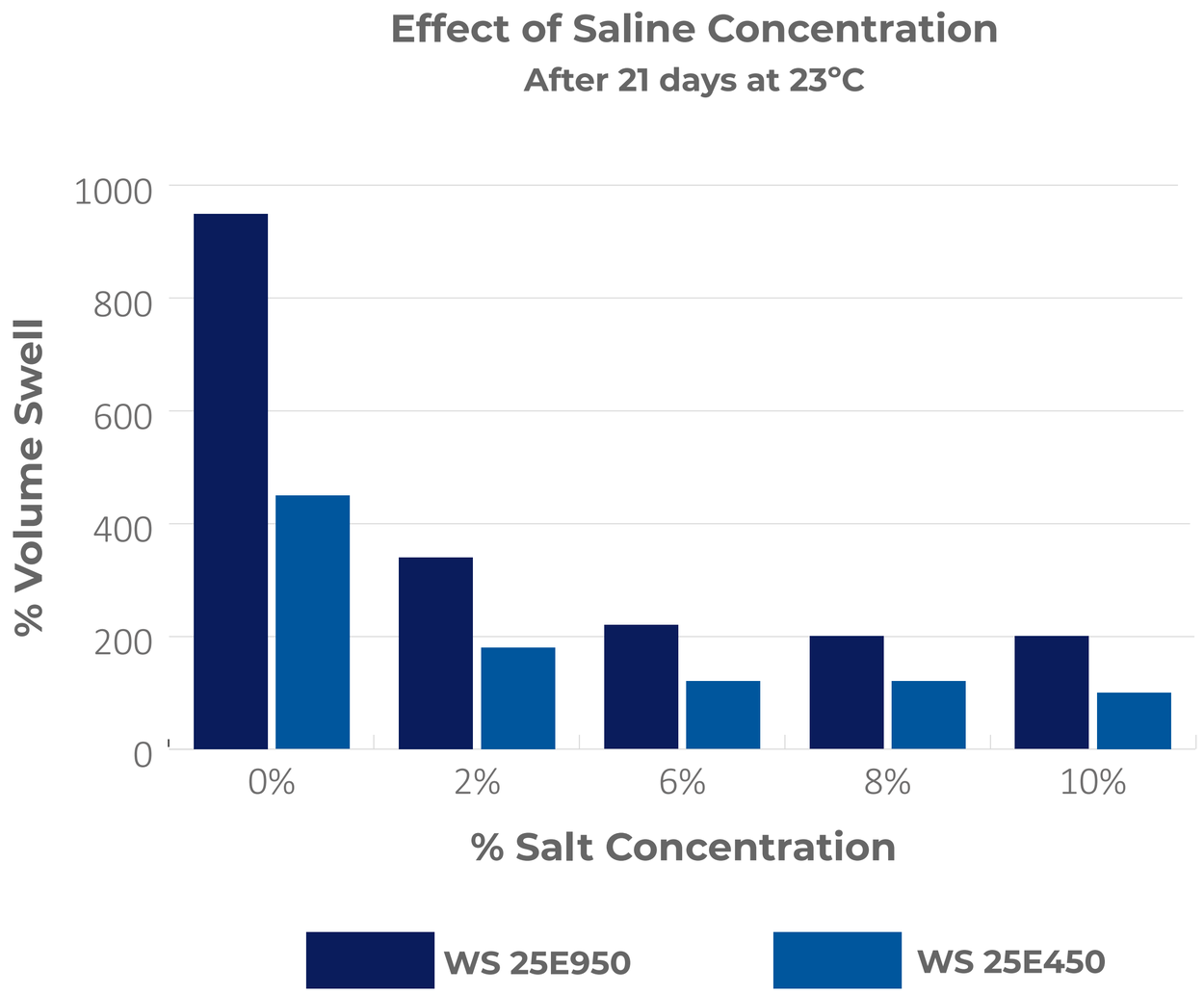
pH 4.5 H_2SO_4
pH 7 **De-ionised Water**
pH 12 $Ca(OH)_2$

Effect of Salinity

The degree of salinity within the environment has a **high impact on the ultimate level of swell**.

Swell rates are also reduced and it can take up to 21 days to reach optimum levels.

The **Dryflex WS+** grades have been optimised for performance in high saline environments (see page 9)



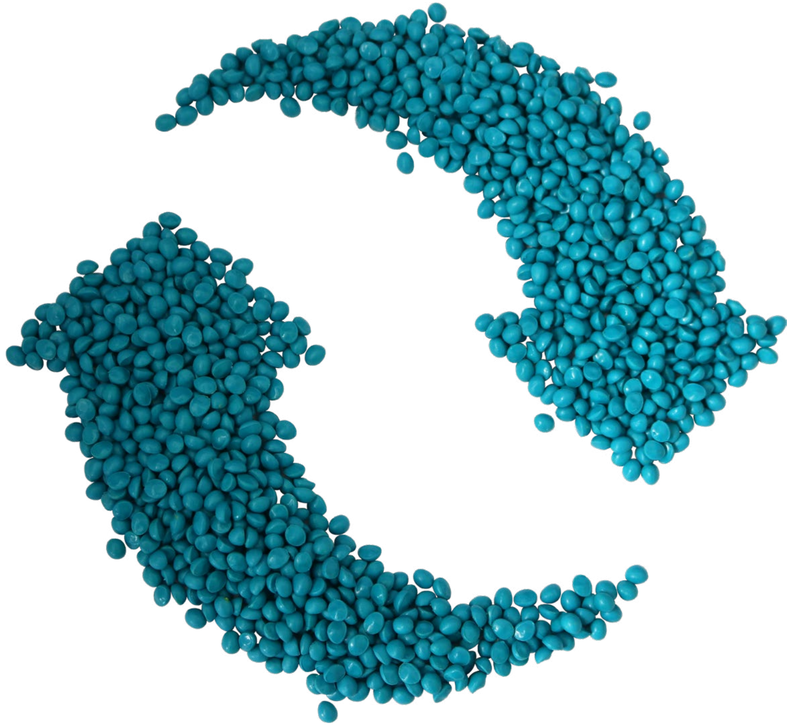
Grades with Recycled Content

To help enable the transition from virgin feedstocks and keep valuable materials in circulation, we have developed versions of the Dryflex WS grades with recycled content.

The source is **Post Industrial Recyclate (PIR)**. This is defined by ISO 14021 as:

Material diverted from the waste stream during a manufacturing process. Excluded is reutilisation of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Dryflex WS TPEs can incorporate up to **35% recycled content**, although the percentage may vary depending on the desired swell level. Generally, higher swell levels may result in lower levels of recycled content.



Typical Applications

One of the main applications for Dryflex WS materials are **hydrophilic waterstops.**

These are typically used as part of a concrete structure and help to prevent the passage of fluids (e.g. water) when embedded in concrete joints.

Other applications include **tunnels**, **water treatment plants, drains, sewers, tanks, glazing and cable protection.**

So applications where you want to stop water getting in or out.

How would you use it?

Typical Dryflex WS and WS+ Grades

Grade selection should be based on the **hardness** of the material and the **environmental conditions** to which the product will be exposed. In general, extremes of pH and salinity require grades with higher levels of optimum swell in de-ionised water. **We recommend that products produced from Dryflex WS are fully evaluated under processing conditions and expected service environments.**

Grade	Hardness [1] ISO 868 Shore A	Density ISO 2781 g/cm3	Swell Level % Volume Swell
Dryflex WS 25E450	25	1.21	450 [2]
Dryflex WS 25E800	25	1.22	800 [2]
Dryflex WS 25E950	25	1.23	950 [2]
Dryflex WS 40E350	40	1.24	350 [2]
Dryflex WS 40E450	40	1.25	450 [2]
Dryflex WS 40E850	40	1.25	850 [2]
Dryflex WS+ 51446	25	1.23	300 [3]

[1] After 15 seconds
[2] Minimum swell level, up to 21 days immersion period in de-ionised water at 23°C
[3] Minimum swell level, up to 21 days immersion period in 8% saline solution at 23°C

Processing

Dryflex WS TPEs are **primarily processed via extrusion** processing techniques, but may also be **injection moulded**.

- In general these materials do not require pre-drying, however, after periods of prolonged storage pre-drying may be necessary.
- Venting of extrusion lines may be used as a method of preventing the build-up of volatiles during continuous processing.
- Cycle times for injection moulding will be governed by temperature and section thickness. Care must be taken to allow sufficient cooling of parts prior to demoulding in order to prevent permanent distortion of the article

Due to the nature of the swelling process, **many factors can affect the overall level of swell and the rate at which swelling occurs**, we have created processing guides for each grade within the Dryflex WS range. These guides outline specific processing conditions that should be used. **Deviation from recommended processing conditions can adversely affect the rate and ultimate level of swell.**

Please contact us at **WS@hexpolTPE.com** for grade specific processing guides.

Inclusions

Dryflex WS is manufactured using swell additives based on acrylic salts. A characteristic of these products is that **they can leave deposits within processing equipment which can cure to form hard particles**. During processing, deposits can enter the polymer flow path and appear in moulded articles and extruded profiles as creamy coloured inclusions.

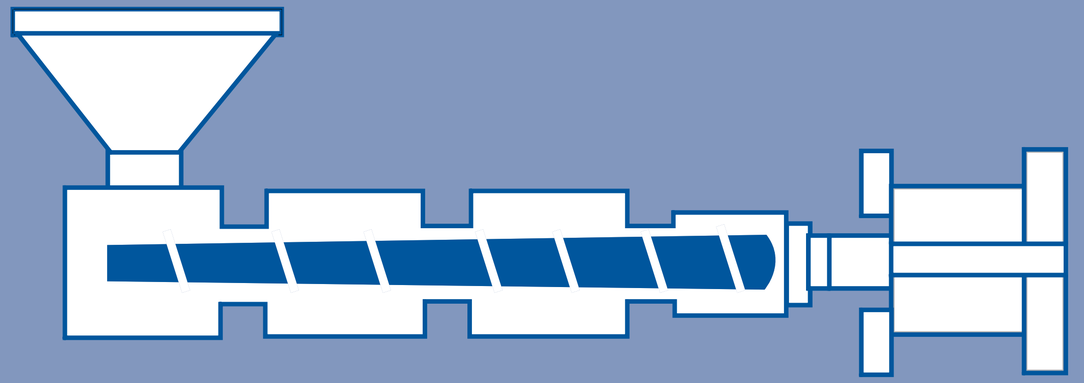
It is recommended to purge and clean processing equipment with suitable products on a regular basis in order to minimize the build-up of deposits on the screw and barrel. **Ideally sieve packs should be used during extrusion to filter out any particles.**

Despite best working procedures, we cannot guarantee that Dryflex WS will be totally free of such inclusions. **This must be fully evaluated when designing profile geometry, mould gates and process engineering.**

Processing : Extrusion

These conditions are only indicative, **please refer to the grade specific processing guide for precise details**

L/D Ratio:	**20:1 - 25:1**
Compression Ratio:	**2.5 - 3.0**
Breaker Plate/Screen:	**Both should be used**
Draw Down:	**5 - 10%**
Cooling:	**Air cool only**
	(must not come into contact with water)

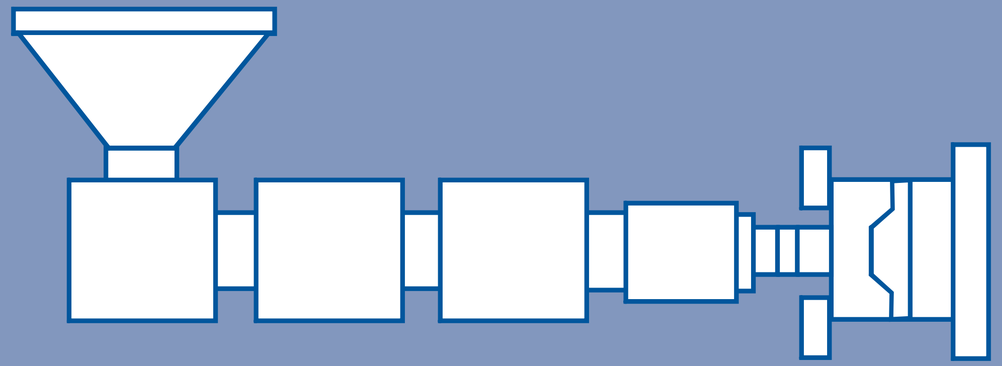


Recommended start-up temperatures °C	**20 - 30 Shore A**	**80 - 90**	**80 - 90**	**90 - 100**	**90 - 100**	**110 - 120**
	WS+ 20 - 30 Shore A	**80 - 90**	**80 - 90**	**90 - 100**	**90 - 100**	**110 - 120**
	35 - 45 Shore A	**110 - 110**	**110 - 110**	**110 - 120**	**110 - 120**	**120 - 130**

Processing : Injection Moulding

These conditions are only indicative, **please refer to the grade specific processing guide for precise details**

Injection Speed:	**Medium - Fast**
Injection Pressure:	**Medium - Fast**
Back Pressure:	**Low - Medium**
Holding Pressure:	**Sufficient to pack the mould**
Cooling:	**Can be demoulded when parts have cooled sufficiently**



Recommended start-up temperatures °C	**100 - 110**	**110 - 120**	**120 - 130**	**130 - 140**	**15 - 30**

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