PVC

Facts and issues –

prepared by
European Council of Vinyl Manufacturers
for the Hong Kong Productivity Council

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EXECUTIVE SUMMARY

Main characteristics and uses of PVC

PVC is a thermoplastic made of 57% chlorine (derived from salt) and 43% carbon (derived from oil / gas via ethylene). In terms of world consumption PVC accounts for approximately 23%, of all plastics, with an annual volume of about 25 million tonnes.

The global use of PVC grows at the rate of 4 to 7% per annum. It is not only the excellent cost performance of PVC that causes its rapid and sustainable growth, but also the fact that there are no other plastics which can be modified by additives to such an extent as PVC and that PVC can be processed through practically all common technologies.

The properties of PVC make it suitable for long-life applications. PVC products used in some construction applications have an expected “service-life” of minimum 50 years. 65 to 70% of all PVC is used in the construction sector. In addition to its long life, this is due to its excellent mechanical properties, low flammability, excellent weatherability and UV resistance, low weight of PVC construction products resulting in easier installation and in lower emissions generated during transport, and recyclability.

PVC finds also widespread use in the cable and electric industries. Due to its excellent electric and isolating characteristics at a wide range of temperatures, ease of processing, resistance to aggressive natural environment and to UV, durability, low flammability, possibility to recycle, competitive price.

Whereas the healthcare market accounts for less than 1% of all PVC it is a very important application in terms of contribution to saving lives. PVC has been successfully used in healthcare for about 50 years. PVC is the most widespread thermoplastic used for medical devices due to its chemical stability, excellent blood-preserving properties, transparency and clarity, ease to sterilise, resistance to kink, easy assembling.

PVC is used in a wide variety of other applications. For instance, PVC is the second most important polymer in automotive industry after polypropylene.

Health and environmental impact

During the recent years, European PVC producers have modernized their production facilities. A substantial effort has gone in to improved Health Safety & Environmental standards, resulting among other benefits in an impressive reduction of emissions, especially of the monomer VCM. This has mainly been achieved by joint voluntary commitments going much beyond regulatory requirements.

PVC products are mostly long-life products consuming relatively low amounts of energy in the course of the production and comparing favourably with most alternative products when analysed in a Life Cycle Assessment (LCA).

PVC, like all other thermoplastic materials, can be recycled relatively straightforwardly. All recycling techniques can be applied, depending on the composition of the waste and possible outlets for the recycled products.

Mechanical recycling is well suited when clean fractions are available in sufficient quantities on a regular basis. PVC can be recycled up to 10 times; depending on the application because recycling does not significantly decrease the chain length of its molecules. There are already several purpose-built operations in Western Europe, which recycle pipes, profiles, flooring, and membranes. The West European PVC industry has made clear public commitments to significantly increase mechanical recycling in these applications.

Next to mechanical recycling, a dissolution process (Vinyloop)has been recently developed to extract PVC from products such as cables, tarpaulins, etc. The recovered product is PVC compound that can be used without further processing and cleaning. The first commercial plant has started up in Italy early 2002. Several more are planned.

Feedstock recycling is an alternative to overcome the limitations of mechanical recycling. Its purpose is to recover a basic chemical element such as carbon and/or chlorine. Trials are going on to determine which of the various available techniques could be supported into commercial implementation.

Recent studies commissioned by the EU authorities have confirmed that incineration of PVC can be carried out without causing health or environmental harm. Modern incinerators generate some hazardous waste and a (very limited) quantity of dioxins, whether PVC is present or not. Dioxin “production” depends primarily on combustion conditions, not on PVC content in the waste.
The Dutch research organisation TNO stated: “Complete elimination or even strong reduction of PVC in incineration will not lead to any substantial ecological or environmental gain”

The role of PVC in fires has been thoroughly investigated. Concerns that HCl released by PVC in fire could be a prime cause of death have been proven incorrect.

There is an emotional debate around additives. Although the concerns have been proven unfounded by many studies, the European PVC Industry accepts its responsibility also in an emotionally driven debate and has therefore agreed to stop using cadmium and to gradually replace lead in stabilisers.

Plasticisers are used to impart flexibility in vinyl compounds, thus improving the impact resistance and softness of the material. The main group is phthalates.
Allegations of carcinogenicity and of hormone disruption have been disproved by recent studies. Effects observed on rodents are now considered to be of little relevance because no such effects occur in non-human primates, which metabolise phthalates in a manner similar to humans. Nevertheless, the health effects of phthalates (especially as potential endocrine modulators) are being further evaluated and the results in form of a EU risk-assessment will be available in 2003. On the basis of what we know today about the outcome of these risk assessments, phthalates should not be considered as endocrine modulators.
Furthermore IARC confirmed in January 2001 that Phthalates were not a carcinogen to humans.

There is absolutely no intention to ban PVC at European Union level. PVC issues have been investigated through the Horizontal Initiative of The European Commission for three years and a Communication Paper by the Commission is due to be published, defining the EU policy on PVC. This document will define the way forward to make progress, especially regarding the use of additives and the development of recycling schemes.

Substitution of one polymer for another

Plastics are modern materials as compared to many alternatives and in many applications plastics have substituted other materials. Subsequently, often one polymer has replaced another, depending on progress and on advantages and disadvantages in the different applications.

Phasing out a material is not as easy as some seem to believe because it means phasing in an alternative. If this is done like a "knee-jerk" reaction only because of political pressure , it can cause harm when the alternatives are less well tested.

There is no increased trend to substitute PVC with an alternative, on the contrary; in Europe there is an improved understanding of the use of Life Cycle Analysis as a tool when considering alternatives.
Whenever products made from PVC are compared to alternatives made from other polymers or other materials (see for example the study commissioned recently by the UK Ministry of Environment) , PVC is found equivalent to its alternatives and in many cases is considered the most favourable solution.

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1. Introduction

This report has been prepared by ECVM, (the European Council of Vinyl Manufacturers) Brussels as a follow-up to the specific request made by Hong Kong Productivity Council.

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2. Facts about PVC

2.1 History

Since the very start of mankind, people have been trying to develop materials with better characteristics than the natural products. Plastics were first developed in the 19^{th} century. Plastics we meet practically everywhere and everyday.

Alexander Parkes discovered the first plastic –cellulose nitrate – in mid 19th century. It was first introduced to the public at the Great London Exhibition in 1862.

The first new polymer materials represented modified natural materials. By far the most important one is viscose fibre.

Plastics development continued in the 20-ies and 30-ies. They found mass use during WW II. In early 50-ies, plastics found their way into our homes.

2.2 Today

Today, plastics replace traditional materials, such as wood, metals, glass, leather, paper, rubber, because they are lighter, corrosion resistant, sturdy, and easy to process and have better insulating characteristics. Therefore, the use of plastics is more economical compared to traditional materials. Plastics are found in the industry, homes, shops, schools, hospitals, cars etc. they influence the fashion and our lives. There are various types of plastics: polyethylene, polypropylene, polymetylmetacrylate, polystyrene, etc. One of the major plastics is polyvinyl chloride known as PVC, it represents about 23% of all plastics produced and sold globally

3 What is PVC?

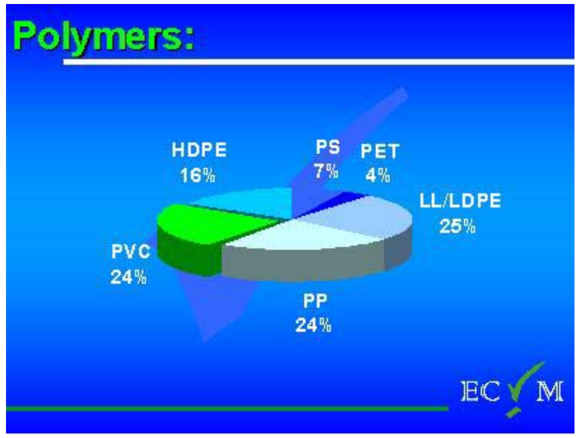
PVC is a thermoplastic made of 57% chlorine (derived from salt) and 43% carbon (derived from oil / gas via ethylene). H. V. Regnault first synthetically prepared it in 1835. Its mass production was initiated in Germany 90 years later by Farbenindustrie (I.G.Farben). The first designation of PVC was derived from this company title - „Igelit“.

PVC has a special position due to its physical-chemical characteristics. There are no other plastics, which can be modified by additives to such an extent as PVC. With regard to costs/performance, there is very seldom a better alternative to PVC. If there were one, it would already have been used.

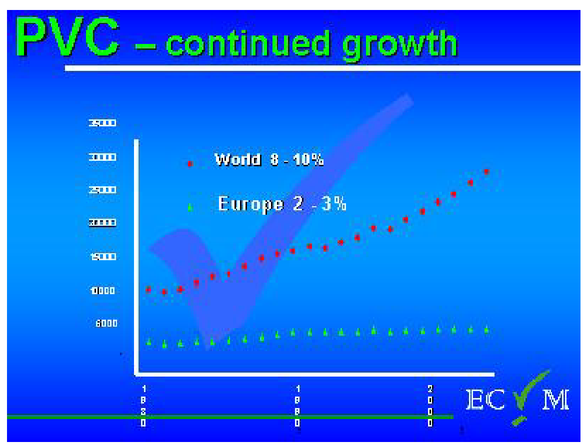
4. PVC 2nd most widely used plastic

Even though PVC was discovered already in the 19th century, its production took off after WW II. Currently, most of industrialised countries have PVC production facilities. In terms of world consumption PVC account for approximately 24%, of all plastics, with an annual volume of about 25 million tonnes. Polyethylene

(LDPE, LLDPE, and HDPE) represents 41% and Polypropylene (PP) 24%.



The global use of PVC grows at the rate of 4 to 7% per annum. . Currently the utilization of production capacity is about 90 to 95%. New factories are being built, mainly in the Asian countries.



During the recent years, European PVC producers have restructured, expanded and modernized their production facilities. A substantial effort has gone in to improved Health Safety & Environmental standards, resulting among other benefits in a significant reduction of emissions. This has mainly been achieved by joint voluntary commitments, such as the ECVM Charter [1]

[1] ECVM Industry Charter for the Production of VCM and PVC, Division of the Association of Plastics Manufacturers in Europe, Ave E. Van Nieuwenhuyse 4, Box 4, B-1160 Brussels – www.ecvm.org

In Western European the PVC market is expected to grow at about a 1 to 2% over the next 5 years.

It was not only the excellent cost performance of PVC, that caused its rapid growth, but also the fact that it is easy to process through practically all usual processes (extrusion, calendering, injection moulding, blow moulding, vacuum forming, etc)

The global PVC production capacity is split as follows:

Western Europe	26%
Northern America	25%
South-east Asia	17%
Japan	11%
Eastern Europe	7%
Latin America	6%
Middle East	3%
Africa	2%

5. PVC production

The two basic starting ingredients for PVC production are chlorine derived from salt and ethylene from natural gas or oil derivatives. These basic components are combined in a direct chlorination or an oxychlorination process to produce ethylene dichloride, which in turn is then 'cracked' to produce vinyl chloride monomer - VCM and hydrogen chloride. The HCl can then be recycled back into the oxychlorination process. Production of chlorine leads to the production of a similar quantity of caustic soda, which is used by very different industries such as in aluminium, pulp / paper and soap production.
VCM is converted to PVC resin by one of three polymerisation techniques; suspension, emulsion or the mass processes. The suspension process is by far the most commonly used.

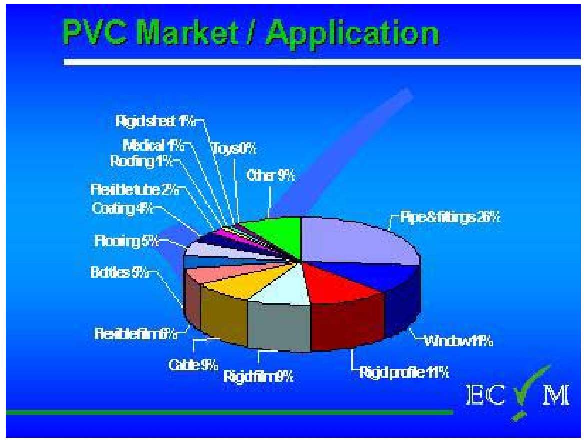
Clearly with regard to economic use of scarce non-renewable resources the fact that approximately 57% of PVC is derived from the immense global reserves of natural salt, is itself an important factor and may become increasingly so with regard to society's current usage of the more limited non-renewable resources such as oil.

6. PVC characteristics

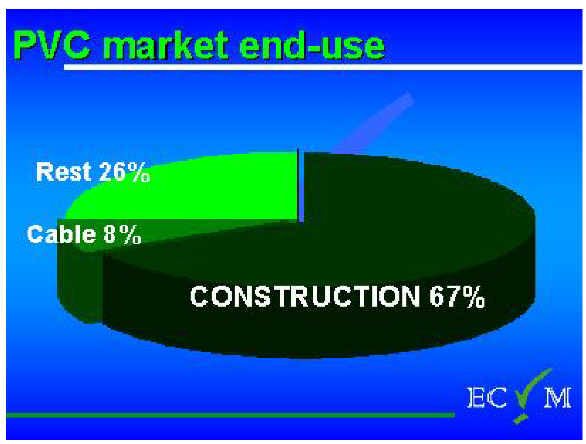
PVC is a white powder. The powder is compounded with various additives to achieve all the unique properties of PVC. PVC can be rigid, semi-rigid or flexible. It can be clear, translucent or coloured. The desired characteristics depend upon the required properties that are needed for the final applications. The properties of PVC make it suitable in tough long-life applications. For example, PVC products used in some construction applications should have an expected “service-life” of minimum 50 years. Studies show, that PVC pipes may reach a ”service-life” of 100 years in 75% of all cases, provided there is no mechanical damage.

PVC products are long-life products consuming relatively low amount of energy in the course of the production and comparing favourably with most alternative products or solutions when analysed in a Life Cycle Assessment (LCA). PVC products are furthermore non-toxic and can be recycled several times.

7. Applications / Markets



7.1 Building and construction - 65 to 70% of all PVC is used in the construction sector, both in new buildings and in renovation projects.



Within this segment PVC is used several applications such as:

- profiles for windows, doors and fences etc;
- pipes such as water pressure, sewage, drainage etc.
- floor coverings;
- roofing and insulation membranes;
- cables and electrical installations, switches;
- sanitary equipment;
- exterior facing, cladding;
- wallpaper;
- etc.

The main advantages of PVC in construction – are achieved by*:*

- excellent mechanical properties, relatively low specific weight and toughness
- low flammability – PVC is self-extinguishing, that is when the source of fire disappears, and PVC immediately stops burning. This makes it a very suitable material for demanding construction applications such as windows, doors and siding
- excellent weather-ability and UV resistance, make PVC a material very suited to the external use, when long-life is desired
- cost effectiveness – it is achieved by the competitive price and a very long life expectancy versus many alternative solutions and materials
- low weight of PVC construction products compared to concrete, steel, iron products results in easier, cheaper installation and lower emissions generated during transport
- very long life of PVC products results in decreased material consumption and low maintenance.
- recyclability – PVC products can be recycled many times without loss of mechanical properties. In many Western European countries there are well-established recycling schemes for waste coming from the construction industry such as pipes, window-profiles, flooring and roofing etc. There is furthermore a voluntary commitment by the PVC industry to increase recycling.

7.2 Cable, electric and electronics - Synthetic materials, especially PVC, find widespread use in the cable and electric industries in a broad range of applications such as:

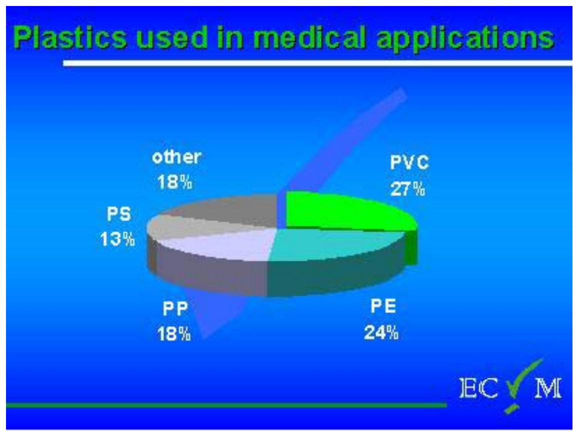
- insulation and sheeting of cables
- cable harnesses
- white / brown goods
- computer housing and keyboards
- etc.

PVC is a material suitable for electro technical industry especially due to the following characteristics:

- excellent electric and isolating characteristics at a wide range of temperatures
- ease of processing providing for the required final product characteristics

- resistant to aggressive natural environment, UV
- low flammability
- possible to recycle
- competitive price compared to alternative materials
- PVC is very durable and therefore suitable in long-life applications requiring minimum maintenance

7.3 Health care – Whereas the healthcare market accounts for less than 1% of all PVC it is a very important application since it contributes to saving lives. Furthermore PVC is the most widely used plastic in the healthcare sector.



PVC has been successfully used in healthcare applications for about 50 years – it is used in applications such as:

- catheters
- tubes for feeding and medicine
- bloodbags
- miscellaneous medical devices
- breathing apparatus
- etc

PVC is the most widespread thermoplastic used for medical devices due to the following characteristics:

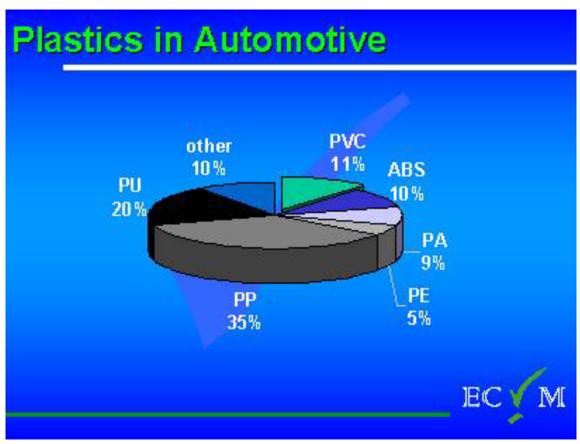
- chemical stability
- excellent blood-preserving properties
- transparency and clarity
- ease to sterilise
- resistance to kink
- ease to assemble separate devices (welding etc)

These characteristics have contributed significantly to improved health care. It has simplified the work of medical staff and contributed to reduce the cost of health care.

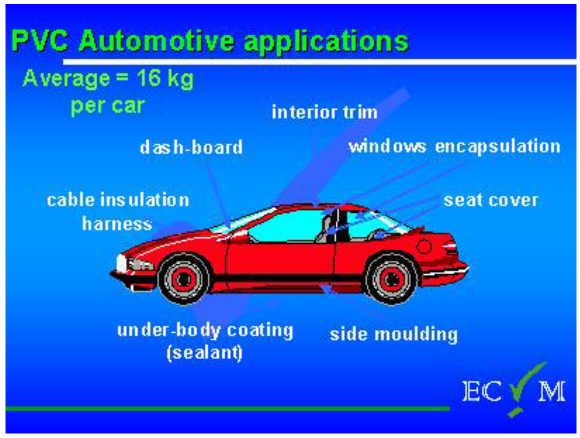
***7.4 Various applications* -** PVC is used in a tremendously wide range of applications such as:

- protective clothing,
- lifeboats and jackets,
- plastic shoes, soles and trainers
- bottles, tanks, containers,
- packaging, film and trays
- sports equipment, hobby articles and toys
- furniture components,
- garden and industrial hoses,
- conveyer belts and transport equipment
- etc.

PVC is the third most important polymer in automotive industry after polypropylene.



The average car in Europe contains 16KG of PVC. This contributes to increased safety and reduced production costs.



The applications in the car industry include - internal parts such as:

- dashboards, door-panels, seating etc

and under-bonnet and external parts such as:

- sealants, coating, cable harness and protective mouldings, etc.

The advertising industry use PVC boards, which are easy to process and shape and so are used for the production of billboards, shields, etc. Flexible and printed film is another application used for advertising. Once again it is the advantageous cost, ease of fabrication that makes PVC the material of choice.

Within the packaging market PVC is used because of its range of properties in applications that range from bottles for water and cosmetics, etc to films and trays for vegetables and sandwiches and blisters for pharmaceuticals.

8. Safety issues :

Vinylchloride- In early 70-ties of the last century, it was discovered, that the monomer vinylchloride is a carcinogen. Since then, its use is subject to strictly observing maximum emission limits and exposure levels. The very low emission levels reached by the current technology do not represent any threat to humans or nature. Further, European PVC producers associated in the ECVM have signed a common charter on EDC, VCM and PVC production, whereby they have voluntarily committed to implement stricter limits, than those legally required. PVC producers committed to improve environmental standards through the reduction of emissions. Results of an independent audit showed, that almost 100% of all ECVM members met the stricter voluntary limits.

9. Environment & Issues – see also 19 Questions & Answers:

9.1 Environmental Impact – whereas all manmade materials have an impact on the environment it is important to note that in the case of PVC the possible adverse effects on the environment are by far outweighed by the advantages. PVC uses less natural recourses than some alternative materials and as such has a lower contribution to any depletion of natural resources.
PVC presently contributes less than 0.2% of all waste in European Union.

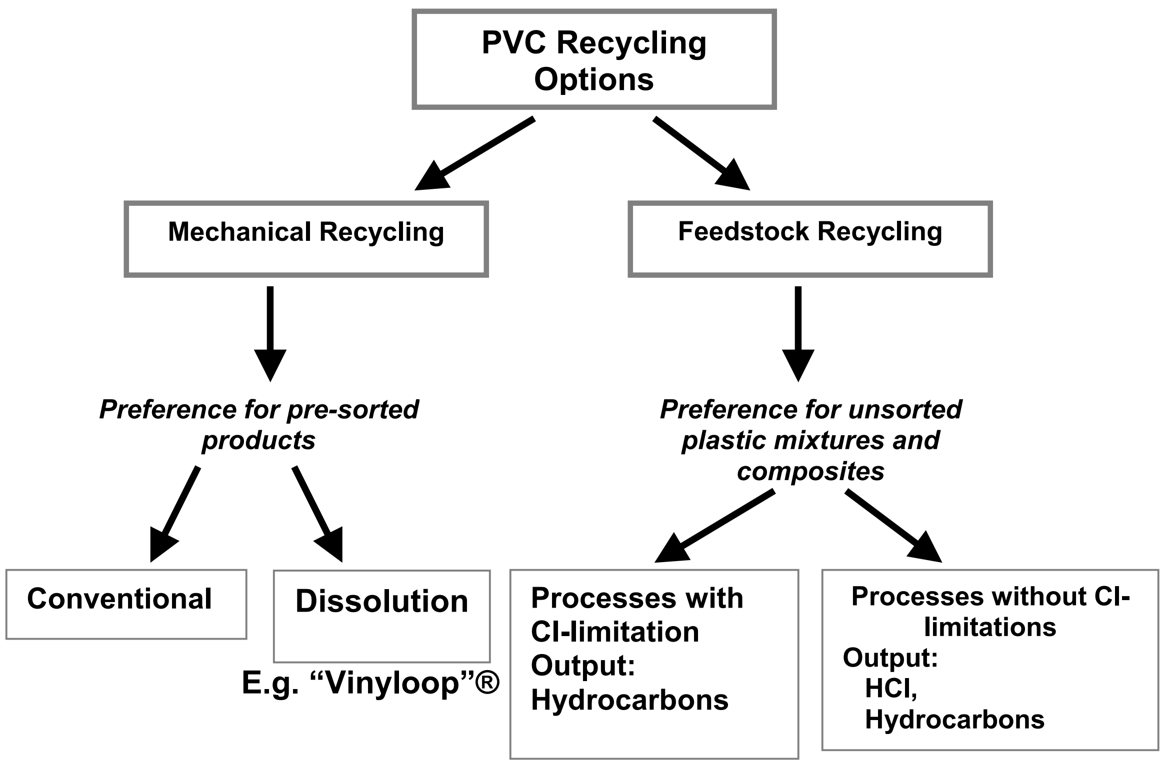
9.2 Waste management - Different types of plastics products will have different optimal routes for deriving residual value from waste (valorisation). Assessing a combination of environmental, logistical, and economic and market considerations will determine the best option. Therefore, the whole range of waste management options should be considered when deciding on the treatment of plastic waste.

Method	Suitable option for
Mechanical Recycling	Sorted, single PVC products
Feedstock Recycling	PVC mixed with other plastics
Energy Recovery	Non-sortable / contaminates mixed plastics and other solid waste
Landfill	Non-recoverable products and residues

10. Recycling *:*

PVC, like all other thermoplastic materials, can be recycled relatively straightforwardly – the various options depend upon several parameters such as recovery rate, cleanliness of waste, economic viability etc.

10.1 PVC Recycling Options:



10.2 Mechanical Recycling – Preconditions for mechanical recycling to be successful are:

- ✓ The waste must be relatively easy to sort in clean factions
- ✓ Sufficient quantities must be regularly available
- ✓ Minimal transport from collection point to recycling plant
- ✓ There must be a viable outlet for the recyclate
- ✓ The scheme must be able to withstand adverse economical conditions also during downturn in prices of prime material

PVC can be mechanically recycled up to 10 times, depending on the application because recycling does not significantly decrease the chain length of its molecules.

There are already several purpose-built recycling operations in Western Europe. The examples include recycling of pipes, profiles, flooring, membranes, packaging, etc.

10.3 PVC - Dissolving Processes (Vinyloop® - Solvay) -Process to extract – dissolve – PVC from products such as tarpaulins, artificial leather, cable etc.
The recovered product is PVC compound, including additives that can be used without further processing and cleaning.
This process has been demonstrated on pilot scale. The first commercial plant, located at Ferrara (Italy) is in commercial operation. Several more are already being considered in Europe, Canada and Japan.

10.4 Feedstock Recycling - The main purpose for Plastic Feedstock recycling is:

- ✓ To overcome the limitations of mechanical recycling for mixed plastics – or multi material products which cannot be economically separated into single polymer fractions
- ✓ To recover a basic chemical element such as carbon (in the form of synthesis gas) and/or chlorine (in the form of HCl), for use in the petrochemical industry.

Several other trials have been carried out, using existing facilities in Germany and Denmark. The overall objective is to compare the various techniques and to determine which of them should be supported into commercial implementation. With the financial support of the European Union and of the PVC industry, a Danish waste management company has decided to modify one of its plants in order to reach 40 kt/a capacity of PVC waste treatment, yielding salt and hydrocarbons.. Completion is expected towards the end of 2004.

10.5 Incineration/Energy Recovery PVC, like other thermoplastics, has intrinsic energy, which can be recovered through incineration. Flexible PVC will generally contribute higher energy content than unplasticised PVC, although even rigid PVC has a calorific value similar to burning paper.

11. Incineration of PVC –

With or without PVC in the waste, all incineration plants produce HCl, NO_x and SO_x. These gases have to be neutralised to respect emissions limits – as a consequence solid residues are generated These residues are considered hazardous waste because they contain heavy metals and other hazardous substances. This is

essentially **not** because of PVC. PVC products contribute to less than 2% of the heavy metals in incinerator residues.
The Dutch research organisation - TNO states: ***“Complete elimination or even strong reduction of PVC will not lead to any substantial ecological or environmental gain”***

12. Dioxins

An erroneous allegation regarding PVC is that its incineration increases dioxin emissions. Extensive tests proved such allegations to be wrong. They confirm, that the dioxin production depends mostly on combustion conditions, not on PVC content in the waste.

12. 1 Dioxin emissions from Municipal Solid Waste Incinerators MSWI – the facts:

- Reduction of PVC in MSWI does not impact on formation of dioxins
- Inorganic chlorine contributes to dioxin formation in the same way as organic chlorine
- Formation of dioxins in MSWI is dependant upon parameters like:
  - Combustion conditions
  - Cooling of the off-gas when passing the critical temperature range (500 to 200 C)
- To achieve compliance with EU standards of 0.1 ng I-TEQ/M_3 – cleaning of off-gas is necessary

12.2 Dioxins from uncontrolled burning – the facts are:

- Uncontrolled combustion of PVC can be intentional (e.g. open burning of household waste) or unintentional (e.g. accidental fires)
- Uncontrolled burning can be a major source of dioxin – because of unfavourable combustion conditions - not because of PVC[2]
- Any uncontrolled combustion of PVC or of any other organic material releases significant quantities of polyaromatic hydrocarbons (PAH). The health risk of PAH is higher than the risk of dioxins because of their formation at much higher quantities[3].

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[2] Dr. E. Wikström, Umea Univ. “the role of chlorine during Waste Combustion 1999
[3] P.M. Lemieux, US-EPA “Evaluation of Emissions from the Open Burning of Household Wastes in barrels” - 1997

- Whilst landfill fires are less well researched, accidental fires containing PVC are well documented. PVC does not release more PAHs than other organic materials. Despite this, in several large fires it has been concluded that with an occurrence of PAHs at concentrations 10.000 times higher than for dioxin, the carcinogenic risk potential from PAHs in the soot is at least 500 higher than for dioxin[4]

13. PVC and Additives:

- All plastics use some sort of additives (e.g. antioxidants, lubricants, etc.)
- The versatility of PVC – is achieved through the use of additives (e.g. stabilisers, plasticiser etc.)
- All the additives used in Europe for PVC production or compounding, have undergone rigorous risk assessments - and can be used safely.[5],[6]
- At the end of the lifecycle these additives does not cause harm to humans or to the environment

There is an emotional debate around additives (stabilisers, plasticisers) in PVC in general. The European Union PVC Industry has therefore agreed and committed to stop using Cadmium (Cd) and to gradually replace Lead (Pb) in stabilisers.[7] These decisions have not been taken for technical, economical or environmental reasons.

13.1 Plasticisers - Plasticisers are used to impart flexibility in vinyl compounds, thus improving the impact resistance and softness of the material. There are a number of chemically different types but the main group are phthalates. The environmental concern regarding an alleged potential health hazard with phthalate plasticisers, came to the fore following a publication in 1995 by Dr Richard Sharpe of the Medical Research Council, Edinburgh [8] There had been previously reported effects but this was the first report, which was based on in-vivo studies. In this publication

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[4] Dr. E. J. Spindler, Vinnolit GmbH, “Brandruss – eine Risikoabschätzung” publication in “Chemisce Technik”, 1997

[5] ESPA, European Stabiliser Producers Association -

[6] ECPI, European Council of Plasticiser Industries – www.ecpi.com

[7] PVC Industry Voluntary Commitment, -**www.vinyl2010.org**

[8] Sharpe, R.M., Fisher, J.S., Millar, M.m., Jobling, S. and Sumpter, J.P. 1995, 'Gestational and lactational exposure of rats to xenoestrogens results in reduced testicular size and sperm production'. Environmental Health Perspectives, 103 (12), 1136-1143.

Sharpe hypothesised that the observed effects on rat testes after administration of a low dose of butylbenzyl phthalate were related to an oestrogenic mechanism. However, there were some inconsistencies in this work which has since been repeated by other researchers[9] and these more recent programmes have failed to show any effects on testes at these low doses. So to date, there has been no validation of Sharpe's early work;
Moreover there is a growing body of evidence to indicate that the effects are not demonstrated.

Allegations of hormone disruption have been disproved by recent studies. These showed that phthalates do not produce estrogenic or anti-estrogenic effects. Effects observed on male rodents are considered to be of little relevance because they only occur at levels of exposure many orders of magnitude higher than experienced by humans. In addition, no such effects occur in non-human primates, which metabolise phthalates in a manner similar to humans, but very differently to rodents.

Nevertheless it is important that continuous research and assessments are undertaken on these additives and this is currently ongoing under a risk assessment procedure within the EU. The European Council has prepared a useful information fact file on this issue for Plasticisers and Intermediates
(ECPI) [10]
The health effects of phthalates are being evaluated and the results in form of a EU risk-assessment should be available in 2003.
IARCH confirmed in January 2001 that Phthalates were not to be considered a carcinogen for humans.

13.2 Stabilisers - The use of stabilisers is essential in order to allow the successful processing of PVC as well as ensuring product performance during use. There are several types some of which are based on heavy metals. However, the use of heavy metal compounds, especially in critical applications such as e.g. drinking water pipes, has been thoroughly investigated for many years to ensure the safety of the public. The migration of lead from PVC water pipe has been comprehensively studied over many years and

[9] Ashby, J., Tinwell, H., Lefevre, P.A., ODum, J., Paton, D., Millward, S.W., Tittensor, S. and Brooks, A.N., 'Normal secual development of rats exposed to butyl benzyl phthalates from conception to weaning'. Submitted for publication in Reg. Tox. Pharmacol.

[10] Information Fact File 'Plasticsers and Phthalates' European Council for Plasticisers and Intermediates, Ave E Van Nieuwenhuyse 4, Box 1 B-1160 Brussels Belgium. www.ecpi.org

all the data show that the levels of lead extraction fall well within the recently revised limits of 10 parts per billion set by the World Health Organisation. (WHO)
Despite this, and in order to address the concerns of authorities and the general public, the PVC industry has completely eliminated use of cadmium compounds as from March 2001.
Lead compound stabilisers are still widely used because they provide high-level performance economically and there is no evidence of significant impacts on the environment or public health. They tend to be used mainly in long life applications such as pipes and window profiles. The European Union PVC producers have anyway made a voluntary commitment to gradually replace lead stabilisers by available alternatives.

It is important to take notice that recycling of cadmium and lead containing PVC waste will continue to be made in the future, as it is the best way to avoid dissemination of these heavy metals in the environment.

14. PVC Industry Importance

PVC represents approximately ¼ of all polymers and most of its production growth is based on replacement of natural products. There will always be some substitution with modern materials, such as polymers – one polymer replaces another. In the competitive environment of market economies, alternatives should be accepted, but only if such replacements are proven to be economically and environmentally better, based on scientific research as extensive and thorough as has been applied to PVC over the last decades.

PVC use in Europe keeps growing. Western European PVC market expects a growth of 1 to 2% over the next 5 years. This should amount to 4 to 7 % worldwide. In the future, the growth of PVC consumption will be mostly seen in the long-life products, such as profiles, pipes and sheeting and membranes.

Considering the cost of PVC production and processing and its final characteristics providing for its extensive use in various areas, especially the possibility of long-term use in e.g. construction, there is no alternative to PVC as a universal material. Otherwise, it would have been long used.

Currently, the total PVC industry (including conversion) employs about 530 00 people in European Union companies. PVC is processed in more than 21 000 companies many of them SMEs, 90% of which have less than 100 employees. European Union PVC producers reach yearly turnovers of about Euro 75 billion.

15. European Union:

The legislative decision making process is based on 3 pillars.

- The Commission,
- The Parliament
- Council of Ministers representing the Member States.

16. European Union policy on PVC:

16.1 The Horizontal Initiative on PVC - The EU took the decision three years ago to carry out what was referred to as the **Horizontal Initiative on PVC**.
The objective was to avoid a repetitive debate on PVC issues.

16.2 The EC Green Paper - As part of this Horizontal Initiative, the European Commission published a Green Paper on PVC issues in July 2000. Green Paper containing the results of the 5 studies commissioned by the Commission as well as additional information collected by the Commission such as economical and social aspects, employment, etc
The emphasis of the Green Paper is on waste management and the use of additives.

The PVC Industry response is attached – **Attachment I**[11]

In summary The European PVC industry consider it positive that the Green Paper:

- ✓ Recognised PVC as one of the most important modern synthetic materials;
- ✓ Raised no significant issues specific to PVC;
- ✓ Recognised the Voluntary Commitment as a serious option for the EU policy on PVC;
- ✓ Recognised the need for scientific assessments of alternatives in request for limitation of use;

The Industry does however object to the fact that the Green Paper on PVC:

[11] The European PVC Industry's Response to the Questions Contained in the EU Commission Green Paper on Environmental Issues of PVC - October 20, 2000

- Focused on end of life waste management rather than on the entire life cycle;
- Did not place enough emphasis on the value of the Voluntary Commitment;
- Still considers regulation as an option;

The subsequent step in the process – after publication of the Green Paper in June 2000 - was the Public Consultation that took place between July and November. (32000 responses – 95% positive to PVC) In addition each Member State had to provide the Commission with its official position regarding PVC application and PVC future policy at EU level.

***16. 3 European Parliament Resolution*[12] –-** Based upon all the elements obtained the European Parliament produced a Resolution on April 3, 2001.

The resolution did not indicate any major obstacles but there are some points of concern that will need clarification and or action – such as:

- The Parliament calls on the Commission to issue a recommendation not to use PVC in high fire risk buildings – definition of which is unclear; Anyway, this recommendation is not in line with existing regulations on the use of materials in building and construction.
- The Parliament calls on the Commission for legislation on lead stabilisers phase-out (no deadline);
- The Parliament makes a recommendation regarding incineration: polluter pays principle (for all materials);
- PVC waste incineration and landfill are not sustainable options (but EP support incineration with energy recovery and require evaluation of all available studies on landfill to judge whether it is safe);
- Compulsory marking of articles (but for all plastics);

17. EMCEF

European Mining, Chemical and Energy Federation EMCEF and the European PVC industry signed a social dialogue document on October 2000 and EMCEF has a clear position on the Green Paper. [13]

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[12] A5-0092/2001 European Parliament resolution on the Commission Green Paper on environmental issues of PVC (COM(2000) 469 - C5-0633/2000 – 2000/2297(COS))

[13] Social dialogue agreement EMCEF ECVM, ECPI and ESPA - October 2000

18. PVC Industry Voluntary Commitment:

The joint PVC Industry in The European Union (PVC, Stabilisers, Plasticisers and converters) – has made a serious attempt at reviewing the concerns (public and political) and made a very constructive Voluntary Commitment

Building on the chemical industry's Responsible Care® programme, the Voluntary Commitment drives PVC producers and their partners towards achieving four objectives:

- ✓ Continuous environmental improvement and resource efficiency during manufacture;
- ✓ Sustainable use of additives within PVC applications;
- ✓ Responsible management of PVC products at the end of their useful life;
- ✓ Managing delivery of these projects and provision of appropriate financial resources.

This commitment includes matters such as voluntary reduction of the use of certain additives such as cadmium and lead, commitments to recycle and to fund innovative initiatives that deal with waste management options.

The essential elements of the Voluntary commitment are that it:

- ✓ Includes all parts of the industry
- ✓ Covers entire lifecycle
- ✓ Measurable targets
- ✓ Clear milestones / deadlines
- ✓ Independent audit
- ✓ Finance for practical / viable projects

A Voluntary Commitment Progress Report was published March 2001 and can be reviewed on *www.vinyl2010.org*

Two progress reports have been published until now [14] and [15]

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[14] progress report # 1 (available on www.vinyl2010.org)
[15] progress report # 2 (available on www.vinyl2010.org)

19. Frequently asked Questions and Answers about PVC:

PVC is one of the most popular modern plastics. It is durable, modern in production, use and disposal. It is used in many areas of our everyday life.

Not many synthetic materials were studied so thoroughly. The impact of PVC on human health and the environment has been studied in every production phase, from the use to the final disposal. Recently, it was subjected to further environmental studies. Producers trust this material and invite the increasing emphasis on environmental protection in general.

The following questions and answers have been put together by the PVC Information Council working as part of **ECVM** (European Council of Vinyl Manufacturers) in 1998.

People working in PVC production, particularly in production of monomer vinylchloride (VCM) may contract cancer. How do you justify such risk exposure of workers?

This problem has been solved already 30 years ago. It was discovered, that VCM causes a rare type of liver cancer in workers with long-term and strong exposure. The current limit defined by a European Union Directive eliminates the health risks.

Are European PVC producers really concerned about the environment or are they just taking the minimum measures required by national and international regulations?

European PVC producers committed to high environmental standards. This was proved in 1995, when all member countries of the European Council of Vinyl Producers signed voluntarily the Charter on VCM and PVC production. This Charter commits them to observe the agreed objectives and standards and to use environmentally friendly production methods.

Are some components used in PVC packaging production carcinogen?

PVC packaging is non-toxic and absolutely harmless. Test performed in the USA really proved cancer in mice fed plasticisers. However, the administered doses represented 3000-fold of the same plasticisers food intake of humans. Similar results were documented only with rodents, not e.g. primates.

Recent results showed, that plasticisers contained in PVC were harmful to the human hormonal system and resulted in sperm count decrease.

There are worries about some chemicals, including plasticisers, impacting human and animal reproduction through their likeness with the natural sexual hormone – estrogens. This hypothesis is not supported by facts and there are many voices against it. Some daily eaten food, such as Soya or dairy products also contains estrogens that are more efficient than artificially produced substances.

Heavy metal based stabilisers are used in PVC processing. Some of them are known to be dangerous. How can you justify the use of these materials?

Heavy metal based stabilisers are used in PVC processing. These metals are "closed" in a polymer matrix and are not harmful to human health of the environment. When assessing environmental impact of stabilisers, it is necessary to consider the portion able to migrate from the plastic into the environment and its toxic potential. The use of stabilisers is strictly regulated and there are detailed regulations listing authorised materials for use in toys, objects in contact with food and drinking water. These applications use organic zinc stabilisers, or calcium/zinc based stabilisers.

Why is lead used? It is a toxic material, isn't it?

Lead is a metal often found in nature. PVC products have been stabilized through lead based stabilisers since the early 30-ies. Lead is the most important stabilizer for fixed PVC applications and is used also in some flexible applications, especially in cable production. The most important application is in long-life products for construction, such as pressure pipes, water pipes, underground drainage pipes, sewage pipes, gutters, window profiles, etc. Lead stabilized products have been recently subject to various pressures due to the possible risk to humans and the environment. PVC objectors do not mention the fact, that e.g. heavy metals are chemically bound in the stabilisers, so they cannot exercise any effects on the surroundings.

It is generally known, that PVC produces toxic gases and harmful dioxins during fires. Why is PVC used in construction?

One of the reasons for PVC use in construction and its support by firemen is the fact, that it has excellent fire prevention characteristics. It is very difficult to light and it stops burning after the removal of an external flame.

During burning, salt acid, carbon dioxide and little heat are produced. Dioxin emissions are minimum, so fires are a negligible source of dioxins. Toxically more relevant are carcinogen polycyclic aromatics produced in relatively large volumes during the burning of any flammable organic material. This fact is very often forgotten. Every fire produces carbon dioxide and this gas is the most common cause for death during fires. It is colourless, odourless and the victims often do not even realize they are breathing it in. On the other hand, even a very small amount of salt acid irritates the nose and functions as an early fire alarm. Dioxins are produced in the course of many incineration types, e.g. smoking, grilling, or fumes.

Its waste threatens the world. Suitable space for landfills is limited. How much PVC is disposed of?

Plastics form about 7% of total domestic waste; Weight. PVC forms 9% of the entire plastic waste. It is less than 1% of the entire national domestic waste production.

What is land filled PVC impact on ground water and soil? Why is PVC not separated from the domestic waste?

PVC is inert at landfills and there is no proof of any gases production and toxicity increase. The industry, in co-operation with the relevant institutions has been testing the long-term effect on underground PVC products in various conditions. Most attention was given to testing of plasticisers and stabilisers lixiviums and degradation. No measurable impact has been demonstrated.

Every scientist can tell you, that incineration of PVC produces salt acid contributing to the production of acid rain in Europe.

This issue has been subject to studies proving that 98% of all atmosphere acidity is caused by sulphur dioxide produced mostly by thermal power plants and nitrogen oxide produced by cars. The remaining 2% are attributed to hydrochloric acid. Of that, communal waste incineration plants may produce 0.5 %. As incinerators are now being equipped with efficient gas filters, the figure will have a declining tendency And PVC is anyway partially contributing to this figure.

Incinerators emit dioxins and we breathe them in. Why not excluding PVC from the waste flow?

This information is old and wrong. Scientific studies performed in the last 5 years in the USA, France, Belgium, Italy, Germany, the Netherlands, Sweden and Great Britain showed, that the exclusion of PVC from incinerated waste will have no influence on the volume of produced dioxins. Even without PVC, there will be sufficient amount of chlorine from other materials, such as paper, vegetal waste, kitchen salt. Today, it is possible to regulate dioxide emissions through proper incineration plants operation and installed monitoring systems. Modern plants emissions are low enough for most European institutions and may be taken as the basis for EU standards.

PVC disposal through incineration and land filling is environmentally unsound and represents a waste of sources.

PVC in old products does not represent in a modern, well-operated incineration plant or landfill any problem. The inherent energy content may be used during incineration. The aim is to decrease the volume of PVC stored at landfills. It is important for the disposal method to be acceptable both economically and technically. Recycling is one of the options suitable for some product types. Such systems are in operation for various PVC product types in most European countries (window profiles, pipes, floor coverings, roofing, bottles, etc.). The industry itself is developing new recycling methods. For products, where recycling would not be economical, energy production is a good option. The waste is delivered to incineration plants to produce heat, light and power for industry and households. From the environmental point of view, landfills are the least desirable method of disposal, as not sources are reused. However, for some products there is no regeneration possibility.

Is PVC easy to recycle?

Production waste has been recycled for years. Recycling of used products is more demanding, as they mostly consist of several materials (e.g. plastic windows consist of PVC, glass, rubber, metal). Thereby, to produce new products, clean and homogenous recycled PVC is necessary. There are many recycling systems in operation in Europe. For example, pipes are recycled in Sweden and Holland, windows and profiles in Germany and Austria. The recycled material has several uses, including reuse in original products (windows, floor and roof coverings) or new products (mostly sewage pipes). The most important task is establishment of a system for PVC sorting and collection.

With all the problems around PVC, wouldn't it be better to replace it through more environmentally friendly plastics?

In most products almost every material is replaceable. However, the replacement has to be functional, safe, and available at reasonable price and represent a contribution to the environment. An objective comparison tool is the Eco-balance assessing the environmental impact of a material throughout its lifecycle, from initial production to disposal. Deciding on alternative materials without the objective assessment may lead to a trap resulting in environmental losses. There are several Eco-balances available proving that PVC is environmentally friendly.

Why did some local and state authorities ban the use of some PVC products, or the production and processing of PVC?

There have been cases of PVC restriction for the use in some products. However, there are many cases of such bans withdrawal following thorough studies. Currently, there is a discussion underway in many European countries on the national and local levels indicating, that the general attitude towards PVC is improved as soon as there is access to information and facts.

PVC does not have a good reputation. What is PVC industry doing to change its name?

European PVC industry has been improving its standards and has been working on a clarification campaign. Environmental activities of PVC producers are constantly improving. Currently, Cadmium stabilisers are not used anymore. Further, PVC industry is developing a recycling policy.

What is PVC industry doing to meet its long-term commitment of PVC observing the constantly changing business and social requirements of the 21st century?

The European Union PVC industry (including PVC Resin producers, stabilisers producers, plasticisers producers and converters) has developed a sustainability programme aiming at implementing projects in

order to make progress regarding for example the use of additives and the development of recycling schemes.
This programme is ongoing (see www.vinyl2010.org).
This 10 years programme is ongoing and corresponds to expenses up to 25 million euro per year.