Transcript presentation

PU in the sustainability and circular world
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Ladies and gentlemen, it's my real honor and pleasure to present in the International PU Forum 2023, the presentation of what polyurethane is doing to the sustainability and circular world and what are the impacts for the PU-industry, next to what has been done worldwide in efforts to deal with all these trends.

But first of all, I want to thank the organizers of the international polyurethane forum and in specific Mr. Inoe, for inviting me in this forum, the organizing committee for all arrangements and in specific Mr. Hirayama for his incredible support.
It's much appreciated and many thanks again.

The agenda of my speech can be split out in five topic points.

1. Status of Europe and the European flexible PU foam industry
2. Sustainability of flexible PU foam & the environmental impact and challenges.
3. The regulatory framework in the European Union.
4. Flexible PU Foam recycling initiatives, and renewable alternatives in Europe.
5. Conclusions and open questions.

Let me first start with the status of European flexible PU foam industry.
Europur is the European association of the flexible PU foam block producers. Our members operate PU foam production plans in 28 countries in geographical Europe. Together our members operate more than 70% of the PU foam plants in wider Europe and produce around 1.1 million tons of PU foam which is roughly 80% of the total production in the region EU-28. Some of them, also produce mattresses and furniture directly.

Europur is organized in working groups. We have a fast majority of our members who are participating and contributing to these working groups. The working groups are split into four different groups.

1. the Environmental Health and Safety working group.
2. the Product Stewards working group
3. the Sustainability working group.
4. the Communications working group.

When we look at the European flexible foam industry in 2021, we saw that in total 1.7 million tons of flexible foam was produced of which 279,000 tons was in of molded PU foam production and roughly 1.4 till 1.5 million tons of PU slab stock foam production. When we split up the slab stock foam production in polyester and polyester slab stock production, we could see that most of the total production was polyether slab stock foam production, with roughly 1.4 million tons and 61000 tons was polyester slab stock foam production. The total number of continuous foaming plants were 160, and the estimated PU foam industry turnover was more than €5 billion. The market could be roughly split into furniture foams

50%, mattresses 35%, foams to the automotive industry 10% and 5% was going to the industrial applications.

Let me take you now towards the sustainability of flexible PU form and the environmental impact and challenges. The main environmental impacts which are caused by flexible PU form can be split out into the following.

1. resource depletion
2. energy consumption
3. pollution
4. landfill waste
5. and lack of recyclability

Let me quickly run you through this; **resource depletion**→ flexible polyurethane foam is typical made from fossil-based chemicals. **Energy consumption** → the production process of flexible polyurethane foam requires a significant amount of energy which contributes to greenhouse gas emissions and climate change. **Pollution** → the production process of flexible polyurethane foam can be harmful to human health and the environment and **landfill waste** → flexible polyurethane foam is not biodegradable and when it ends up in landfills it can take hundreds of years to decompose and then we look at when we look at **lack of recyclability** → the lack of effective recycling technologies for flexible polyurethane foam means that much of it ends up still in landfills or incinerators exacerbating the environmental impacts.
So, to conclude these environmental impacts make it necessary to find **more sustainable solutions for flexible polyurethane foams** to reduce its negative effects on the environment.

When we look at the challenges to make polyurethane more sustainable, we see a couple of aspects which are very important. Let's first look at **cost**→ sustainable materials and production processes can be more expensive than traditional ones making it challenging for companies to adopt them. And when we look at **performance** → flexible polyurethane foam has specific performance requirements such as durability and comfort which sustainable alternatives may not meet without compromising performance. The next three which I want to take you through are.
regulation
lack of infrastructure
and consumer behavior
Looking first at **the regulation** there is a lack of consistent regulations and standards for sustainable materials and production processes, making it difficult for companies to know which solutions are best to adopt.
When we look at the **lack of infrastructure,** we see that the lack of recycling infrastructure makes it challenging to recycle and repurpose end of life products.
When we look at **consumer behavior**, we see that there is still a lack of awareness and education among consumers about the importance of sustainability in products, making it challenging for companies to prioritize sustainability without consumer demand.

So, conclusions on the challenges to make PU more sustainable; overcoming these challenges will require **collaborations among stakeholders in the industry** to promote sustainable solutions and make them economically viable and readily available.

When we look at the regulatory framework, we see that '**the global 2030 UN agenda for sustainable development**' is influencing the world of polyurethanes a lot.

Not all goals influence PU as such and therefore I took. out of the 17 sustainable development UN goals, those goals which are influencing our industry the most.

Let's quickly look over it; **good health and well-being** is influencing polyurethane next to **decent work and economic growth** 9 **industry innovation and infrastructure** 11 **sustainable cities and communities** 12 **responsible consumption and production** and 13 **climate action.**

When we look at the regulatory framework in the EU the European Green deal is influencing the PU markets a lot. There are several action points which are immediately taken effect on our industry in general. **The European Green Deal is demanding 55% reduction of greenhouse gases emissions by 2030 and climate CO2 neutrality by 2050**
We see in this regulatory framework in the EU, lots of legislation coming up. Let me mention two of them where Europur is also involved in the discussion.
We talk about the **sustainability product policy initiative** including furniture and the **review of the end-of-life vehicles directive.** The chemical industry is also involved a lot, via their several association participations. Some of the the initiatives which are discussed for the moment like for example **review of industrial emissions directive,** but also many others.

Let me take you to the **draft Eco Design for sustainable products regulations,** layed out by the EU commission.
The core of this initiative is to explore the potential of expanding the scope of the eco-design directive to non-energy related products and propose additional legislative measures as appropriate. It aims at making products placed on the EU market more sustainable. The Commission considers addressing the following aspects as part of this legislation initiative.

1. Improving product durability reusability, upgradability, and repairability, addressing the presence of hazardous chemicals
2. Increasing recycled content and products and enabling remanufacturing and high-quality recycling
3. And finally rewarding products based on their different sustainability performance including by linking high performance levels to incentives.

When we look at the timeline; in March 22 there was a proposal and in June 22 there was an end of consultation followed by ongoing review by the council and European Parliament. In Q4 there was a trilogue and in 2023 there will be an adaption.
So you see this looks slow, but it will come to us rather quickly!!

The conclusions on regulatory developments are that.

- changes will affect three main markets for PU upholstery furniture bedding and automotive.
- they will include increased recycling of postconsumer foams and creation of market space for recyclates.

- there is a need for increased circulation of information along this supply chain like LCA data.
- and requirements for increased openness towards consumers like digital product passports
- there is also potential danger of multiplication of closed loop for materials.
- and there is a potential danger of overlap of legislations like for example REACH, CLP, ESPR.

When we look at the current EPR schemes in Europe for mattresses and furniture we see that this has been taken off in only a couple of countries. We see in the Netherlands MRN and retour mattress (part of Ikea) successful in the first stage, in Belgium it's called Value-mat and in France the initiative is leaded by Eco-mobilier, the French governmental organization. For the moment there are also discussions in Scotland and Spain and Italy and we see also clearly that the other countries like for example Germany, UK and also some other big countries are hesitating and waiting a lot. My advice don't wait too long…!

When we look at the regulatory developments globally, we see that in China there are a couple of standards coming up like the VOC emission standards, the Environmental Protection tax and import and export regulations. In the US it is mainly the flammability standards, the VOC emission standards, and the anti-dumping tariffs.

Let me take you now to the PU foam recycling initiatives and sustainability alternatives in Europe.
First of course we have mechanical recycling where companies make from PU waste materials, rebounded PU Foam. The waste materials used, are either post industrial waste or post-consumer waste. This is going through a process with mechanical grinding, mixing with prepolymer and pressing under high temperature (steam), pressuring up till the right end-product is obtained.

We estimate that 40 million mattresses reach end of life per year in the wider EU in the coming years to come, and the estimates are that potential postconsumer EOL foam could be available for recycling, at around 240 to 290,000 tons/ year from mattresses and 350 to 400,000 tons from furniture, so that's a lot.
When this all must go back in circularity this means lots of development work still to be made.

When we look at mechanical recycling in Europe clearly the end-markets are the limits
In the graph you can see the global flexible PU slab stock production in kilotons from 2013 to 2020, which shows that we reached roughly 5 million tons PU produced year globally in 2020, where China was the biggest market after Europe.
When we than look at the graph of the estimated global supply and demand for trim foam and we look at the 2020 figure, then we see that postproduction (PIW) was roughly 1.3 million tons and postconsumer was 140,000 tons resulting the total trim from supply of 1.4 million tons. Estimated demand amount was 1.3 million tons so there was a surplus of 151,000 tons.

Next to **mechanical recycling** there are also a lot of initiatives on **chemical recycling**.
Chemical recycling is a process where flexible polyurethane foam is broken down into specific constituent raw materials which can be used again to make fresh foam or other polymeric plastics. It allows the use of plastic waste, especially feedstock, not feasible for mechanical recycling.
We can see two types of chemical recycling.
depolymerization which involves the breaking down of the polymer chain of foam into smaller molecules that can be used to create new products. The main methods here are hydrolysis, glycolysis, acidolysis and aminolysis.
These technologies are all differentiated by the base materials used to dissolve PU foam.

Next to this we see **thermochemical recycling.** Materials mostly non-PU disintegrated at molecular level, creating new raw materials by the petrochemical industry. The three main technologies here are pyrolysis, gasification, and hydrogenation. The important difference between them is that pyrolysis happens in the absence of oxygen.

Chemical recycling helps to reduce the amount of waste ending up in landfills or incinerators and it helps also to meet increasing demand for sustainable products and materials.
It reduces dependence on virgin materials, conserves natural resources and reduce to carbon footprints.

Let me look a little bit at the pros and cons of depolymerization and thermochemical recycling. A plus of depolymerization is that it helps to conserve resources by converting end of life polyurethane form into feedstock for new polyurethane applications and the plus for thermochemical recycling is it could deliver virgin quality material with 100% recycled mass balance. The negative side of depolymerization is comparatively higher costs than of mechanical recycling, a somewhat poorer environmental performance due to the energy intensive processes, and lower recycling yields by current available technologies than of mechanical recycling.
The negative side of thermochemical recycling is comparatively higher cost than of mechanical recycling, substantial poorer environmental performance due to the energy intensive processes and significantly lower recycling yields by current available technologies than of mechanical recycling.

Let me take you through the current initiative which we see in the EU-28 already on the aspects of depolymerization.
The following companies were already in a recent progress.
Orrion Chemicals in France in cooperation with DOW; the plant has been operational since autumn 2021.
Repsol build a chemolysis process in Spain and the production has now started.
Retour mattress is majority held by the holding company IKEA, which has built a chemolysis plant in the Netherlands which has started now also in 2023.
We see the company Evonik, who has started a hydrolysis recycling process and the company Triple Helix in Belgium who has obtained planning permission for a chemolysis plant in the Port of Antwerp.
In 2021 Covestro started a pilot plan for PU chemical recycling in cooperation with eco-mobilier (as announced in 2021).

Next to this all there were also some other initiatives like Urban-rec, rePURpose by Tempur and PureSmart which was a cooperation between Recticel and Covestro which have commonly developed a new type of PU Capu plus chemical recycling (the project has been completed at the end of 2022)
There are lots of ongoing projects, as you can see on this slide. I don't want to go into detail, but you can see that in Europe there is a lot of action, communication, and developments around chemical recycling.

When we look at the different types of recycling methods, we can see actually four different types of recycling methods in this slide you can see mechanical recycling which I already explained, as also depolymerization and thermochemical recycling, But I did not elaborate into mass-balance approach.

Let me go a little bit in a 'deep dive' of mass-balance approach.
Up to 100% virgin equivalent of polyols and isocyanates can be used in foam formulations, coming from mass-balance approach and the properties of the output from the mas-balance approach is the same as of fossil based raw materials so there is no compromising on specifications. Unknown now is the regulatory attitude towards this recycling approach and whether it will be accepted as recycling technology. Unknown is also the energy consumption contributing to the overall CO2 footprint.

When we look at the foam recycling recyclates and downstream markets.
Mattresses and furniture are most suitable for PU-recycling. High specifications in the automotive chain require virgin equivalence of raw materials.
So let us look at the downstream market when we look at a furniture this means large volumes, but not always easy to dismantle and they are hardly recycled today. They can be used for mechanical recycling, chemical recycling, and mass balance approach in this preference order.
For mattress and bedding, the recycling increases across Northwestern Europe. Ongoing challenges are separate dry collection and design for dismantling.
The potential use of to recycle is here suitable for chemical recycling, partly mechanical recycling, and mass balance approach.
In the automotive industry we see that many small pieces and multi material parts followed by difficult dismantling makes recycling also very difficult today.
The very high and complex specification of this industry could lead the way towards potentially mass balance approach as preferred option, and secondly potential use in mechanical recycling and third chemical recycling.

So when we look at the total circularity we see that raw materials are being put into production and transformation, there's logistics, there's a use phase, there's an end of life phase, there's energy recovery and there's recycling and then it can go back into the circle.

Let me talk a little bit about non-fossil materials for foams in foam formulations.
Research has been done to make NIPU's, but it has never been successful at industrial scale implemented. Also here the debate comes up again whether we should use food sources to make plastics? Regarding polyols, non-fossil or less fossil alternative exist at variable percentages in foam formulations.

This is for example **biomaterials** (example Castor oil rap- seed and soybean).
CO2 polyols maybe less mainstream than for biopolymers, but foams are on the market today. Up to 20% of CO2 is bound into the polyol.
Then we talk about **recycled polyols**; one larger foam producer in France is offering foams with recycled polyols. Others will likely follow soon. Current products can be used up to certain percentages in formulation.
Some companies work at **re-polyols** that can be used 100% in formulations. And then we talk about **grinded foams**. Some companies use this technology to save on fossil-based materials. However, this technology is rather energy intensive.
Via mass-balance; making partial use of biomaterials or recyclates.
Main chemical providers are working on it. Both for the di-isocyanides and polyols fractions. Same production processes as conventional di-isocyanates and polyols, also able to go to a 100% in formulations.

Conclusions like many other industries the flexible PU foam supply chain is going to experience fundamental changes due to the European Green Deal and pertaining policies in its three main markets upholstery furniture bedding and automotive. The EU's ambitious targets will require.

1. development of collection systems
2. coexistence of recycling technology
3. improved design for dismantling and design for recycling
4. amendments to EOL's handling of goods.

It's easier said than done. There are also plenty of open questions still…
Let me take you a little bit through the open questions.

1. **recycled content** which percent by when versus carbon footprint. Closed loop versus open loop
2. acceptance of chemical recycling we **need recycling facilities** which are not present today.
3. how can **sorting** be improved to facilitate chemical recycling because we see that the input raw material coming out of EOL and the quality of that is very important to sustain and stable chemical reactive process?
4. what about **biobased** raw materials?
5. conformity to information obligations?
6. will **OEM and consumers** be willing to **pay a premium** for advanced technologies. Compromise on the specifications? and to what extent these compromises affect durability? and what's its correlation with product life cycle environmental impact?

Let's go back to real politic!
We see also that **lots of European countries are returning to dirty coal** as Russia turn off the gas taps. The eurozone **inflation climbed to a new high record of 10.7%** in October last year and the **energy prices will remain high** and volatile till at least the end of 2023, or even probably the coming years (the EU Commission says), and EU lawmakers remove the last hurdle to **label gas nuclear as green**? Parliament votes to approve **include gas in taxonomy.** Regulation will most likely enter into force in 2023.

There are lots of things to do! Personally, **I think that polyurethane is a versatile material for the future, taken into account that we have to solve also certain aspects** which could endanger polyurethane as a future material. Let's all work on that!!

Thank you very much for your attention and the stage is open for questions now.

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President Europur AISBL
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