

Chat 1: Chemistry is all about you

Welcome everybody,

Hello everybody and welcome to the first Xperimania V chat in collaboration with inGenious.

I'm Barbara Schwarzenbacher, pedagogical adviser at European Schoolnet and in charge of coordinating the online chats. The topic of this chat today is "Chemistry is all about you".

We are now in Brussels in the office of European Schoolnet, and we have with us 4 industry representatives Aniouta Belevitch, Wouter Bleukx, Pierre de Kettenis and Christian Koulic. Welcome to them and to all of you the students and to your teachers who are here today for this chat.

The industry representatives will be available for the next 1:30 hour to answer as many of your questions as possible. First of all let's ask the industry representatives to introduce themselves .

Aniouta Belevitch (AB): Hello everybody, my name is Aniouta Belevitch and I work for Total and more specifically for Total Petrochemicals and Refining. I am an economist and I don't know anything about Chemistry. Nevertheless I have a commercial background and during my career I went from finance to crude oil trading, procurement and petrochemicals where I am currently a commercial manager handling some products that we produce at Total.

My name is Wouter Bleukx (WB): I am an agricultural engineer with a speciality in food chemistry. I started in a real chemical job in research and development, responsible for supply chain activities. Today as a Product Manager I am more in a commercial job, and although I started in a real chemical job, also in a chemical company there is a lot of room to move into other disciplines and do other jobs.

Good afternoon everyone, my name is Christian Koulic (CK), I work for Total as well as Aniouta, and I am based here in Brussels. I am a polymechanist by training, so I started in a Lab in the University making plastics and then I decided to move to the industry and I started within Total as a Research and Development Chemist, in the development of new plastics for packaging, piping and different types of applications. For the past five years I have moved into more business development activities so you see that chemistry leads to almost everything. I am now in charge within Total of business development related to new technologies especially related to bio-based chemistry.

Good afternoon everybody, my name is Pierre de Kettenis (PdK). I am also working in Brussels for the European industry trade association. I am a biologist by background, but as you know, Chemistry is one of the fundamental sciences of life, so I started my career in research, I moved later to industry as a sales person and then in product management, business development, sales and marketing at international level, and after almost 20 years in the industry, I decided to join the industry federation which offered the opportunity to talk on behalf of industry with decision makers at member states and at European level. So we have a role of focal points to represent industry but also trying to manage close contacts and relationships between authorities and industry to encourage positive economic framework for the development of the industry.

*BS: Ok, thank you very much for this introduction. This is very interesting; we have some scientists by background and some with an economic background. As you can see you can work in industry with any kind of background. Now let's start the questions. We have the first question from **Estonia**: "If oil supplies are exhausted, what are the future raw materials for plastics?"*

AB: I will try to answer the question. First of all I don't think we are any close to the end of oil supplies. First of all thanks to new technologies we constantly discover different types of oil. It is getting more and more complex and complicated, but reserves are basically there. On the other hand plastics will definitely not exhaust the oil reserves but help us not to do so. Because in fact it helps the world consumes less hydrocarbon. Basically with plastics on one side and more oil reserves on the other side, we can definitely go into a world where the oil will be transformed rather than being burnt. And at the end of the day, the purpose is to transform as much as we can and then recycle, not only one but several times. When we have gone through the whole life cycle of plastics then we can burn the waste and get the energy from there. So if we all work together on that, we will have oil reserves for quite a number of years.

*BS: Thank you very much for this great answer, I think it answers the questions extensively. Now the next question comes from **Croatia**: "Tell us more of re-use of waste-materials."*

WB: I would like to answer this question with a few examples. We know that the population in this world is growing and the industry needs to look for solutions to use all kinds of waste-materials. Let's take the example of gelatine. Gelatine is a protein which will look more familiar to you if I mention gummy bears. Another example is medicines in capsules. Both in gummy bears and in capsules of medicine we have gelatine. Gelatine is coming from a waste material, which you find in bones and skins of pork and cattle. The bones and skins are re-used as a raw material for the production of gelatine. It is used in pharmaceutical applications like capsules which are a highly controlled and very important ingredient. This is a very nice example for the re-use of waste materials. Another example is old iron, which you find in everything when you go to the container park and you see old refrigerators for example. All these things are re-used. They take the iron out and turn it into iron chloride. So iron chloride is a chemical product which is made of waste of the old iron, but this iron chloride is then used in water purification plants. So you see with old crap of old materials at the end it becomes a product that you can re-use for the purification of drinking water. That proves that the industry has to look for good solutions to re-use the waste. We have to be inventive so that we can re-use the waste and make new applications with it.

*BS: Thank you very much Wouter. I just learned something myself. The next question comes from the **UK**: "What are benzene rings?"*

PdK: Benzene rings are natural components that are extracted either from biological base or from fossil material like coal or petroleum. Each ring has six carbons and six hydrogens, but it is one of the fundamental building blocks to make a lot of well-known materials, such as styrene, which is used to make polystyrene, one of the main packaging material and also well known in isolation material for energy performance. It can also be used in the nylon production. Through cyclohexane manufacturing you can produce nylon fibres which are well known by all of you in the textile and fabrics industry. These rings are essential for manufacturing of many compounds. They are used also in pharmaceuticals. They can in fact be used in hundreds of different applications.

So, they are currently mainly extracted from fossil material, but in fact they also form the basis of the majority of natural aromatic scents, which are combined aromatic strings extracted directly from plants.

BS: Thank you very much Pierre. I see we have a question for each expert here, which is brilliant. The next question comes from **Germany**: **“How will chemistry help in the future?”**

CK: This is a very broad question, and it is basically the core of the topic of the day.

If we take the main mega trends for the next 20-30 years, we know that in 2050 we will be 9bio people. We will need energy, we will need water. We have to be careful with greenhouse gases emissions and try to reduce them. For all those mega trends, chemistry can be considered as a solution enabler, although it is very often referred to be the opposite. I can give you a few examples. If you take into account the amount of greenhouse gases emitted to produce chemicals in Europe the use of those chemicals will allow preventing three times more greenhouse gasses than the greenhouse gases that have been emitted to produce them. So clearly as a whole, the chemical industry allows to reduce greenhouse gases emissions. Another example is the food wastage. We know that food is wasted from the field to the fork, and packaging which is most of the time made in plastics helps preventing this food wastage along with the cold chain. And of course this is taken into account in this carbon balance of the chemical industry. So these are a few examples showing that chemistry can be a solution enabler for the future.

BS: Thank you very much Christian. The next question comes from **Lithuania**: **“How can we get energy from plastics.”**

CK: Most of the plastics put on the market today are made from fossil raw materials, so basically they contain energy. Plastics basically contain as much energy as fuel. When plastic is put on the market, it brings solutions during its use phase, as packaging, in building and construction, in electronics and electric equipment. When these products reach the end of their life you can either recycle them and then they go into another use phase, but at some point you may end up in a situation where the waste is too dirty or too mixed up making recycling very difficult. In that case you can burn plastics in an incinerator and recover energy. You basically recover energy with the same technology that you use to produce electricity, with natural gas or with fuel oil. And since plastics contain the same amount of energy as fuel oil, it can be considered in its end of life as a substitute of fossil fuel. Maybe before I finish, here are some data: 50 mio tons of plastics are put on the market in Europe every year. 60% of those are recovered and 30% of those are used to make energy.

AB: It is maybe the occasion to add something. Out of the 60%, 10% are wasted, and a lot of that is either recycled or burned at the end of the recycling life. What we really want to avoid is the 10mio waste that we have today. In Europe some countries do recycle pretty well and some other countries less well. This gives me the opportunity to tell you, that being the young ones, you may have to educate your parents. The first thing to do is to recycle plastic. You don't want to have plastics on the side of highways, because that gives a bad image to plastics. And there we see that some countries, especially the northern part of Europe does recycle more than 95% of their plastics while the southern part is not even recycling 25%. The message for today is : please recycle, and don't forget this message during your entire life.

BS: Maybe you can just explain what would be good recycling, how to recycle well, especially for the countries that don't recycle? I know in Belgium you have the recycling method where you have different bags for paper and for plastic. In Austria we have a different method; we have different bins for the different types of waste. Maybe you have an ideal recycling suggestion.

AB: It is true that the Belgian system, the Austrian system, and the German systems are of equivalent value. At the end of the day, the purpose is to not throw everything into the common garbage bag. As long as plastics go into a specific bag or specific place it is fine.

WB: I would like to add something. In my community they also collect all the different waste materials, and every year they say “Your family is above or below the average of our community in terms of recycling”. How does this work? Every family has container bins with a bar code, and when they bring in the waste, they read the code and they weigh their amount. Each family knows how much waste they have generated. So this is a very good system that helps citizens to understand recycling.

*BS: Enough about waste recycling now, let's move on to the next question. I can see the experts are discussing who wants to answer which question. The next question comes from **Slovakia**: “Do you think that solar highways can be built for roughly the same price as highways made of concrete? Will these highways make a significant saving of electrical energy?”*

PdK: Difficult question. If I understand correctly the question you think about using the surface of highways to cover them with solar panels instead of using just the concrete. Well, the first point is that solar panels remain today fragile material, they are coated with glass. So I don't think that a car could run on a solar panel. But the surface of highways is a massive surface in a country and indeed it would be useful to think whether that surface or the lane between the car lanes or the surface on top of the highways could be covered with solar panels. Highways can be used for most of the equipment bought for wind mills or solar panels or railway tracks. So I think definitely they could be used for that purpose – it's a kind of utility use that could be optimized for many uses. In terms of price, solar panels remain expensive material today. And their productivity in terms of electricity production is only 30%, so chemists are working extensively on the development of new generations of solar panels, not only with silicones but also with other polymer materials that are developed to produce electricity not only from UV but also infrared wavelength. So the following decade will see very extensive development in conversion of heat or solar energy into electricity.

*BS: Thank you very much Pierre for answering this difficult question. The next question comes from **Italy**: “What new chemical technologies are in the future of the study of car building. What new chemical technologies will be used to build cars in your opinion.”*

CK: I can answer in two parts. Let's first focus on the technologies that are used now and to see how they will evolve, and then some breakthrough technologies that may arise in the future and which should make a difference. However they don't exist yet.

As far as chemistry is concerned in the car industry, it is used in various ways. I will bring 3 examples: first, the use of plastics. You can find between 150 to 300 kilos in a car that weighs more than a ton, so more than 1000 kilos of material. You can keep in mind that every kilo that you remove from a car allows to save 220 to 230 litres of gasoline throughout the life cycle of the car. And we know that more and more plastics will be used in the future to make cars even lighter and hence to reduce the consumption. Other examples of chemicals used in cars can be found in the adhesive. To move a little bit away from the car industry, let's go to the plane industry where the technologies are sometimes the same. The new airbus 3AD is fully bound, that means that they don't use screws or nails anymore. It is fully bound with polymeric adhesives, and these technologies should come in the near future in the car industry, which will make it lighter of course. And last but not least, the electroplating is a technology which allows making plastic look like metal, so you find that in the forefront of the cars for example which used to be made in metal they are now made in plastics, but coated with material which makes them look as if they were made in metal. If we are talking about breakthrough technology that should come in the medium term future, we can talk about electric cars, which will not emit carbon dioxide anymore and will not consume any fossil fuel. In order to make an electric car you need a battery. This is the key of the technology in order to make sure you have enough autonomy to drive more than 100 km. And to make this battery you need chemicals such as plastic

membranes to store your energy. Those breakthrough technologies should allow in the near future many more electric cars on our roads.

AB: Maybe I can add some more examples concerning the cars. If you take the tires for instance; they are made with butadiene and today the trend is to make those tires greener and greener, so that they will correctly adhere to the road, but without too much friction. Today a labelling is being developed for green tires, just like on the refrigerators which are either class A or class B, depending on how much energy they consume or how they have been made. Another use of the product is Nylon and more especially Nylon 66, which is made of butadiene and is used in the part of the engine that gets very hot as this nylon 66 is very resistant to heat. So without this specific polyamide you wouldn't be able to have a light car either. So chemistry is really evolving every day, in order to make a car lighter and consume less energy.

BS: *The next question comes from **Germany**: “They would like to know how much chemistry is in us?”*

PdK: We are all actually 100% made of chemistry. Whatever you are made of, it is always chemicals-based. Within your bones there are some minerals, but it remains chemicals, and all the rest is made of organic chemicals, so it is very often the confusion that we are making between synthetic materials or natural materials, after all they are always made of chemicals. Some are inert, some are very reactive, some are resistant, and some are recyclable. But every living organism is made of the same main constituent: carbon, hydrogen, oxygen and nitrogen. And with all these you make almost everything on earth. So it is really an important perspective that we need to keep in mind when we have controversies on chemicals, that much of the synthetic chemistry has been developed on the base of natural compounds. If you take pharmaceuticals for example, all the initial compounds came from nature, but they have been improved through chemical processes in order to change the physical properties, make them more efficient and change sometimes their recyclability.

BS: *WB would like to answer the question from **Italy**: “How can the exploration of the universe and space missions help the development of chemistry?”*

WB: The exploration of the universe and space helps the development of chemistry, but how can chemistry help in order that we can explore the universe? Without chemistry, without research we would never have been on the moon or on Mars, so chemistry and science help us to develop and to explore. On the other hand of course, if we explore the universe, we can find new materials, we can find new things that we might not have thought of today, where we cannot even yet see what future applications it could bring to us, but all these explorations teach us about minerals and substances and they will later on lead to new creations. This is a little vague, but it's the best answer I can give so far.

PdK: I would like to make the following analogy. If you look into race and competition in general, the Olympic race or car race or sailing race, in order to improve the performance of the equipment and the performance of the athletes, there is a lot of research about new materials, and very often these new materials are not directly available to consumers because they are too close to research and development or too expensive. But what you see is that five, ten years later, they are in every product that you use on a daily basis. Very far exploration or very intense records are always sources for discoveries of new materials. This is really something to keep in mind, that something which might look very far from your daily life or maybe useless in terms of performance, is usually a source for the material that we will use tomorrow.

BS: *Thank you very much. The next question comes from **Belgium**: “Why are so many chemical products added to food, when you know that most of them are not really necessary?”*

WB: This links a little bit to the previous reply of my colleague. Sometimes people have a negative image of chemistry. Although chemicals are certainly not always natural, chemistry cannot always be regarded as negative. Often when we talk about chemicals in food people think that non-natural products are added. In food, the chemicals that are added today are often from natural original and they help for instance food conservation etc and this is a positive aspect. Food chemistry deals with natural products: with enzymes, with micro-organisms which occur in daily life.

BS: We saw a question from the UK: "What is a day to day STEM job like?" We will ask every expert to explain their day, let's start with Aniuta.

AB: My daily life looks like – I negotiate many contracts, so I am basically a seller of molecules. I have many customers around Europe. I receive a lot of phone calls, a lot of mails, I hold a lot of discussions, a lot of negotiations, which implies also a lot of calculations, studying alternatives, etc. I also have to deal internally with the plants, with the lawyers, with the industrial development people, with the project people. I have to check what is the balance between what the plants produce, what is in storage, do we have the products supply that we need on a daily basis, what are the problems of my customers, why a barge or a vessel can't arrive, or why a train is delayed, or where my tank cars are lost in the middle of nowhere. So things like that, that are very practical and involve many contacts internally and externally.

WB: I will explain a little bit more my previous job. What is "Order to cash"? Our sales responsible sells our products to our customers, but then our customers of course have to order our products. We have a big team accepting the orders from the customers and making sure that all the orders arrive at the customers: by truck, by vessel, by train, in bags, in big packs, in small parcels. To make sure that all this functions well, which is in fact a supply chain, our Order to Cash team is in contact with transporters, internally with the plants and the planning people who make sure that all the products are produced in the right way. We check with the customers when they want to have their goods, how they want them to be delivered, etc. So it is a job with a lot of internal and external interactions to make sure that the products ordered by customers arrive in good shape, in good condition and on time.

KC: I can maybe emphasize the first job that I had when I joined the industry, since I was not expecting that kind of job when I left the University. Although I was hired to work in a Research centre, I was not working in a Lab; I was doing what we call product development and technical service. The core of the job was basically to visit customers, make sure that we understood their needs in terms of new products and new applications, translate those needs into new products. So it involved working a lot with the plants, with the lab people and try to turn those developments into new products. It also included a lot of travelling, a lot of hands-on work with the customers, very pragmatic – very different from what you do in a research position at university.

PdK: My job is a bit different. I am working for a trade federation. When I joined that federation coming from the business sphere, many of my friends told me "why are you joining a federation and leaving the business?". After 14 years I could not imagine that I would be so satisfied with the variety of tasks that I am doing on a daily basis. Of course we spend a significant amount of time on the phone and organizing meetings and conferences, congresses, preparing speeches. At the moment for example we are running an extremely interesting project looking at the potential contribution that the chemical industry could bring to society by 2050 in order to move to a low carbon economy. Such a project includes almost everything. It is market analysis, it is consumer needs analysis, but it is also very in-depth technical discussions with operators on plants to understand what type of performance improvement they could bring, in terms of energy efficiency into Co2 emission reductions. The final objective of that is to assess how an industry like the chemical industry could bring benefits to society in order to help the climate change debate by

developing new products, new technologies and by improving the efficiency of existing materials or plants. Although my job is more in the administrative part of industry, you can see that in my daily activity I have to get in touch with people who are in many different fields of industry.

*BS: Thank you very much. It was very interesting also for me to hear what your daily working day looks like at the office. Let's move to the next question which comes from **Slovakia**: "Are there more men or women in the chemical industry or at least in your company?"*

AB: Well, I think it really depends what we are talking about, because the chemical industry is very wide. Personally I work for a petrochemical industry with lots of engineers and a lot of boys go to University to study engineering, much more than girls. There is nothing that we can do about, but just tell you to please study STEM. But at this stage in my company we still have much more men than women. This is evolving quite a lot and not only at Total, but in a lot of different companies, there are now women networks being developed to try to promote women and women careers. I don't know exactly the precise figures, but the trend is changing slowly. It was supposed to be voted yesterday at the European Commission if we were going to go for quotas in company boards or not. This is a complicated debate. So to answer your question, in my company, we have than 20 % women coming out of university from 25 years old until the retirement age.

BS: Thank you very much. I am surprised. I thought there would be already more women more in industry. Now this is for you to change this, so all the girls, go and study sciences to be able to work in industries.

WB: If I can give a positive note to this. In my team we do this customer service where we are linked directly to all the customers and making sure that the orders are well executed and the products arrive on time. In my team there are 90% women. Of course this is only a small part of a big chemical industry, but in the supply chain organisation and certainly in customer service organisations, women are the majority of the people executing this job. It is also proven that they are often very stress resistant, because often it is not easy to do this job, but they stay calm and they are very efficient. So certainly in my team women are welcome, because they do a very good job.

PdK: Maybe a quick feedback from the previous Xperimania work that we did in the last years. The majority of the winners of the different contests that we organised were girls. So girls, you have a route.

*BS: Thank you very much for this encouragement for girls. As you see we really need girls, but of course also boys in the future in industries. Now next question comes from **Lithuania** and it says "Are plastics produced from hydrocarbons only, or are they produced from something else?"*

KC: It is very important to have in mind "what is the origin of hydrocarbons?". Most plastics are made of carbon, so I could say that more than 95% of the plastics which are on the market today are made from hydrocarbons, which comes from the fossil origin. This means that it comes from oil, from natural gas, and marginally it can come from coal. But more and more the industry is trying to use carbon coming from carbohydrates, which is renewable carbon coming from plants. The demand for these plastics is more than 20% per year, so we shall see an increase of the production of those plastics coming from plants.

*BS: Thank you Christian. The next question comes from **Croatia**: "What are the benefits of using plastic bags as we know that there are loads of problems. Is it better to use paper bags, reusable plastic bags or canvas bags?"*

AB: I am personally totally convinced that we can do much better with hydrocarbons than make simple plastic bags for shopping. Definitely use reusable bags which last longer and can be used for years. If you

still use plastic bags in supermarkets, please re-use them as garbage bags afterwards. In Belgium for instance supermarkets do not provide plastic bags any longer. This is regarded as an ecological behaviour of supermarkets as they no longer spend money to buy the plastic bags. It might be considered as a loss for the plastic makers, but in fact it is definitely much more interesting to do something else with hydrocarbons than producing supermarket bags.

BS: Thank you Aniouta. The next questions come from the UK: “How realistic is the assumption that renewable energy sources can replace fossil fuels?” and the second question is “How close are we to use superconductivity to increase efficiency and so reduce the waste?”

PdK: I will concentrate on the first part which is in my scope. I think there are already two different things in the first question, namely the renewable energy and the renewable materials. The question is about using renewable energy to provide energy to industry. Yes, it is possible to provide significant amount of energy to industry using renewables. The problem with renewables is the reliability of supply. If you use wind or solar power or waves it is very difficult to have a very consistent supply of energy. And for industries like steel, cement, chemistry which use very high quantities of energy in a small amount of time, it is probably very difficult to compete and replace them by renewable energy, but you could use renewable energy for lightning, for heating, for transport and keeping the high energy contents of fossil materials like gas or oil to produce the large amounts of energy we need for industrial processes. If the question is related to renewable materials, we start to have very good ideas today on how much renewable material we could use to replace fossil material. There are more and more studies now in different countries trying to quantify how much land you will need to replace the fossil material and the results are not very optimistic. I have one example of a study in the Netherlands which indicates that the Netherlands would use six times the surface actually used to grow sugar beets to replace only 10% of the olefin production capacity in the Netherlands. So that would mean no sugar anymore for the Netherlands and that would only supply 10% of the total olefin capacity. So we need massive amount of lands if we want to replace fossil materials by renewable materials. The future is really made of a mix of different sources. We can estimate that probably 10-20% of fossil materials will be used to produce renewable materials. The rest will be a combination of gas, coal and fuel and maybe other materials to come. We are looking at the waste added value that we could get. All of us produce significant tons of waste on an annual basis. There is probably much more than we can do with this waste. Parts can go into production of energy, but a significant part can go into the production of material. I think it is more at that level that research and development will go in the future to produce what we call business loops, which are in fact replacing finite resource by endless loops of recycling, reforming and reusing of material.

BS. Thank you very much Pierre. Thank you very much to all the students out there who are sending so many interesting questions. Let's move to the next question which comes from Croatia: “How can we encourage our government to invest more in recycling and using alternative sources of energy?”

KC: Waste management is a very interesting and important topic. Our vision for the future is that we must clearly prevent that when plastics for example reach their end of life, they end up in a landfill. We believe that by 2020 Plastics should not end up in a landfill anymore and recycling is one of the ways in order to prevent that. But as we said, before recycling plastics waste it must be collected and it must be sorted into different types of plastics which can be recycled. When you go through a sorting process you always create side waste. Then you must complement recycling technologies with other technologies such as energy recovery. With regards to alternative sources of energy I guess that the question is related to sources which are not emitting any greenhouse gases. Waste can be considered as such. This relates to my previous part

of the answer. By recovering the energy in plastics in its end of life you basically prevent the use of fossil energy.

BS: So how would you convince a government to recycle more?

PdK: Without going into too much detail on the initiative by the plastic industry, what they try to achieve at the moment is a process by which at national level the representative of trade association and industry will discuss with the industry partners in charge of collecting waste, in order to optimise how the recycling parks are organised. So it is at the same time motivating the governments to invest into recycling programs, but it's also helping either associations or small business to start up specific businesses with material collection. An infrastructure is required, so every town should have a place where you can put recycling containers. There should be communication in the public, advertising material, TV adverts, and all these initiatives will be put together between industry associations and local authorities. It is a 9-10 year programme that will try to benchmark with the countries where recycling has been pushed to the highest level. Some countries reach 90% plus in recycling. Thus, there are models that can be implemented easily in other countries. The rest is for private partnerships between authorities, local authorities and industries.

*BS: Thank you very much Pierre for adding to this questions. The next question is from **Italy**: “**Why is the EPCA film more oriented to plastics than to other materials?**”*

AB: I am not sure if this film was a little misleading or not. It is maybe a question of perception. I am not sure plastics were the favourite element of the movie. What is completely sure is that without plastics, our modern life would be difficult. Let's take the main building blocks that we have in the film: for instance water, without piping you would get water with a lot of difficulty or a lot of loss or waste. If you take food, you would have no packaging. If you take your kitchen, you would have trouble having a refrigerator. If you take your daily life, especially young people; iPhones, iPads, headphones, all of those wonderful machines that you love; thousands of text messages every second, you wouldn't be able to do it without plastics. It is the same if we talk about clothing: many fibres are made out of Nylon, which is a sort of plastic as well. If we talk about cars, it is the same. If we talk about housing, the joints, everything – no way this would be possible without plastic. If we talk about health, you wouldn't get any perfusion without plastics, you wouldn't get any syringe. Chemistry is also about medicine, water purification etc. You need a lot of different things. But it is true that in each of the building blocks plastics are important elements.

*BS: Thank you Aniouta. There is one question that we find quite funny. It comes from **the UK**: “**What is the favourite element on the periodic table of the experts?**”*

WB: For me it is oxygen, because oxygen gives life to everything.

CK: Carbon because carbon is into life.

PdK: Hydrogen provides energy for the future.

*BS: The next question comes from **Croatia**: “**Can we use old computers to make something new?**”*

CK: Of course and it is true for many other electric and electronic devices. Basically in the computer you will find a number of very precious metals and plastics, so the key is to make sure that they are disposed of properly when they reach the end of life. So it means they should not be dumped in nature, they should be brought somewhere where dismantling can take place, as it includes the recovery of plastic which is shredded and then recycled. If recycling is too difficult then it is sent to an incinerator where energy will be

recovered. And the rest, the metal parts, the different metals will be recovered. And when you see now the price of those precious metals, this business could be very profitable in the future.

BS: Thank you Christian. The next question comes from Portugal: "How is the water treated?"

PdK: Water treatment in fact involves two major categories of treatment. There is the physical separation and the chemical separation. Physical separation, you use stone, sand, and in that respect you will remove most of the physical material that is in water. At the molecular level, you need to remove any contaminants or different material that are not necessarily visible. You really come to articulate matters, or organic molecules, which are invisible. Then you need to start precipitating the material, to get it sedimented down the purification tanks. Usually you do separation by adding compounds which will bind different materials that are in suspension to water, even those that you cannot see. And in fact they will agglomerate those articulate matters and organic molecules together and then sediment down to the tank. And by doing successive addition of chemicals you will come to the water that is almost ultra-pure. You just have salts remaining in it which are important. If you use osmosis, you will use membranes which in fact only allows each water molecule to pass through the membranes. For that you need pressure and electrical currents to form the molecule of water to pass on the other side of the membrane. Then of course after that you need to add salt back in order to get drinkable water. In fact you could make fully synthetic water that is perfectly drinkable. What is different between the water in your tap and the water that you buy in bottles? Just the addition of minerals, the rest is exactly the same. So, chemistry is important in order to prevent other chemicals to be found in the water, except maybe a quantity of chlorine, which is needed to keep the water clean while it is travelling in the pipes.

BS: Thank you very much Pierre. I think as time is running out, we have to slowly pick the last question. The last question comes from Germany" How much chemistry is used in agriculture? And would agriculture exist without chemistry?"

WB: I would like to answer again with two examples. As already mentioned, in 2030 we will be with 9 billion people, and these people need to eat. To ensure that they all get enough food, we need to produce that food. We have less and less land available to feed all the people in the world and that is why we have to also use land which is not so rich to grow crops on. This is why we need fertilizers today. What are fertilizers? They are adding N-P-K, Nitrogen Phosphorus and Potassium. So to be able to grow crops, they need to have these three elements. By using fertilizers we can gain more land. We can also in the future grow crops on these lands, so that we will be able to feed all the people in the world. This is also an example of how chemistry can help in agriculture to feed the world population.

BS: Thank you very much for answering this last question. Unfortunately we have to stop to answer the questions now, but I would like to ask the experts now to say a few words to the students. Something you would like to tell them.

CK: Maybe just a few words to make sure that you are not afraid about Science. I know trustworthy that nowadays more and more students don't go into Science just because they think that science is not trustful anymore. I mean back in the sixties it was a great pride to be a scientist. I would just like to make sure that you believe that this is not the case. Science is very important for your future. And it is basically the field in which you could at some point have an education. As a scientist you can either work in a lab or do some fundamental research, which is extremely important. But also, as we have shown you today, work in an industry and try to contribute to a sustainable future.

AB: You can be a chemist and not work in the chemical industry and vice versa, so never hesitate to do whatever you like, but sciences are great and will offer you very great career opportunities. The second thing is that as you will become adults, please be intelligent consumers; consume the best way you can, recycle your waste, don't burn hydrocarbons inefficiently and keep in mind that the more we transform and the more we recycle, the better we will survive.

WB: I can only add that you can also teach your parents how we can cope with waste, how we can recycle. The future is yours, you will live longer on this earth, and we all have to work together to give everybody a good life. You have your voice, so teach your parents how they can improve.

PdK: I would like to thank you all for participating to this chat which, as an Industry, we see as an essential part of our thinking process. First of all, you may have read that the European Commission made a call a couple of years ago stating that Europe will need 500.000 Scientists more in the future to meet the future challenges of society which is related to food, aging population, health and climate change. Society really needs more researchers in order to boost innovation. From the industry point of view I think it is really important for us to understand the expectations of your generation, because we are in fact paving the way for your future. It is the future in which you will live longer than us. So it is very important for us to get your feedback. What are the ways that you expect your future lives to be, because we are preparing that way for you.

BS: Thank you very much to all of you for everything you have said today. Thank you very much also to the participation of all of you the students and the teachers. Please show your appreciation to the experts by clapping. You can see the little clapping icon at the top next to the smiley. Please use it if you like to show your appreciation to the experts. To close this chat I have a few announcements to make:

- *Please look at the slide that I am displaying now. You can see important links. I am proud to say that we have launched the Xperimania facebook page (<http://www.facebook.com/xperimaniaV>) as well as the Xperimania Twitter page (<https://twitter.com/xperimaniaV>). So you can now please like the pages and tweet on Xperimania and re-tweet just by using the hastag #XperimaniaV.*
- *Don't forget to participate to the competition. You can find all the relevant information on the Xperimania website and we will link it to the inGenious website*

Thank you very much in the name of inGenious and of Xperimania. We will talk to each other next time, during the next chat. Have a nice afternoon everyone.