Environmental Matters

1. Environmental Matters

Our activity covers the efficient manufacture of raw materials and products and the minimisation of plant emissions and waste. We are also focused on the sustainable waste management of used products, the appropriate roles of re-use, recycling and energy-from-waste, with the aim of minimising the quantities of used materials and products going to landfill.

2. What is PVC?

Polyvinyl Chloride (PVC) is a major plastics material which finds widespread use in building, transport, packaging, electrical/electronic and healthcare applications.

PVC has been in commercial production since 1933 (year the BPF was founded). It now accounts for about 20% of all plastic manufactured world-wide, second only to polyethylene. The UK produces approx. 500,000 tonnes of PVC per annum.

PVC is a very durable and long lasting construction material, which can be used in a variety of applications, either rigid or flexible, white or black and a wide range of colours in between.

The essential raw materials for PVC are derived from salt and oil. The electrolysis of salt water produces chlorine, which is combined with ethylene, obtained from oil, to form vinyl chloride monomer (VCM). Molecules of VCM are polymerised to form PVC resin, to which appropriate additives are incorporated to make a customised PVC compound.

3. The Constituents of PVC-U Windows

3.1. How PVC-U Windows are Made

PVC-U windows are made from sections of profile, which are cut and joined together to for the shape of the window. These profiles are produced by forcing molten PVC through a precision die, the material is cooled almost immediately before being cut to length. The flatness, squareness, and straightness of the profile is maintained by the design characteristics of the profile and the tooling.

The windows are then fabricated from pieces of profile that have been cut to the correct size. These pieces of profiles are joined together using either heat-fusion welding or T-joint connectors. Steel or aluminium reinforcement sections are fixed inside the PVC-U profiles to provide additional strength, where required.

PVC-U is based on the polyvinyl chloride polymer, however, in order to make the material suitable for use as a window, a number of different additives and stabilisers are used. These special heat and UV stabiliser additives are an essential part of any PVC formulations destined for the manufacture of PVC-U windows.
The choice of stabiliser will largely depend on the particular end-application, and there are good technical reasons why certain stabiliser types are used for specific applications. Stabilisers often comprise a metallic component together with various organic compounds - the simple elemental form of a metal is never used. There are several types of metal salts and soaps used to stabilise PVC for window applications, and some specific examples are discussed below:

### 3.2. Cadmium

Cadmium based stabilisers are now very rarely used for PVC-U window applications in Europe, though they may be present in some older windows as cadmium based soaps were used as stabilisers. The move away from cadmium by manufacturers of window profiles has not been prompted by any major risk to people or the environment. Indeed, the 1992 EC Cadmium Directive recognised the lack of acute threat in allowing a phased reduction in the use of cadmium pigments and stabilisers, and in permitting their continued use in certain applications such as PVC-U window profiles.

The Swedish Environmental Protection Agency recently confirmed that heavy metal stabilisers are firmly bonded into the PVC material and do not leach out (19).


### 3.3. Lead

Elemental lead is not used as a PVC additive. Special compounds known as salts and soaps are used in PVC applications to give very good processing and weatherability characteristics. The presence of lead based stabilisers in PVC products does not represent any significant risk of damage to health. The safety of lead stabilisers has been confirmed by the UK Drinking Water Inspectorate, the Swedish Environmental Protection Agency, the Swedish Water and Waste Waterworks Association, the World Health Organisation and the OECD, which have all approved the use of lead stabilisers in PVC pipes intended to carry potable (drinking) water.

In fact, an official Swedish test institute conducted tests to see how lead migration from PVC pipe would compare to the limits set down in the EU Ceramics Directive (which covers migration limits for food contact ceramics) (1). Their results showed that it is just as safe to eat meals off a lead stabilised PVC pipe as it is to eat them off a ceramic plate (2).

2. Donnelly, P. Current Legislative Position of Stabilisers Used in PVC-U Risk Assessment papers and National and International Regulations ECVM/ELSA/ORTEP 1996

### 3.4. Organotin Stabilisers

These stabiliser systems are now well established for use in PVC items, though their use in PVC-U window profile applications is limited. As with lead and cadmium based stabilisers, they remain firmly bound within the polymer matrix. The organotin compounds used as PVC stabilisers are safe to use (3). Indeed, certain organotin stabilisers have been approved for use in food contact packaging under EU regulations (4).

Referring back to the OSPAR Convention, a special Workshop on Plastic Additives was held in Paris in May 1997. The workshop concluded that there are several different, significant sources of certain
organotin compounds found in the environment (e.g. anti-fouling paints, biocidal applications and the use of tributyl-tin) and also that natural processes acting on inorganic tin (methylation) also contributed to environmental levels (5). Octyl-tin, being only used as a plastic stabiliser is not found significantly in the environment. The environmental concentrations of organotin compounds used as stabilisers are therefore estimated as very low and should not pose an environmental risk (6).

4. Ibid.
6. Ibid.

3.5. Calcium Organics

Calcium Organic stabiliser systems have been used in PVC applications for over 20 years. They are generally based on metal carboxylates and will sometimes incorporate other elements to boost performance such as aluminium or magnesium.

Because of the characteristics of calcium organic stabilised materials they are widely used in many flexible and rigid PVC applications, including PVC-U window profile. This type of stabilising system can give products that have a high degree of clarity, good mechanical and electrical properties, excellent organoleptic properties and good outdoor weatherability.

In recent years there have been significant performance developments in calcium organic stabilisers, which now means they are viable technical alternatives to most other stabilising systems. These newer forms of calcium organic stabiliser are in general more complex and expensive than the traditional soaps mainly because of the specialised co-stabilisers required to meet the specific requirements of these applications. However, a number of PVC-U systems suppliers now use calcium organic stabiliser systems and the remainder are expected to follow suit over the next few years.

Some concern has been raised regarding the safety of these stabiliser systems, however, calcium organic stabiliser systems incorporating the proven range of co-stabilisers have low-toxicity and are often regarded as non-toxic. Solid calcium organic stabilisers have to meet the general requirements for dust emissions in the workplace although dust-free forms are readily available.

Any of the currently available stabiliser systems can be used in safety to produce PVC-U windows, doors or conservatories, provided compliance with the current chemical and product specific regulations is maintained. The different metallic based stabilisers are used for a variety of good technical reasons and they have provided society with very valuable products, varying from life saving medical applications to high quality, long life building products (7).


4. Life of a PVC-U Window

PVC-U has been used for fabricating window frames since the 1960s, first in Germany and then more recently in the UK. Over the past 15 years the use of PVC-U windows has grown dramatically and now
over 85% of new and replacement window projects use PVC-U, usually to replace timber framed windows. There are many reasons for this success, but the main one is the quality of the product. PVC-U is a very durable and lightweight material that lends itself perfectly for use in fenestration products.

4.1. Window Maintenance

PVC-U can be successfully maintained by following the guidance provided by the British Plastics Federation’s Windows Group. It is important to remember that timber window frames are also subject to weathering, and they will require cleaning just the same as PVC-U. PVC-U windows, however, do not rot, warp, peel or chip.

In the BPF’s own guidelines (8), we identify low maintenance as being a major benefit of PVC-U windows. We recommend regular cleaning with appropriate detergents and warm water, and the checking of certain hardware components such as gaskets and hinges, which may need lubrication from time to time. This would hold true for all materials, however, and is not unique to PVC-U.

In a report undertaken by the German Institute for Construction with Plastics on behalf of the German Federal Ministry for Environmental Planning, Construction and Urban Development, the long-term characteristics of PVC-U were identified as follows:

"Faults on windows using PVC-U profiles occur usually in the operating mechanism or the seals, i.e. the components that are not made of PVC. Hence the long term characteristics are determined by the durability, low maintenance and wear characteristics of the components installed into the PVC window frames, and not by those of the frame itself. Since the PVC window frames do not have to be painted with fungicides or protective coatings, no maintenance of the frame is required apart from cleaning" (9).

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4.2. Cost Comparison

Whilst it is very difficult to generalise about costs which will vary for all materials in terms of product quality and market conditions, the Northern Consortium of Housing Authorities in the UK has carried out a regular survey of costs of window systems. The Consortium has accumulated a considerable amount of data for the in-use cost of window frames made from different materials. Their data shows that over a 30-year period, the total capital and maintenance costs for a softwood window will be 33% more than for a window in PVC-U, assuming a 10% bank interest rate in a scheme involving 30 windows (10).

An industry study compiled in Germany by AgPU (PVC industry organisation in Germany) has shown that the total investment and maintenance costs for hardwood systems over a 25-year period were 23% more than PVC-U, and aluminium systems were 57% more expensive (11). It is difficult to
transfer the results of cost comparisons in one region to the situation in another. However, the marked success that PVC-U windows have enjoyed in the UK market clearly demonstrates their cost-effectiveness in relation to competing materials.


4.3. Aesthetics

The use of PVC-U windows in modern dwellings is subject to few if any planning regulations, and over the last 15 years the consumer has overwhelmingly chosen to fit replacement windows made from PVC-U. In fact, PVC-U now accounts for some 90% of the replacement window market in the UK. Windows obviously play an important part in the expression of period, image and regional building traditions. The BPF does not support the installation of PVC-U windows where this is against the relevant Planning Laws, as it could well result in a loss of common architectural heritage and may incur costs for homeowners and installers. The BPF would urge installers and homeowners to check that their dwelling or area is not subject to such planning regulations.

5. The Disposal of Old PVC-U Windows

How can PVC be disposed of in an environmentally responsible way?

There is a range of alternative methods available for deriving residual value from used plastics products. The optimal route for a given product will be determined by assessing a combination of environmental, logistical, economic and market considerations. Therefore, the whole range of waste management options should be considered when deciding on the treatment of plastic waste, including PVC-U windows.

5.1. Recycling

The claim that PVC is not recyclable is simply not true. PVC, like all other thermoplastic materials, can be recycled relatively straightforwardly. The primary aim of recycling is to elicit a net environmental benefit through reducing the use of primary resources and/or diverting resources from landfill. The European PVC industry has most definitely achieved real successes in this regard, using the RecoVinyl scheme to co-ordinate the collection and recycling of post consumer PVC building products. It has long been common practice to recover and recycle factory wastes and/or off-cuts after the window has been fabricated. These materials are then incorporated with virgin polymer to produce further long life products including window profiles.
5.2. Recycling Process

The RecoVinyl Scheme is a European wide initiative to collect and recycle post consumer PVC building products to support the Vinyl Plus Voluntary Commitment. Consistently, since inception of the scheme the UK has led the way in the volume of PVC collected and recycled in Europe.

Regardless of the materials involved, a potential barrier to cost-effective recycling of post use products is the ability to retrieve, economically, meaningful quantities of used products to supply a recycling scheme with its feedstock. In Germany, PVC-U windows were commercially introduced some twenty years before they were in the UK. Hence, German companies developed technologies to recycle post-use PVC products, which may arise as demolition wastes, for example.

As tonnages of post consumer PVC products inevitably increase, then the European industry will have the technology and infrastructure to recycle them in commercially viable and environmentally beneficial schemes.

5.3. Incineration

The incineration of PVC need not present any special problems relating to emissions of dioxins. Modern incinerators in Europe are designed to meet stringent EU limits on emissions of a number of substances including dioxins and hydrogen chloride. It should be noted, however, that both of these substances are formed by other materials and not just PVC. Municipal Solid Waste Incinerator

PVC is by no means the only chlorine-containing substance in Municipal Solid Wastes (MSW). Organic materials such as wood, card, paper, textiles and waste foodstuffs, for example, are also capable of forming hydrogen chloride (HCl), as well as other acidic precursors such as oxides of sulphur and nitrogen (SOx and NOx). The flue gas wastes must be treated as hazardous due to the presence of heavy metal components - the vast majority of which come from non-PVC sources. Therefore, the scrubbing and purifying facilities would be required whether PVC was incinerated or not, and so there are no additional capital fixed costs associated with the controlled incineration of PVC, as part of the municipal solid waste stream. However, it is true that the operating costs can vary according to the amount of PVC in the waste stream, but this also depends upon the conditions of incineration and the rate of utilisation on the incineration facility. Based upon studies made and the average content of PVC in MSW, the incremental cost of PVC in the waste stream may amount to 1 - 2% of
the total cost of incineration (12). It should be noted, however, that other component materials present in the waste stream also have associated costs.


5.4. Landfill

A study by the Chalmers University of Technology in Sweden, concluded that rigid PVC does not degrade in landfill (13). PVC-U will remain inert in landfill, and there is no evidence to suggest that PVC-U would be a source of any toxic substances under landfill conditions.


6. Recycling

The PVC industry has invested millions of pounds to develop a sophisticated recycling service, bringing thousands of tonnes of ‘waste’ material back into use in a new generation of advanced energy efficient and sustainable products. Because of its structure and composition, PVC can be easily, mechanically recycled in order to obtain good quality recycling material. Careful and proper sorting is of crucial importance for the optimal recycling of PVC materials.

Importantly, this includes a capacity to recycle not just production off-cuts but also old PVC products, for example doors and PVC-U windows that have reached the natural end of their life cycle – closing the loop on the recycling process.

Old windows are far more complex to recycle than factory off-cuts because they inevitably contain building debris, for example steel, concrete and sealants which need to be removed before re-processing.

The primary aim of recycling is to elicit a net environmental benefit through reducing the use of primary resources and/or diverting resources from landfill. The European PVC industry has most definitely achieved real successes in this regard, using the RecoVinyl scheme to co-ordinate the collection and recycling of post consumer PVC building products. It has long been common practice
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The scheme, which is independently audited, produces regular Progress Reports on all of the measurable schemes.

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As tonnages of post consumer PVC products inevitably increase, the European industry is seeing the development of the technology and infrastructure to recycle them in commercially viable and environmentally beneficial schemes.

Regular Newsletters are also available from Axion Recycling, who facilitate the Recovinyl Scheme in the UK. Please sign up to these via info@axionrecycling.com. These are also available from BPF Windows Group Technical Executive Paul Jervis' website www.pauljervis.net

A significant report has been written by Hydro Polymers, detailing the effects of PVC recycling on performance criteria. The study confirms that "...PVC-U form can be successfully recycled (100%) several times without significant loss in physical properties."

Please keep your eye on the "news" section of the BPF website, where the latest developments re PVC recycling will be recorded. The BPF run several seminars throughout the year, several of which will focus on plastics recycling, with the Vinyl's Group Seminar, held each November, focuses specifically on PVC, around topics such as recycling and REACH. Details of all BPF seminars can be found via www.bpf.co.uk.

In 2006, the UK saw over 16,800 tonnes of post-consumer PVC product recycled. The 2007 figures – released at the PVC 2008 conference, Brighton – show that the UK recycled a total of 42,162 tonnes, showing an outstanding year-on-year increase. The UK leads the field under Recovinyl, in Europe. The indications are that the UK will continue the upward trend in post-consumer PVC recycling from 2008 and beyond, with over 50,000 tonnes expected in 2008 alone.