FACTSHEET

EUROPEAN DIISOCYANATE & POLYOL PRODUCERS ASSOCIATION ISOPA

Saving Energy in Buildings through Thermal Insulation with Polyurethane

SUMMARY

This paper summarises the effects of climate change and the effectiveness of measures to combat it which are based on improving the energy efficiency of buildings. It promotes the greater use of polyurethane rigid foam as capable of providing a significant contribution to reducing CO2 emissions.

Figure 1 : Steel frame factory construction with PU-cored sandwich panels

Climate change is recognised as a major and long term threat to the planet and international agreements have been sought to take the first steps to address the issue. Concrete measures have been taken in the European Union to target the energy efficiency of buildings because they are major contributors to CO_2 emissions and also because there are several references which show that these measures are very cost competitive compared to other measures to reduce CO_2 emissions.

The extreme versatility of polyurethane rigid foam lends itself to the insulation of new buildings and to the renovation of existing buildings.

The main conclusions are:

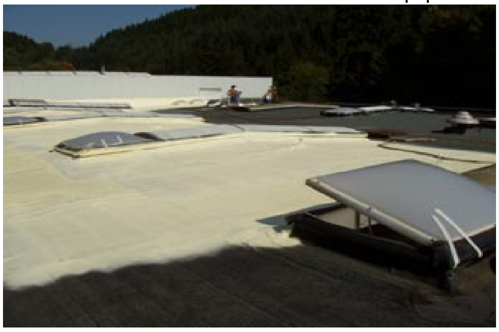
- A significant reduction in the emissions of CO_2 can be achieved by improving the insulation standards in new and existing buildings. This can be achieved with existing technologies.

- Amongst the most important of these is the range of polyurethane rigid foam technologies and products. These are very versatile and can be applied to all buildings new or old, and are adaptable to the building styles and practices across Europe. .

- The cost efficiency of PUR insulation foam applications is very high compared to other materials and ranks very highly when based on the cost per ton of CO_2 emissions saved.

Figure 3 : Agricultural storage building using metal-faced PU sandwich panels in Greece

Figure 2 : Spray insulation on a flat roof and a round roof features and equipment



INTRODUCTION

In terms of Sustainable Development the greatest challenge today is that of climate change. How can the world's population continue to develop economically, socially and environmentally, with the direct implication of ever increasing energy use and without the consequent build-up of the emissions of greenhouse gases? More than 90% of today's energy relies on carbon-based fossil fuels. This is a true sustainable development issue since actions are required now which will be to the ultimate benefit of future generations.

More than 80% of the total greenhouse gas emissions are of CO_2 and most of the CO_2 emissions are due to the use of fossil fuels to provide energy for the heating and cooling of buildings, for transportation and for industrial processes. The first of these, associated with buildings, is currently the largest single contributor in the European Union. This paper summarises how more energy efficient buildings, primarily through the use of more insulation, can make a significant contribution in reducing the emissions of greenhouse gases.

One of the most useful and versatile insulation materials is polyurethane rigid foam (PUR). The widespread use of this rigid foam is already making a major contribution to energy saving but greater use of this material could save even more. PUR is the most versatile insulation material due to the extreme adaptation potential of polyurethane chemistry. The different forms of rigid foam can be used in both existing and in new buildings. In addition, PUR is the most efficient of the high volume insulation materials and can be used in smaller thicknesses than other insulants.

CLIMATE CHANGE – WHAT IS HAPPENING

The global effort to understand climate change is led by the IPCC (Intergovernmental Panel on Climate Change – www.ipcc.org). This is a body of eminent scientists who study all aspects of the phenomenon and periodically issue reports to assist policymakers. Their third report (reference 1) was issued in 2001and in this the scientists were more concerned than before about the estimates for the future of the plant's climate.

Figure 4 : climate change

They have measured the effects in the 20th century and these show a global average surface temperature increase of 0.6ºC with the 1990s being the warmest decade and 1998 the warmest year for the last 1,000 years. There is a continuing decrease in snow and ice cover with mountain glaciers receding and Arctic sea-ice reduced by 40% in the summer. More extreme weather is being experienced with a higher incidence of severe storms in the Northern hemisphere and the increase in the frequency of droughts in Africa and Asia. These effects are mirrored by increases in the measured concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) in the atmosphere.

The increase in CO_2 concentration is predicted to climb by 250% by 2100 compared to preindustrialised times accompanied by a temperature increase of up to 5.8ºC.The sea level rose by up to 20 cm by 2000 and this may accelerate to 88 cm by 2100. The effects are predicted to continue for several centuries just with the amounts of greenhouse gases already released to the atmosphere.

An update was provided (reference 2) by the World Meteorological Organisation (WMO) in 2003. This concluded that 2003 was the third warmest year on record but, in some regions, unprecedented high temperatures were recorded. For example, temperatures of more than 40ºC were recorded in normally "temperate" countries in Europe.

Many scientists recommend that action is essential now to prevent catastrophic effects in the not so distant future.

LEGISLATION TO TACKLE CLIMATE CHANGE

Many of the world's political leaders have listened to the warnings of the scientists and have taken the first steps to slow down the rate of increase of emissions of greenhouse gases.

At the Rio meeting on Sustainable Development in 1992 there was agreement amongst the developed countries to reduce the emissions of three greenhouse gases (CO_2, CH_4 and N_2O) to 1990 levels by 2000. This stabilisation target was only achieved by very few nations and only then by changes which were not directly linked to climate policy.

The Kyoto Protocol was set up in 1997 and calls for developed countries to reduce the emissions of a basket of six greenhouse gases by 5.2% by 2008/2012 relative to 1990 levels. The Protocol only applies to developed countries and the USA, amongst others, wants developing countries to be included. The Protocol has not been ratified so far (01/2004) but the European Union (EU) is a strong supporter of it and has or is developing several items of legislation designed to enable the EU to meet its targets.

The EU's target is for a 8% reduction by 2008/2012 relative to 1990. This target is shared by Switzerland. For the EU an 8% reduction amounts to the avoidance of the emission of 450 million tons of CO_2 equivalent (reference 3). The overall target for the EU is split amongst its member states, according to national circumstances, in a process called "Burden Sharing".

The progress so far in meeting these targets is not uniform and several countries are falling behind schedules to meet the overall targets. Further, the overall emissions grew in 2001 relative to 2000. In 2001 CO_2 accounted for 82% of all emissions (reference 4).

Country	**Emission Targets (CO_2 equivalents) by 2008-2012 (%) relative to 1990**	**Changes by 2001 (%) relative to 1990**
Austria	-13	+10.1
Belgium	-7.5	+6.4
Denmark	-21	+0.3
Finland	0	+4.8
France	0	0
Germany	-21	-18.0
Greece	+25	+26.1
Ireland	+13	+31.1
Italy	-6.5	+7.2
Luxembourg	-28	-44.0
Netherlands	-6	+4.6
Portugal	+27	+36.5
Spain	+15	+33.1
Sweden	+4	-3.2
UK	-12.5	-11.8
Overall	**- 8**	**- 2.0**

Table 1 EU burden sharing targets by country and progress to meet the targets

Many scientists and legislators realise that the Kyoto Protocol and associated measures are a small first step to stabilize and to reverse the trend of climate change. The Protocol will have to be followed by stronger measures whose reduction targets will be even harder to meet.

Considering that more than 40% of the emissions of CO_2 are due to the heating and cooling of all types of buildings (reference 5) it is critically important that the energy consumption of buildings is reduced. There have been several estimates of the potential savings that could be realised from buildings by 2010. One of these was the outcome of research commissioned by EuroACE (reference 6) and this concluded that the total savings which could be realised from buildings was at least 430 million tons of CO_2 equivalent. In addition, this study showed that almost 200 million tons of CO_2 equivalent could be saved by improving the insulation alone.

Further work (reference 7) was commissioned by EuroACE to compare the costs of various measures in buildings. This work is complex because of the great range of building types and insulation techniques. However, this study showed that building energy efficiency measures, when lifetime costs were considered, resulted in savings for both new buildings and for existing buildings when energy efficiency measures were implemented during major refurbishment exercises. Overall, building energy efficiency measures, including improvements in insulation, compare favourably with other opportunities such as renewable energy technologies.

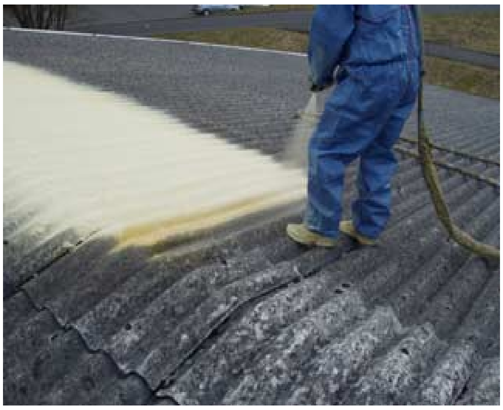
Another key finding is the pronounced importance of improving the energy efficiency of the existing building stock in Europe. This is evident given the longevity of buildings in the region. Technologies which are particularly suited to improving existing buildings will have a key role in enabling the EU to reach its targets.

Figure 5 : Building component production plant in the UK

EU DIRECTIVE (2002/91/EC) ON THE ENERGY PERFORMANCE OF BUILDINGS

The EU's overall range of measures was developed in the European Climate Change Programme (ECCP). This process examined all the options available to legislators and one of the main areas of focus was on measures in buildings. This focus was not surprising because, as noted above, more than 40% of CO_2 emissions are attributed to space heating and cooling of buildings. The Directive (reference 8) calls for a range of energy saving measures and apples to both new and existing buildings:

- The adoption of a methodology to calculate the energy performance
- Setting of energy performance requirements and their regular review
- Ensuring that new buildings meet the energy requirements
- Ensure that existing buildings (above 1,000 m^2 floor area), when undergoing major renovation, are able to meet the requirements
- The provision of energy performance certificates when buildings are constructed, sold or rented.



Again, this Directive is seen by many as a first step in improving the energy performance of the EU's building stock.

Figure 6 : Spray foam being applied to upgrade the insulation on a corrugated profile roof

ADDITIONAL MEASURES UNDER DEVELOPMENT

The EU's drive to greater energy efficiency contains other measures. These include a Directive on energy end-use efficiency and energy services (reference 9). This Directive includes a provision that energy suppliers also market energy efficiency services and products. It also includes an ongoing energy savings target 1% per year.

All measures to reduce energy consumption are also very relevant in meeting the complementary challenge of ensuring that the EU's supply of energy or "energy security" (reference 10) is sufficient to meet societal needs. This Communication from the Commission Energy highlights the role of demand management in the energy security debate.

HOW POLYURETHANE INSULATION MEETS THE NEEDS

There will be a role for all insulation materials in the improving the energy efficiency of existing and new buildings. However, this section shows that polyurethane rigid foam is particularly suited to the task.

Characteristics and Versatility

There are many means of addressing the climate change issue – through the use of renewable energy, the controlled use of nuclear-derived energy, or by simply reducing energy demand by making buildings, new and existing, far more energy efficient. The technology to achieve this exists and is well established and proven. It has been shown that the use of greater amounts of insulation to give more energy efficient building structures could significantly reduce energy consumption. This would give a major boost to the campaign to reduce greenhouse gas emissions and help the world to decouple economic and social development from energy consumption.

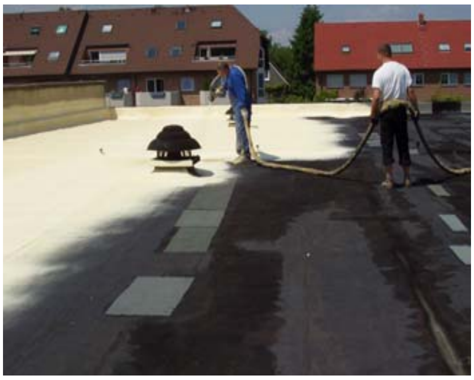


Figure 7 : Spray PU foam being applied on a flat roof

PUR rigid foam has many advantages as a thermal insulant:

- It has the lowest thermal conductivity of any of the large volume insulants, which enables space to be saved by using smaller insulation thickness while achieving the same insulation efficiency as with other materials.
- In the EU it is made without CFCs or HCFCs and hence does not adversely affect the ozone layer

The extreme versatility of PUR rigid foam should be exemplified.

- PUR rigid foam can be the insulant in the core of a steel sandwich panel – serving the dual purpose of insulation and structural integrity, and allowing for rational production of roof and cladding panels as well as rational construction of large industrial buildings, most notably refrigerated stores.

- PUR rigid foam can be applied as a board with a variety of facings to any structure that merely needs insulation. There is an added advantage as, with special joint designs, it proves to be much easier to make a roof insulation air tight than it would be, for example, with roofing foils.

- PUR can be applied as spray foam on site and serves the dual functions of providing to the building structure water and air tight covering and insulating it.

- PUR One-Component-Foam (OCF) is most efficient for mounting doors and window frames and, at the same time, making sure that the building joints become sealed against draft, which is a prerequisite for energy efficiency.

This combination of advantages makes PUR – in its most appropriate way of application - especially suited for retrofitting of existing buildings.

Energy Payback Time

Energy expenditure (and most of it from fossil sources) is necessary for the production of PUR rigid foam. Life cycle inventory data have been established (references 11 and 12) and allow the estimation of energy “pay back” periods. Necessarily, there is a wide variation depending very much on the properties of the building or its part under consideration without the foam. In most cases, though, energy “pay back” times of less than one heating period have been calculated. From then on, the energy saving continues throughout the service life of the foam, which is normally the remainder of the service life of the building. Naturally, greenhouse gases and other air pollutants from space heating are also saved.

Figure 8 : Electronics production plant in the UK constructed using sandwich panels

Cost for Energy Saving

It needs to be understood that also in economic terms there will be a short pay back period. It is difficult to give an estimate due to the varying cost of energy and the multitude of applications. However, the economic pay back time may well be longer than the energy “pay back” period. But, it has also been demonstrated, when comparing total necessary construction costs as opposed to the cost of the insulation materials alone, that PUR insulated roofs can become the cheaper overall solution.

Another aspect is the cost incurred to achieve a certain reduction in the emissions of CO_2. This aspect has been estimated by several authors and it has been found that retrofitting of existing buildings, if done within the normal repair schedule, is very cost efficient: It even saves money per ton of CO_2 reduction.

Socio economic aspects and the role of SMEs

ISOPA has recently reviewed the socio-economic parameters of the polyurethane industry (reference 13) and of the building/construction industry amongst several other sectors. The main parameters for this sector are:

- there are nearly 12,000 companies in the sector operating in the value stream derived from diisocyanates and polyols
- these companies employ almost 400,000 people and 90% of the companies are SMEs
- the market value of the foam-based products is more than € 4 billion

In summary, the industry is a major employer of people, the vast majority of whom work in SMEs, and these create a significant amount of value.

Figure 9 : Spray foam being applied to insulate in between a wall and roof joists

CONCLUSIONS

A significant reduction in the emissions of CO_2 can be achieved by improving the insulation standards in new and existing buildings. This can be achieved with existing technologies.

Amongst the most important of these is the range of polyurethane rigid foam technologies and products. These are very versatile and can be applied to all buildings new or old, and are adaptable to the building styles and practices across Europe. .

The cost efficiency of PUR insulation foam applications is very high compared to other materials and ranks very highly when based on the cost per ton of CO_2 emissions saved. The cost efficiency of insulation foam applications is very much influenced by the type of application such as a domestic dwelling, a commercial or an institutional building.

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