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PACOPAR
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RECOVERING HISTORY

PEDRO GONÇALVES
HEAD OF THE PACOPAR SECRETARIAT
CIRES INDUSTRIAL GENERAL DIRECTOR

This edition of PACOPAR magazine features a brief history of the Complexo Químico de Estarreja (CQE), in a necessarily short and incomplete account, in which, besides the references to the companies' historical milestones, we will also include the reports of some who were actors in that reality. We believe their personal experiences and their stories, merged with the formal historical narrative, help us creating an image of the past and better understanding the evolution and the transformations we were able to achieve.

Our thanks go to Professor Elisabete Figueiredo from the Aveiro University for her contribution with the article "A Fábrica e a Vida...", as well as to all those who agreed to give interviews, which represent an immeasurable contribution for the preservation of our memory.

All accounts make it obvious how impressively the industrial reality has evolved. With all the technological innovations, of which some are perfect examples of "plants of the future", strongly focussed on automated processes, plant operators are no longer nameless workers who carry out hard and painful tasks but rather highly specialized technicians with a profound insight of the manufacturing process and duly skilled in various technological areas.

Equally important is the criticality widely acknowledged to safety and environmental issues, very evident not only in the companies' technological evolution history but also in the people's awareness, visible and reinforced in the personal accounts throughout all the organizational levels.

I also highlight the interesting and wide-ranging historical summary of the Portuguese Chemical Industry, brought to us by APEQ, giving us a picture of the CQE in a national context.

It is beyond any doubt that the CQE's presence in Estarreja has had an enormous impact in the social, economic and even cultural development of the region, and yet the richness and cultural dynamism that has characterized this community even before is unquestionable. An example of this is the Recreational Centre of Estarreja, one of the oldest associations of the region, who agreed to share with us in this edition a little of its long and rich history.

By recapping what has been achieved so far we aim to recall the enormous capacity we have had and still have to transform and improve what surrounds us. May our history inspire us, as the capacity to change comes from the individual and collective sense of responsibility and effort.

Enjoy the reading.

LUIS FERREIRA JOINED AIR LIQUIDE BEFORE THE COMPANY HAD EVEN SETTLED IN ESTARREJA

"TODAY, WE ARE IN THE 4TH INDUSTRIAL REVOLUTION. I CAN BE COMFORTABLY AT HOME AND SEE THE WHOLE PLANT!"

Luís Ferreira started working at Air Liquide (AL), in Lisbon, in 1973. He spent some time in several units of the company in Portugal, namely in Lisbon and Setúbal, until 1989 when he came to Estarreja, to incorporate the new production unit of this new multinational subsidiary. Five years after he started working in Estarreja, he became the production manager and for the last 17 years he has taken the role of plant manager. We have the opportunity to perceive the changes brought to AL over time through the professional and personal experiences of Luís Ferreira.

What were the biggest changes to your work?
Several. When I started in the company in 1973, the operation was completely manual. Later I was transferred to Setúbal where there had been already some evolution in the control system, which had changed from completely manual to pneumatic. When opening an ultra-pure nitrogen plant, in 1985, the electronic control was introduced. When I came to Estarreja, we applied state of the art in terms of process control. The Distributed Control System (DCS), highly computerised, had already been implemented in the companies that were here in the Complex. This allowed the people involved in the production to become more versatile, just as the production process itself became more reliable. Today we have three units operating with the same team. This is only possible with an advanced level of computerisation.

What are the main differences between operating in the 70s and today?
At the time, the operator had a sheet and he had to go out to the plant to read the gauges, check the temperatures and all the indicators. There was a supervisor who had to compile that information so it could be compared with other moments of the same operation. Today, the operator does this reading with a tablet, downloads it to an app, after which he has a complete statistic control over those variables. This also implied a substantial update for the staff. Some of the people have been here since the beginning and had to go through a big evolution in terms of qualifications and intellectual skills. Reliability also improved a lot. The variables are detected to the second and the systems have algorithms that perform automated corrections. Things became less vulnerable to human error. Therefore, work also ceased to take place outside the control room, moving to where the process is controlled and managed.

Does this mean that the exposure to risk also decreased drastically?
The control and prevention means evolved in terms of security and reliability as well. Things that were previously corrected manually are now done automatically. For example, there are pressure, level and temperature controllers which are managed by the DCS and allow for control and safety of the processes. There is better response capacity and an interaction of several instruments... The people's safety mindset has also evolved. In the 70s, AL's challenge was that everybody would wear a safety helmet, harness, etc. People did not have that habit; constant monitoring was necessary. Today, the use of PPE (Personal Protection Equipment) is a natural act. There was a rational and cultural evolution.

And the computer and the internet, what changes did they bring to everyday life?
Currently, we are already in the fourth industrial revolution, which means the operations will be much more integrated and virtual. I can be at home and watch the whole plant. I have access to the same information as the operator. Today I had long-distance meetings with four different people, via web. Before, these involved travelling. Today, the Board holds an online conference with 50 people, to present the results and set paths. When I arrived in Estarreja, in 1989, there were only two computers. Everything was done in print or by hand, like the shipping documents. Today, hand-written documents are an exception. The driver arrives, we log on to the Ministry of Economy and the shipping document comes out. The maintenance organisation was done by hand, with tables done in squared paper; with the computer, all this was done in excel. Papers are nowadays much more difficult to lose, because papers are no longer stored. Everything is kept in a common server, accessible to all. The computers and the internet have become crucial in terms of work. An example of that is how my day starts: I arrive, with my bag, take out my computer, connect it to the company's network, type in my password, open my e-mails... The internet brought us closer together and revolutionised our daily routine.

RUI RODRIGUES TOOK PART IN THE LAUNCH OF AQP, THE COMPANY WHERE HE STILL WORKS TODAY

THE TECHNOLOGICAL EVOLUTION MAKES THE JOB MORE STIMULATING

AQP was still in its early stages when Rui Rodrigues started working for the company, in 1993, coming at that time from Uniteca. In February of that year, he started working as an operator, remaining the only one in the plant for four years. With the necessary production increase, more operators were hired and Rui Rodrigues became the overall responsible of the plant, comprising several operation areas. We have the opportunity to observe the changes brought to AQP over time through the professional and personal experiences of Rui Rodrigues.

What were the biggest changes to your work?
In the beginning, it was more manual and the company didn't have set procedures for certain actions. Nowadays, any task has well defined procedures and everything is more autonomous. The operator is only the supervisor and he already knows how to perform a given task. The whole structure became much more reliable and organised. In 1993, none of that existed. There were instructions on how things were done and specific procedures to follow. Today, operators have written procedures and they may not deviate from them. Also, in the beginning, the operator went into the field more often to do manual tasks, like open valves, collect measurements, monitor, visualise. Nowadays, all that information and mobility are centralised in the control room. Everything can be monitored from there. Currently, 90% of the company is automated and the operator barely handles the installation.

As a result, what were the changes in the working routine?
Besides the fact that the work is now less manual, the strongest change is in the way we perceive the chemical industry. With all these improvements, and the investments in technology and automation, the risks have decreased. The operator has less direct contact with the products, which guarantees less risk. There was also an improvement of the social area, with buildings for the workers' support, such as dressing rooms, which existed when the company was founded, but with a much smaller space. That was also a significant evolution.

What was done previously that is now unthinkable?
Products were handled with little caution. The filtration mud recovery system consisted of removing the mud with a shovel, by hand. Today, it is automated. The mud is separated automatically as waste or reusable material.

What changes did the computer and the internet bring?
When I came here computers were already being used. The biggest changes were brought by the Internet, when we look at how fast the orders are received and the way we communicate with the clients and other people from the group. We can speak with our colleagues in Spain and the Kemira Group in real time through teleconference, the entire organisation is connected via network, we have centralised documentation, online training. Before, the communication was done through telephone and fax and everything took longer.

Did that make the work become omnipresent?
Yes. At home, I can be in contact with the company and know how the work is going.

Did anything change in the way co-workers socialise?
Not much has changed, because it is a small team, as it has always been. We are just a few, qualified in various areas and there's a lot of cooperation between us.

Which daily routine do you prefer? The new one or the old one?
The new one. It is more stimulating. It is a challenge to work with new technologies, working in a network, with different teams. It is completely different from a mere instrumental function like I used to have, being in one place and performing a specific task. It was a very technical function. The evolution in terms of technology and of my tasks allowed me to diversify my type of work a lot more.

CIRES' HISTORY FROM AN OPERATOR'S PERSPECTIVE

"THERE WAS NO ROOM FOR A MINUTE OF DISTRACTION"

Vitor Pereira started working as a plant operator for CIRES in 1975 and stayed in the company for 29 years. After working for some time as an operator, he became head of production, responsible for all the operators in the plant, within his shift. Throughout his career, he has witnessed all the main technological and procedural evolutions of CIRES. We have the opportunity to perceive the changes brought over time through the professional and personal experiences of Vitor Pereira.

What were the biggest changes to your work?
At the beginning, the work was very manual and exhausting because for every operation, we had to go out to the field, where the reactor was located, and then go back to the control room. The manufacturing process was very like today's, but now everything is automated. The operator has little interference in the field, in the plant, almost everything is done in the control room.

What role did the operator have in the plant that he no longer has?
Part of our job was to carry some chemicals to add to the process. We poured water into the reactor, added some reagents and some phased products. All that was added manually.

As if you were adding ingredients for a recipe?
Yes, you could say that! There were solid chemical agents that we had to get from cold storage. We poured water and added the reagents. We had a sequence and a set time to do that. Later, those products started being manufactured in tanks and being injected. It was no longer the operator who fetched them. From then on, it became much easier because the operator no longer had to go down to the chemicals room. At the time, there was a lot of responsibility on the operator's shoulders, since it was a manual work and, if the operator forgot any of the components, it could lead to serious errors.

Did you ever make a mistake in the recipe's ingredients? (laughter)
In this manual process, one of the tasks was to pour water into the reactor with a hose and let it fill up to a level marked in the reactor. One day I was doing that and a pneumatic test at the same time. I did all of the process but forgot to open the water. At the end, I went to the control room to start the heating to trigger the reaction. Following this, I see the ammeter very low, which made me a little uneasy. Then I realised that I hadn't added the water. A few days later, I was called by the hierarchy and I knew I would have to explain myself to my boss.

Was it a physically demanding work?
Yes. There was one task that is an example of that. In each production cycle, the reactor was opened and ventilated and we had to do some scraping. During the production cycle, which took between 8 and 9 hours, the reactor gained a layer that had to be removed manually. Two or three operators went inside and cleaned the reactor. It was the hardest part of production because it had to be done after every production cycle. Today it is cleaned in a different way. Hundreds of production cycles are done without ever opening the reactor. With the technical improvements that were introduced, in terms of equipment protection, with more reliable systems, the operator became less directly involved in the process. Mechanical controllers appeared and we started to have a computer system that changed many things.

Which things, mainly?
A new tool was introduced that really helps us with the process control. Before that, there was a board, a sheet, containing several parameters, where we had to write down the times of each one. During the production cycle, every half hour, we had to register the whole process, and for that we had to observe the various parameters through graphic ammeters. This was a mechanical process. There was no room for a minute of distraction on our part. With the introduction of computer control, these records are made automatically, the operator can rest assured, given that the reliability became less dependent on human intervention. Despite that, he must always be vigilant. He must watch the computer, to check if there's an anomaly with any of the parameters or if there's a warning of any kind. But as of 1989, with the new plant and the computer controlled process, there was a huge quality increase in the work.

What was done before that is unthinkable now?
Before, we had a problem which were the power outages. The reactor needed cold water to control the reaction. When the power went out, the cold water circulation stopped and the reaction parameters spiked. Sometimes valves shot up into the atmosphere. As we know, power outages due to storms were frequent in Estarreja. So, in the days or nights with thunderstorms, we were immediately alert to and anticipating what might come. With the assurance of power reliability, that stopped being an issue.

INTERVIEW WITH LUÍS DIAS, EMPLOYEE OF CUF-QI FOR 47 YEARS

"ESTARREJA LOOKED LIKE A TOWN IN HOLLAND. AT THE BEGINNING AND ENDING OF EACH SHIFT, ALL YOU WOULD SEE WAS BICYCLES AND MOTORBIKES!"

Luís Dias started working in Amoníaco Português in 1968. In the first few years, he was in charge of maintenance tasks, later becoming corrosion inspector, already in Quimigal (Amoníaco's successor company). After that, he worked in maintenance programming at Anilina de Portugal (which resulted from the splitting of the former Quimigal), later accumulating this role with warehouse manager. At the later stage of his career, he took on the role of head of the purchase department at CUF (the successor company of Anilina de Portugal). We have the opportunity to perceive the changes brought to CUF over time through his professional and personal experiences.

What were the biggest changes to your work?
There was strong development in technological terms and also big changes concerning the number of people. When I started in Amoníaco, there were approximately 2000 people; when I left CUF, there were around 200. For example, there was the position of the sample collector, which is now extinct. He used to ride a bike or use a wheel cart and he also worked in shifts. His job was to go to the plant, collect the samples and bring them to the lab. There were quite a few people in this position, also working in shifts.

What are the differences in your work routine?
When I was a corrosion inspector, all the work was manual. By the end, also given my position, everything was computerised. But while working in the corrosion inspection, we already used quite sophisticated equipment for the time. Today there are plenty of machines and instruments to support a work that used to be completely manual at the time, even though the handling and the maintenance still requires some proximity between the worker and the equipment. The plants themselves, as they evolved technologically, no longer require some of the recurring interventions that used to be performed before. Today, the control room oversees the whole manufacturing process without needing any staff constantly at the machines.

What was done before, that is unthinkable now?
Before, environmental and safety issues were not a priority. Neither did we have the knowledge and awareness that we have today. People often worked without using gloves or helmet. There was a big evolution in safety education.

What changes did the introduction of computers bring?
Quimigal started by installing the macro-computers, very large ones, the first ones from IBM. There was a computer engineering service for the whole company. Then they started introducing the personal computers, 25 to 30 years ago. I only started working with a computer later. They tried to provide training in excel and word, but most of the people would not make it. Some people even chose to leave beforehand, even people with degrees, because they were not willing to learn this. I started in the purchase department precisely at that stage. I was asked to replace someone who refused to work with a computer. I already had some knowledge in excel and so I continued to develop my skills.

At the time, CUF was an attractive employer. It was an alternative to farming work. Did you have colleagues that were part-time farmers?
Yes. The plants in Estarreja gave jobs to a lot of people that worked exclusively on farming. Working in shifts allowed them to carry on with the agricultural work. People worked on their shift and when it was finished they would continue working at home. Despite the fact that the work in the sulphuric acid plants was physically very demanding.

Was CUF also a school, a training opportunity for some?
Some of these people had no qualifications, but they were smart, they were used to managing and they had the capacity to adapt. In the lab, there were maybe 50 to 60 people, some of them with little academic qualifications, who became analysts. There were only few employees for the middle management positions and a lot of people without any qualifications managed to have an interesting career because they adapted. Most of them had fourth grade only. There were also people coming from all over the country who had graduated from the so-called industrial schools and the local companies hired a lot of people with these degrees. And then there were the people with university degrees, not many but already significant in the country. All the chemical engineers came to work either here or at Petrogal. Later, many went to the cellulose companies. Above all, this was always a great school, that prepared people for the job market.

In retrospective, what do you miss?
Well, today the work is safer, with environmental and safety precautions always present. Nowadays, compared to the environment at that time, CUF is like a garden. I fondly remember the social life and the personal relationships. At the time of Amoníaco, there was a tangible social awareness, with a building for the staff, for after work sports, recreation activities and social life. The first consumer cooperative of the area was created, along with houses for engineers and senior managers. It was a way for the company to reach out to people from outside of Estarreja. And at the time, Estarreja looked like a town in Holland. Bicycles everywhere. At the beginning and ending of each shift, all you would see was bicycles and motorbikes on the road, some arriving and others leaving. Estarreja already had sustainable mobility without knowing it!

DOW'S HISTORY FROM AN ENGINEER'S PERSPECTIVE

"TODAY I'M SUBJECT TO BIG BROTHER AND I CAN BE THE BIG BROTHER AS WELL!"

Trained as a chemical engineer and currently a production leader, José Luís Figueiredo has worked at Dow since 1980, practically since the beginning. He started working in the lab, later becoming shift manager, supervisor and then production engineer, a position that he occupied in several plant areas. He spent some time in the projects' technical department, played a role in the PMDI plant expansion project, in 2009, and in that year he became the production manager. With his professional and personal experiences, we will perceive the changes brought over time.

What were the biggest changes to your work?
The biggest changes came with the introduction of computers in the mid 80s. The pen stopped being a consumable and was replaced with the A4 sheet, the computer and printing. This had a big impact in the communication. There were many secretaries and a lot of time was consumed typing up reports or sending faxes to managers. The computer and the internet changed the way we communicated and worked.

How, exactly?
It brought us much closer to the world, to Dow's decision centres. It guarantees a rather continuous monitoring of the leaderships outside Dow and provides broader access to the knowledge outside Estarreja. The knowledge was basically in the possession of people and now it has become global. We access information via Internet or Intranet, a world of knowledge at our disposal.

And what changed in the plant?
Before, the control was pneumatic, through PLCs (Programmable Logic Controller), which later evolved to computerised control. From the 90s onwards, we had computer tools and software to program the plant and control the process in a much more standardised way. Before, we got to the plant and went through the report books regarding the progression of the production process, which were done with mechanical registers. The operator had to prepare the reports based on the records. Today, we get here and use the computer to check the progression of the process. Actually, we can even check at home what happened in the last 10 days until only five or ten minutes ago. That changed our routine.

Does that mean work became easier?
By having easy access to information, we also have time for other things, we are much busier. Before, work made us go to the source a lot more. Today, through remote surveillance, we can be further away from the plant. But, despite the reliability of technology, going to the field and checking things is still important. Today I'm subject to Big Brother and I can be the Big Brother as well!

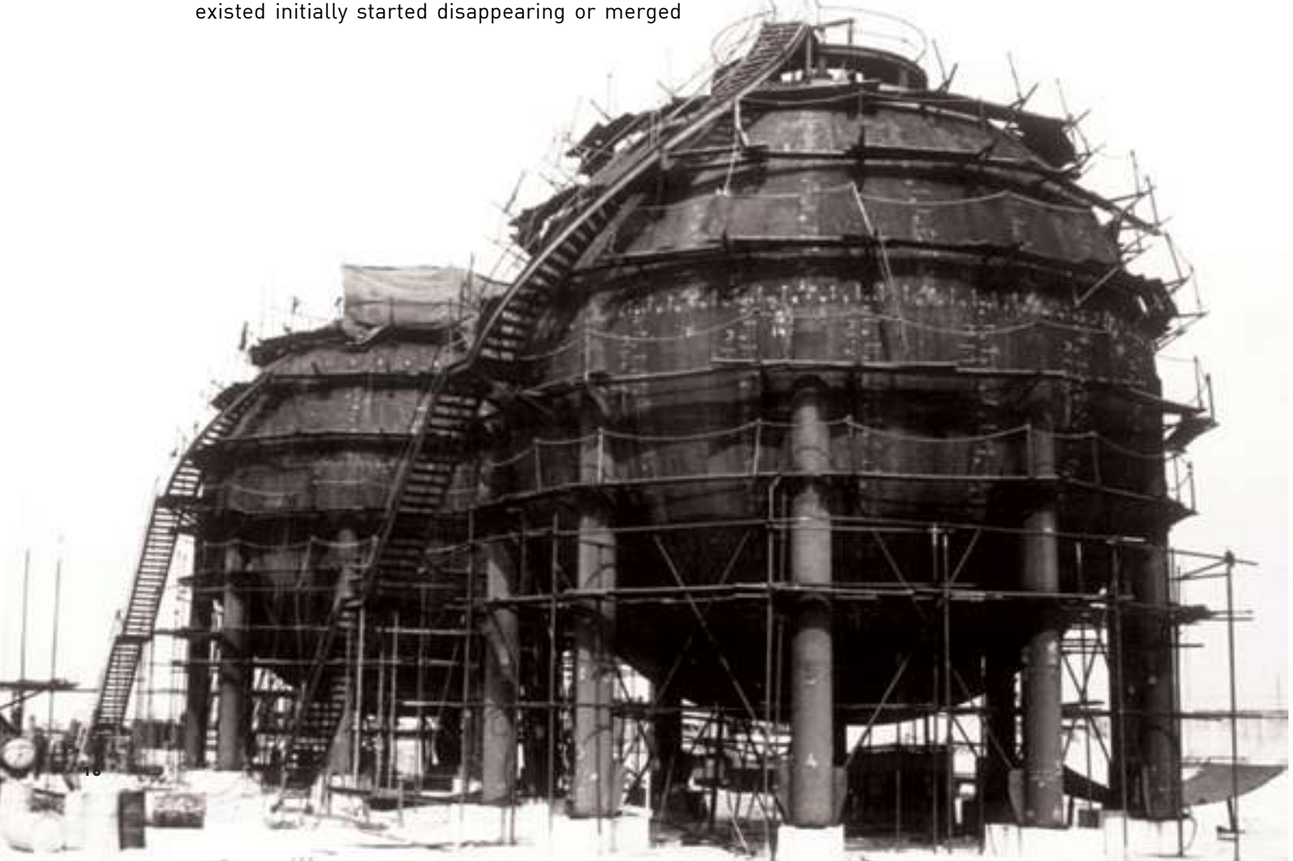
What was previously done that is unthinkable now?
The number of samples that were taken was so huge that we needed a bicycle to transport them to the lab. There was even a role of sample carrier. We had maintenance shutdowns with 600 or 700 people working to perform a series of tasks, half of what is done today. Today, you can accomplish twice as much with 200 people. Also, the concept of secretary is practically non-existent today. I used to have a secretary in the production department. Today, I write my own e-mails, my own reports. Before, it was done by hand and it was then transcribed to the computer. Today, all the engineers and the other positions do their own secretary work.

What would you highlight as the most positive aspects in the evolution you followed?
On the one hand, I would highlight the evolution in terms of safety concepts. Especially with the arrival of Dow, which acquired Upjohn. Not only in terms of work processes and behaviour, but with the technology that allowed for a more reliable control of the whole production process. A particularly positive aspect is the inclusion of women in the production. In recent years, we had a majority of women being hired for production engineering positions and that greatly improved the work environment, brought a higher diversity and created a relation dynamic that I consider very positive.

THE HISTORY OF THE CHEMICAL COMPLEX OF ESTARREJA

OVER 60 YEARS BUILDING INTEGRATION AND COMPETITIVENESS

The CQE currently consists in five companies: Air Liquide, Cires-Shin Etsu, AQP, CUF-QI and Dow Portugal (check their histories in the other articles). The originality of the Complex is the interconnection of production processes between the companies, one of the factors of its competitiveness. The successive settling of companies is related to a strategy to create local synergies for the provision of raw materials and the reutilisation of by-products of the main productive process. Over time, some of the companies that existed initially started disappearing or merged into a single one, until the consolidation of an efficient line production for polyurethanes, PVC and water treatment chemicals. A history with over 60 years has led the companies to create integrated actions not only in production and operation control, but also in taking up commitments within Responsible Care, of which PACOPAR is an example. Let's go to how it all started.



Origins – why Estarreja for the chemical industry?

The chemical industrial activity started in Estarreja in the second half of the 20th century, with the creation of Amoníaco Português, derived from the industrial impulse at the time, coming from the energy produced by the big hydroelectric plants. In the 50s, first with SAPEC and then with UNITECA, the chlorine and caustic soda industries by brine electrolysis developed, and in the 60s, CIRES developed the PVC production, originally producing its own main raw material, vinyl chloride.

The industry of nitrogen fertilisers in Estarreja, established with Amoníaco Português, consumed plenty of electricity and its location close to the northern railroad allowed not only for the shipment of the fertiliser in wagons, but also to receive ground pyrite from Alentejo, which was necessary for the production. Later, Amoniaco Português introduced the production of nitro-ammonia and compound fertilisers.

The 60s - the arrival of PVC

In the 60s, CIRES settled north of UNITECA in order to produce polyvinyl chloride, commonly known as PVC, starting its production in 1963. At first, suspension-type PVC (PVC-S) was produced, and in 1983 the production of emulsion-type PVC resins for pastes (PVCE-E) started.

The 80s - PMDI, the unifier and profit agent of the CQE

In 1979, a new Quimigal unit opened, producing aniline, which is part of an integrated business strategy aiming to create raw material supply synergies in Estarreja and to consolidate national investment, and distribution logistics strategies by absorbing the benzene from a new aromatic compounds plant in Matosinhos. The CQE assumes the role of a crucial element in the Oil Refining/Petrochemical Industry cluster in Portugal.

In 1979, attracted by the presence of aniline, ISOPOR - Companhia Portuguesa de Isocianatos - (a joint venture of Upjohn and Quimigal, which was bought in 1983 by Dow) settles there to produce PMDI (polymeric diphenylmethane diisocyanate), a raw material for the production of rigid foams and polyurethane elastomers. This plant consumes aniline, chlorine and soda (produced by UNITECA), carbon monoxide (resulting from a syngas production process from Quimigal) and formaldehyde (produced by Bresfor, at the Aveiro harbour). This way, the production of PDMI was a driving force for the expansion and profitability of the already existing industries in Estarreja, and the consolidation of the integrated production strategy in the CQE. From 1982 onwards, with the start of the PMDI unit, the CQE stabilised and became profitable.

Air Liquide joins the integrated production strategy

In 1989 a new plant opened, initially named Oxinorte, subsidiary of the French multinational Air Liquide, after which it was named. Located north of Dow Portugal, this unit produces carbon monoxide for the PMDI plant, hydrogen for the aniline plant, and industrial gases (oxygen, hydrogen, helium and argon), replacing, with economical and operational advantages, the Quimigal syngas unit.

The 90s – strengthening the production and integration at the CQE

The 90s consolidated the presence of the CQE on a

business level, with the definitive reorientation of the industrial base of fertiliser lines (with the sulphuric acid, ammonia and fertiliser plants completely shut down and their facilities demolished) towards the petrochemical sector. At the same time, CIRES renewed and increased its plant units, replacing its own production of vinyl chloride with the import of vinyl chloride monomer of petrochemical origin. And, throughout the years, the industries of the CQE continuously increased their production capacity. CUF (which had integrated former UNITECA) performed an important technological conversion, replacing its mercury cells with membrane cells, the best technology available in that sector to produce alkali chlorine.

In 1993, AQP - Aliada Química de Portugal was created (with investments of CUF - Químicos Industriais, S.A. and Kemira Ibérica, S.A., Spanish branch of the company Kemira Oyj), with the purpose of producing chemical additives for water treatment and for the paper industry, two sectors where it became competitive. In 1999, another production unit was launched, for sulphanilic acid one (reaction between aniline and sulphuric acid) and in 2000 started the production of cyclohexylamine (chemical product recovered from the aniline's residual current).

2009 – doubling the production capacity

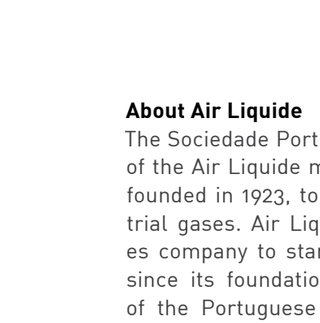
Becoming a renowned example of an interconnected production platform, both on national as well as on European levels, the CQE strengthens its position in 2009, with an articulated project between Dow, CUF and Air Liquide, considered a PNI - Project of National Interest, and benefiting from state funding through AICEP (Agência para o Investimento e Comércio Externo de Portugal), which allowed doubling the production capacity of the Complex. The overall investment, which was around 250 million Euros, entailed the renewal of the supply contracts between the companies for a further 15 years and allowed for the implementation of technological improvements and the enhancement of the procedural safety conditions. The CQE is therefore one of the most modernised European clusters in the chemical industry, included in the Centre for Competitiveness and Technology of the Petrochemical Industries and Industrial Chemistry, renowned worldwide, an extremely significant feat for the national industry.

FROM OXYGEN, TO HYDROGEN AND CARBON MONOXIDE

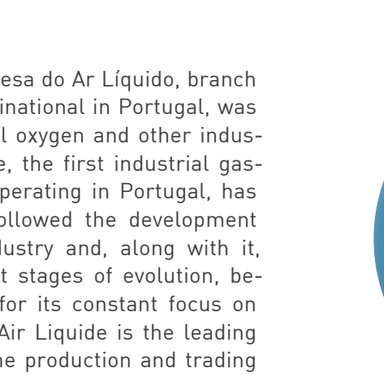
THE HISTORY OF AIR LIQUIDE IN PORTUGAL

About Air Liquide

The Sociedade Portuguesa do Ar Líquido, branch of the Air Liquide multinational in Portugal, was founded in 1923, to sell oxygen and other industrial gases. Air Liquide, the first industrial gases company to start operating in Portugal, has since its foundation followed the development of the Portuguese industry and, along with it, has faced the different stages of evolution, becoming a benchmark for its constant focus on innovation. Currently, Air Liquide is the leading national company in the production and trading of gases, technologies and services for industry and health, thanks to a growth model based on innovation, diversity and long-term commitment with its clients. Its industrial clients, from the craftsmen to the big companies, use these gases in five key sectors: food and pharmaceutical, auto mobile and manufacture, craftsmen and distributors, materials and energy, technologies and investigation. Safety, integrity, transparency, permanent challenge, performance improvement, innovation, thorough management and focus on the client are some of the values that are present in Air Liquide and its workers.



1923
AIR LIQUIDE STARTS ITS ADVENTURE IN PORTO.



1940
ESTABLISHMENT OF THE HEADQUARTERS IN LISBON.

1970
FIRST LIQUID OXYGEN PLANT (ÁGUEDA).

1989
FIRST HYCO (HYDROGEN AND CARBON MONOXIDE UNIT) IN ESTARREJA.

1993
CREATION OF AIR LIQUIDE MEDICINAL.

2001
AIR LIQUIDE IS A FOUNDING MEMBER OF PACOPAR.

2002
ASU (GAS SEPARATION UNIT) IS LAUNCHED IN ESTARREJA.

2003
CREATION OF AIR LIQUIDE SOLDADURA.

2008
CREATION OF AIR LIQUIDE MEDICINAL LABORATÓRIO FARMACÊUTICO.

2009
HYCO III IS LAUNCHED IN ESTARREJA.

2012
ASU IS LAUNCHED IN SINES.

2013
AIR LIQUIDE IS A FOUNDING MEMBER OF COMSINES.

2014
NEW SIGNATURE BRAND – AIR LIQUIDE CREATIVE OXIGEN.

2017
NEW VISUAL IMAGE OF THE BRAND.

APQ'S HISTORY

STRONG PRESENCE IN THE WATER TREATMENT MARKET

About AQP

AQP – Aliada Química de Portugal, Lda – is na invested company (holded) by CUF - Químicos Industriais, S.A. and Kemira Ibérica, S.A., Spanish branch of Kemira Oyj, the major Finnish chemical group, which possesses a high degree of know-how in the provision of solutions for the water treatment and paper pulp industry. AQP devotes its activities to the production and trade of chemical additives for water treatment (drinkable and waste) and for the paper industry, committing to providing safe and high-quality products and services that meet its client's needs. It applies the scientific and technological knowledge within Kemira in order to provide sustainable solutions for the water treatment market, thus allowing one of man's most precious resources - water - to be reused and therefore to contribute to the planet's sustainability. This company is concerned with the promotion of a sustainable development, which also includes using energy and natural resources efficiently in the production processes.

AQP is present in the entire national market; its main customers are the City Halls, municipal water companies, the paper industry and chemical industries in general.

1991 AQP IS FOUNDED.

1992 THE CONSTRUCTION OF THE PLANT IS INITIATED.

1993 LAUNCH OF THE PLANT'S OPERATION.

1995 AQP JOINS THE RESPONSIBLE CARE PROGRAM.

2000 PACOPAR IS FOUNDED (BY AQP ALONG WITH THE OTHER CQE COMPANIES).

2001 CERTIFICATION OF THE QUALITY MANAGEMENT SYSTEM, ACCORDING TO ISO 9002 STANDARD.

2003 INCREASE OF THE SHARE CAPITAL TO 910.000€ AND REDEFINITION OF THE SHAREHOLDER'S INTERESTS.

2004 CERTIFICATION OF THE QUALITY MANAGEMENT SYSTEM, ACCORDING TO THE ISO 9001 STANDARD.

2005 CERTIFICATION OF THE ENVIRONMENT MANAGEMENT SYSTEM, ACCORDING TO THE ISO 14001 STANDARD.

2008 AQP ENVIRONMENTAL LICENCE.

2013 OHSAS 18001 CERTIFICATION.

THE ARRIVAL AND EVOLUTION OF CIRES IN ESTARREJA

CIRES IS THE HISTORY OF PVC IN PORTUGAL

About CIRES

CIRES is part of SHIN-ETSU CHEMICAL, world leader in the sector with a 4 million ton PVC production capacity, 10% of the world's overall consumption. Its factory in Estarreja is a modern and versatile unit with a high industrial and environmental efficiency. In the development of the company, we can highlight the sense of social responsibility, harmonizing its industrial growth with the principles of sustainable development and strengthening the connection to the local community.

PVC - the second most consumed plastic in the world - has 57% pure chlorine obtained from common salt electrolysis, which makes it the thermoplastic that is least dependent on fossil fuels. It has been produced continuously for more than 80 years and its significant development is intimately linked to the progress and the well-being - respecting current society's sustainability requirements - and to economic competitiveness. Present in the most diverse applications used daily - in our homes, in transports, in leisure and work objects and equipment - it assumes an important role in the domains of energy saving, hygiene and food safety and medical applications. To perfecting its processes and integrated actions, among other goals, in the context of VINYLPlus - a European programme recognised by the United Nations - the whole chain has contributed for the sector's development, with the PVC industrial line being one of the most well equipped for the challenge of guaranteeing a sustainable future, as demanded by everyone.

1960 CIRES IS FOUNDED.

1963 START OF THE REGULAR PRODUCTION OF VCM MONOMER AND PVC POLYMER.

1982 START OF THE REGULAR PRODUCTION OF POLYMER THROUGH EMULSION PROCESS (E-PVC).

1989 START OF PRODUCTION CAPACITY EXPANSION OF S-PVC.

1991 ACQUISITION OF PREVINIL, A PVC COMPOUNDS COMPANY IN PORTUGAL.

1992 START OF THE SECOND HIGH-CAPACITY REACTOR AND S-PVC COMPUTER CONTROL. ACQUISITION OF CYGSA, A PVC COMPOUNDS AND POLYOLEFINS COMPANY IN SPAIN.

1993 START OF THE VCM PIPELINE OPERATION BETWEEN THE AVEIRO HARBOUR AND THE ESTARREJA PLANT, PUTTING AN END TO ROAD TRANSPORT.

1994 START OF THE ENERGY COGENERATION UNIT.

1997 ACQUISITION OF SOPLASNOR, PVC AND PE TUBING COMPANY.

1998 IMPLEMENTATION OF THE CLOSED REACTOR TECHNOLOGY IN S-PVC - THE BTA, BEST TECHNOLOGY AVAILABLE, IN THE PRODUCTION OF S-PVC.

2000 THE COMBINED PRODUCTION IN THE ESTARREJA PLANT SURPASSES THE 2 MILLION TONS MARK.

2001 START OF THE THIRD HIGH-CAPACITY S-PVC REACTOR.

2016 THE COMBINED PRODUCTION IN THE ESTARREJA PLANT SURPASSES THE 5 MILLION TONS MARK.

2017 INVESTMENT IN A NEW COGENERATION UNIT BASED ON NATURAL GAS.

CUF ALSO REPRESENTS THE ESTABLISHMENT OF THE NATIONAL CHEMICAL INDUSTRY

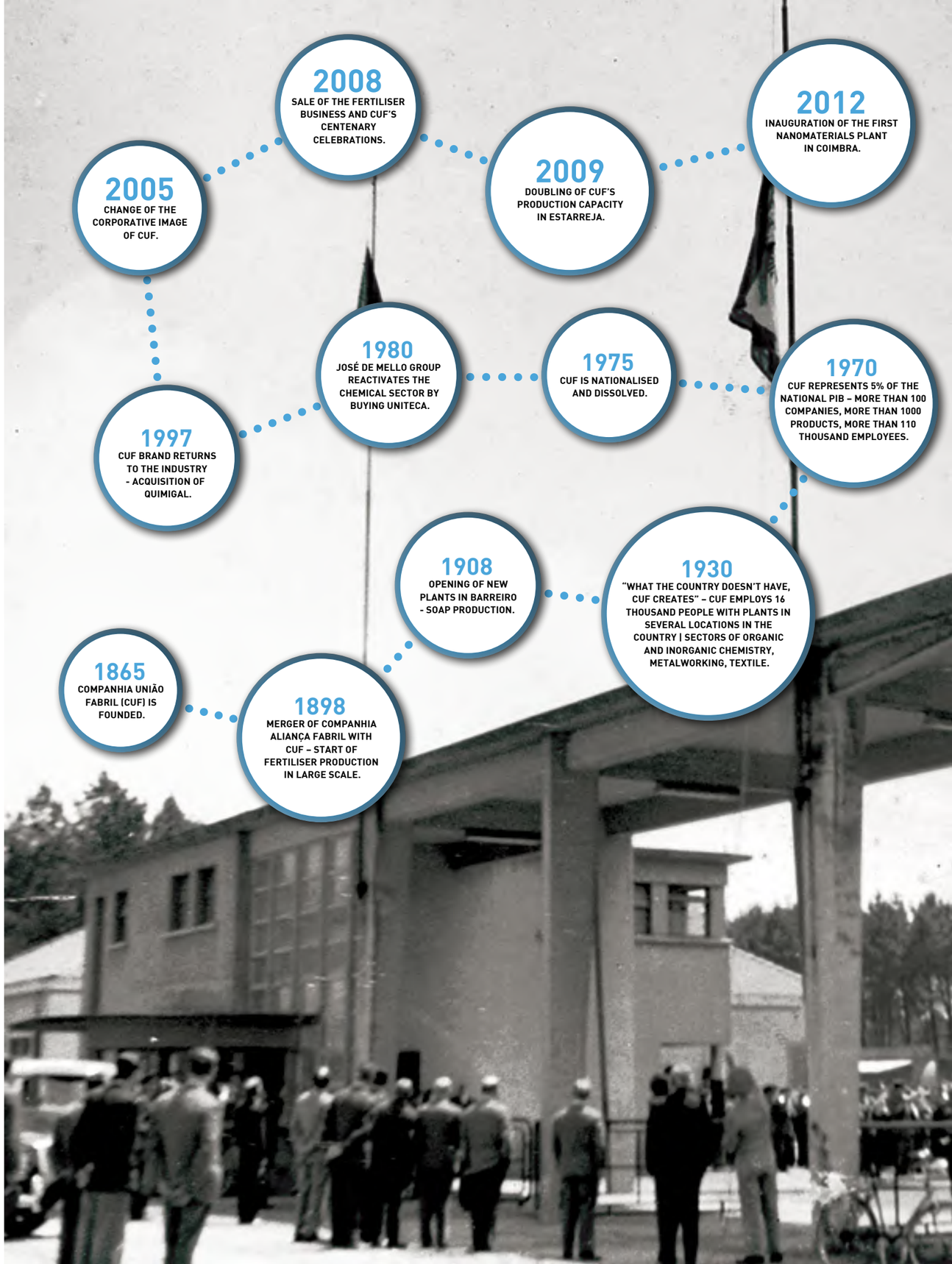
THE HISTORY OF CUF - FROM LISBON TO ESTARREJA

About CUF

In CUF we are united by Chemistry. A passion inherited from the founder of the company, Alfredo da Silva, which spread to shareholders and workers throughout 150 years.

CUF produces chemical products indispensable to our daily life. Organic and inorganic chemical products, like Chlorine and Aniline, Nitric, Sulphanilic and Hydrochloric acids, Caustic Soda or Nitrobenzene, among others. Products that are present in the purification of the water we consume, which are used in several industries, such as the pharmaceutical, rubber or paper. But, essentially, CUF's main products are used as raw materials in the production of polyurethanes (MDI) and hygiene and cleaning products, for disinfection and bleaching.

These products are distributed from Portugal to several European locations. Spain, Belgium, the Netherlands, Hungary or Germany are just a few examples of the exports' destinations. CUF is the leader in Europe in Aniline sales, as a non-integrated producer, and the third producer of Chlorine in Iberia. Over 90 percent of its whole production is exported, direct or indirectly, every year. CUF's Chemical area is represented by the following companies: CUF-QI (production and trading of industrial chemicals - organic and inorganic), APQ (production of Aluminium Salts), ELNOSA (production and trading of chlorine and its derivatives) and RENOESTE (extraction and purification of salt). The area of Nanomaterials is represented by the company INNOVNANO (Nanostructured Materials). Integrated in a prestigious and ancient Portuguese business Group, CUF nurtures values more than numbers: Innovation, Competence and Human Development. It is considered an employer of excellency and it has partnerships with the most important Portuguese universities, but it also runs projects with research centres in Spain, England, Germany, United States of America, among others.



INTRODUCTION AND EVOLUTION OF PMDI PRODUCTION

DOW'S HISTORY IN PORTUGAL IS THE HISTORY OF PMDI IN THE COUNTRY

About Dow

Dow (NYSE: Dow) combines the power of science and technology to constantly innovate in what is essential for the progress of mankind. With an annual turnover over 48 billion dollars and around 56,000 employees worldwide, the company offers a wide range of products and services to a portfolio of clients in 175 countries. Dow Portugal operates in the country for more than 35 years and employs currently more than 100 people. The group is present in Portugal from 1985, first through the acquisition of shares in ISOPOR – Companhia Portuguesa de Isocianatos de Estarreja, and lately, three years after, through the acquisition of the entire company. In 1989, Dow inaugurates a production unit in Estarreja, a strategic centre to produce PMDI (methylene-diphenyl-isocyanate), a raw material used in the manufacture of polyurethane rigid foams and polyurethane elastomers. Twenty years later, Dow finished the expansion of Estarreja unit, by doubling the production capacity of PMDI, to address the growing global market need for raw material. The expansion project comprised the replacement of industrial equipments and a bet on state of the art technology. In 2015, Dow launched its 2025 Sustainability Goals to help redefine the role of businesses and lead the transition to a more sustainable planet and society. Dow's Goals are divided in three areas: Footprint (continuous improvement of operations), Handprint (solutions for products that can address global challenges, such as food, energy, water, climate change, nature and social issues), and Blueprint (actions and innovating leadership of Dow). Dow will achieve it through the power of its products and the talent of its people.

2016
THE NEW NOMINAL PLANT CAPACITY IS REACHED IN JULY.

2015
DOW PORTUGAL REACHES NEW PRODUCTION RECORDS.

2014
PMDI PLANT REACHES ITS NOMINAL PRODUCTION CAPACITY.

2013
DOW PORTUGAL GOES THROUGH THE FIRST BIG TECHNICAL OUTAGE AFTER ITS EXPANSION PLANS.

2012
DOW ANNOUNCES THE SHUTDOWN OF THE STYROFOAM UNIT.

2011
CONSOLIDATION OF PRODUCTION CAPACITY.

2009
PMDI PLANT INCREASES ITS CAPACITY AND STYROFOAM'S LINE II STARTS. DOW PORTUGAL 30TH ANNIVERSARY. ISO 14001:2004 CERTIFICATION.

1995
APPROVAL OF THE EXPANSION PROJECTS FOR THE PMDI AND STYROFOAM™ PLANTS. RENEWAL OF THE CONTRACTS FOR A PERIOD OF 15 YEARS.

1994
LINE 1 OF THE STYROFOAM PLANT STARTS ITS OPERATION.

1993
DOW PORTUGAL JOINS THE VOLUNTARY COMMITMENT "RESPONSIBLE CARE PROGRAM".

1989
NAME CHANGE FROM ISOPOR TO DOW AND COMPANY CONSOLIDATION.

1988
DOW ACQUIRES QUIMIGAL SHARES.

1985
THE DOW CHEMICAL ACQUIRES THE POLYMER PRODUCTS DIVISION FROM UPJOHN.

1982
THE PMDI PLANT STARTS ITS OPERATION.

1979
ISOPOR, 50/50 "JOINT VENTURE" UP JOHN/QUIMIGAL.

CQE COMPANIES SAFETY AND ENVIRONMENT PERFORMANCE

Safety

The PACOPAR chemical companies keep showing a good performance in terms of the safety of their employees, particularly last year, when practically all of the companies had no accidents. These indicators reveal that the companies maintain their focus on accident prevention, either through technological improvements implemented in the production process or through safety training and adopting safer work methods. The accident frequency index represents the number of accidents with medical leave that occurred in the last year, while the severity index reflects the number of working days missed per year, per every thousand working hours per person.

Environment

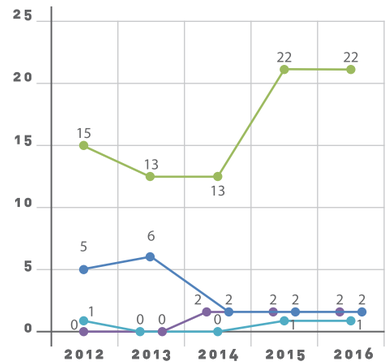
In general, the CQE has been maintaining a steady decrease for the last three years with regards to the indicators of pollutant emissions into the atmosphere, solid waste and consumption. There are cases in which we can observe some increases, which are related to specific periods or special contingencies in the production process. For example, the increase of solid waste may coincide with the occurrence of maintenance shutdowns in the plants, which leads to the cleaning and servicing of the equipment. These interventions are prone to peaks in the production of solid waste.

Since last year, the companies started publishing in the PACOPAR magazine the atmospheric pollutant emissions in a detailed way, specifying the figures of the different components emitted. It is assumed that the detailed publication of emissions of the various components discloses more complete and exact information to the public, and better reflects the reality of each company and the diversity of production processes in the CQE. Precisely because of the specifics each production process, there are indicators that are not applicable to all of plants and that fact is properly stated in each graphic. These indicators reflect the emission of several gas components, the power and water consumptions and the emission of solid residues, while relating these with the production quantity. To know more about all the indicators regarding the companies' performance, you can check them at www.pacopar.org.

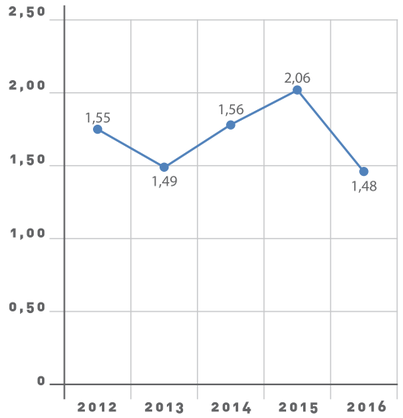
AIR LIQUIDE PERFORMANCE

ATMOSPHERIC POLLUTANT EMISSIONS

The indicators of sulphur dioxide and heavy metals are not applicable.

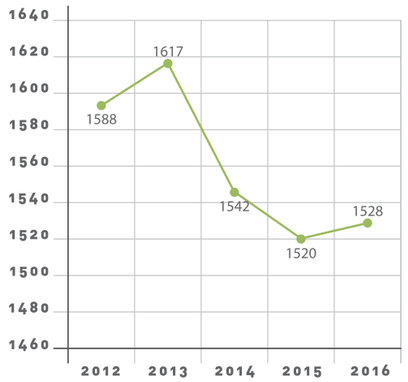


WATER CONSUMPTION

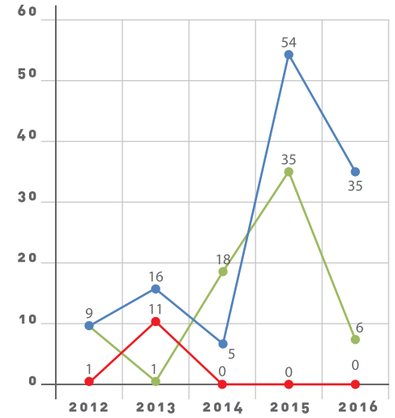


ENERGY CONSUMPTION

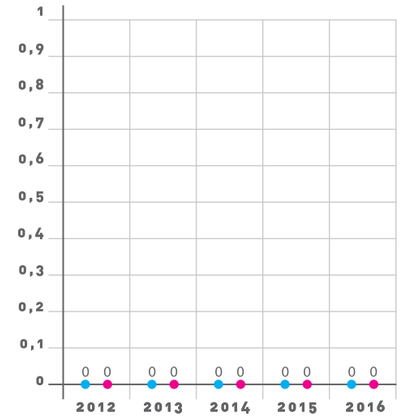
The raise in energy consumption is due to the load increase in the ASU (gases separation unit), which produces oxygen, nitrogen and argon and uses atmospheric air and energy (KWH) as raw materials.



SOLID WASTES



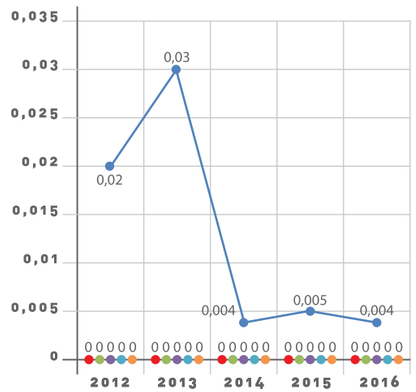
SAFETY



AQP PERFORMANCE

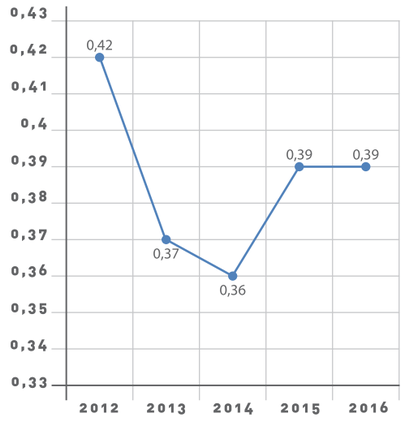
ATMOSPHERIC POLLUTANT EMISSIONS

The CO2 emissions indicator is not applicable



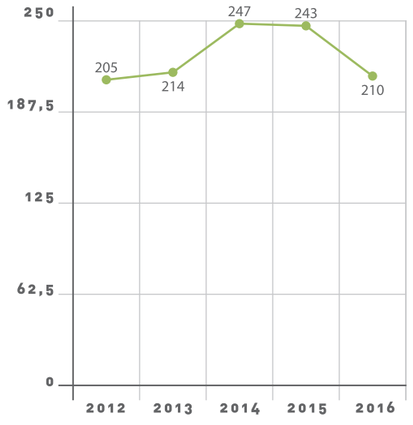
Particles t
Sulphur Dioxide t
Nitrogen Oxides (in NO2) t
Carbon Monoxide t
VOC t
Heavy metals (total) t

WATER CONSUMPTION



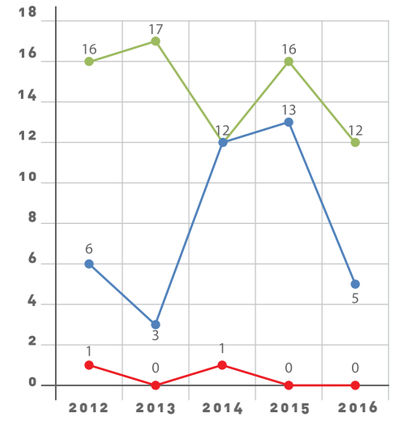
Water m3/production tons

ENERGY CONSUMPTION



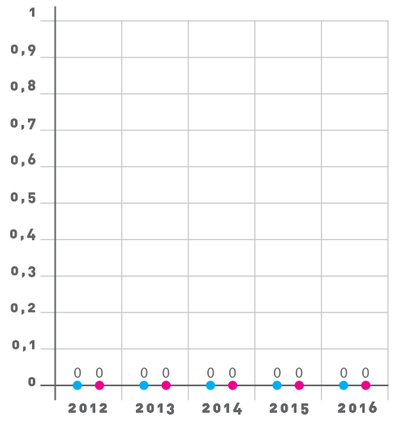
Energy Mj / production tons

SOLID WASTES



For recycling t
Hazardous waste for final disposal t
Common waste for final disposal t

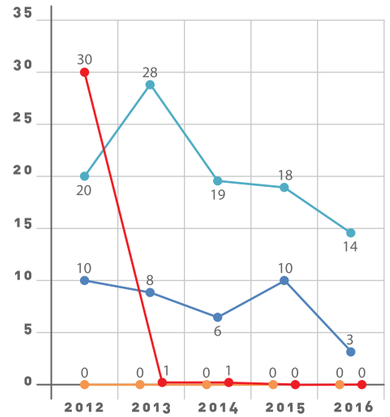
SAFETY



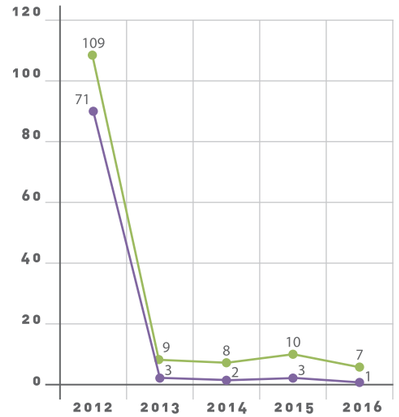
Accident frequency rate
Severity rate

CIRES PERFORMANCE

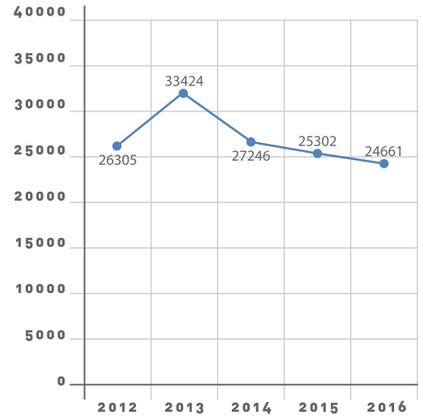
ATMOSPHERIC POLLUTANT EMISSIONS



- Particles t
- Sulphur Dioxide t
- VOC t
- Heavy metals (total) t

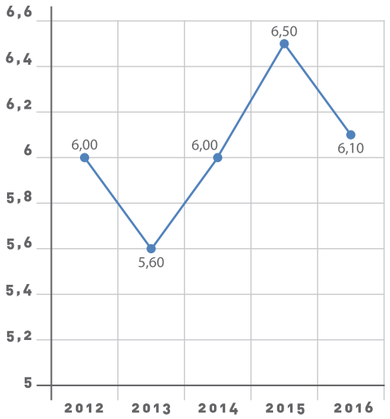


- Nitrogen Oxides (in NO2)
- Carbon Monoxide



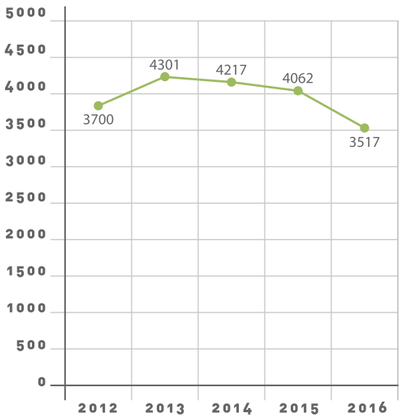
- CO2 Emissions - total energy consumption

WATER CONSUMPTION



- Water m3/production tons

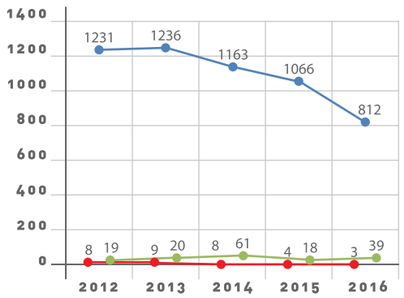
ENERGY CONSUMPTION



- Energy Mj / production tons

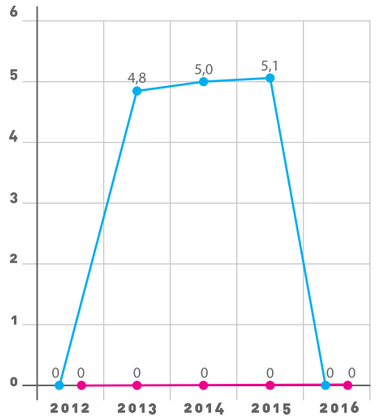
SOLID WASTES

In general, the amount of solid wastes produced by CIRES in 2016 register a slight decrease.
It's only detectable a slight increase of common waste for final disposal, which is due to an extraordinary cleaning made to the plant facilities during the maintenance shutdown.



- For recycling t
- Hazardous waste for final disposal t
- Common waste for final disposal t

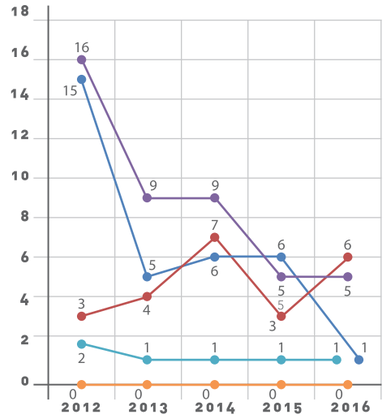
SAFETY



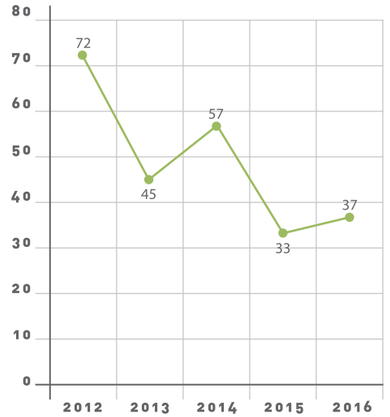
- Accident frequency rate
- Severity rate

CUF PERFORMANCE

ATMOSPHERIC POLLUTANT EMISSIONS

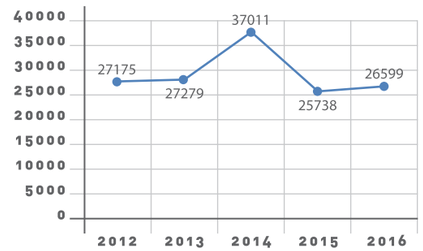


Particles t
Sulphur Dioxide t
Nitrogen Oxides (in NO2) t
Carbon Monoxide t
VOC t
Heavy metals (total) t



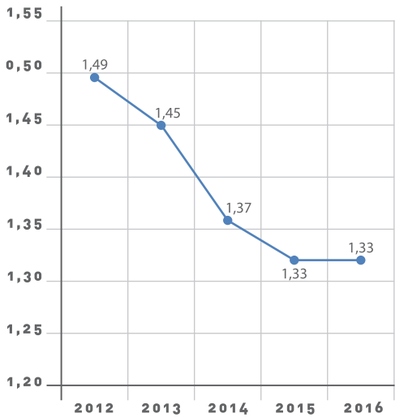
Nitrogen Oxides (in NO2)

The slight increase, about three percent, in CO2 emissions is justified by a slight release of this pollutant in the incineration of wastes, while the increase of NOx occurred in the combustion emissions, this is, for the production of vapor.



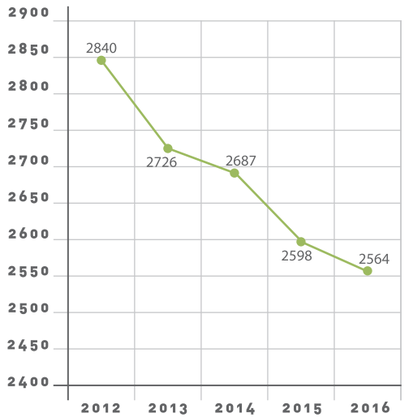
CO2 Emissions - total energy consumption

WATER CONSUMPTION



Water m3/production tons

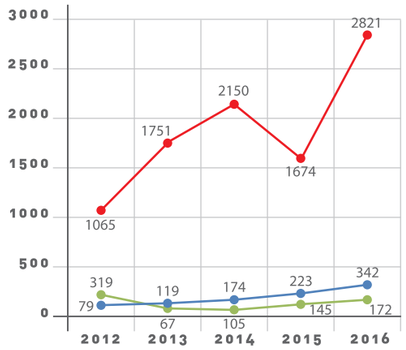
ENERGY CONSUMPTION



Energy Mj / production tons

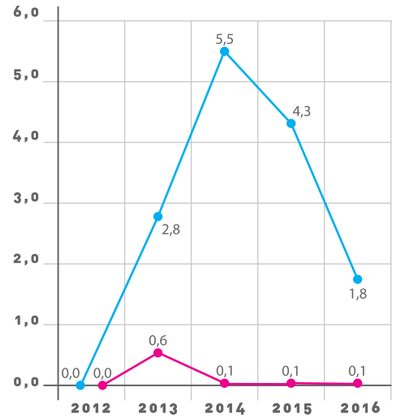
SOLID WASTES

In 2016, there was a general shutdown in CUF-QI, which originated a general increase in solid wastes, given the need for equipments cleaning, to allow the execution of inspections and other maintenance works.



For recycling t
Hazardous waste for final disposal t
Common waste for final disposal t

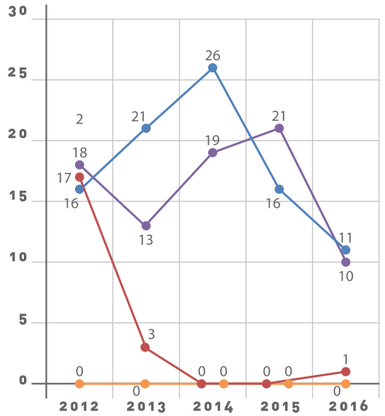
SAFETY

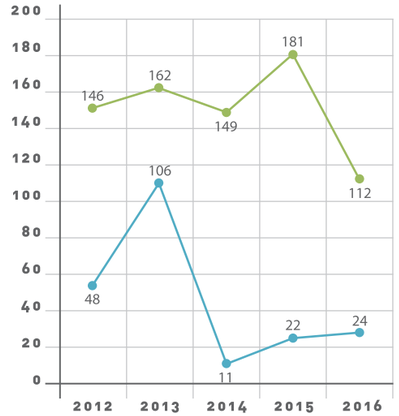


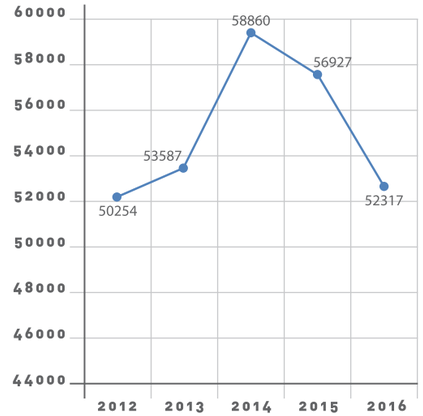
Accident frequency rate
Severity rate

DOW PERFORMANCE

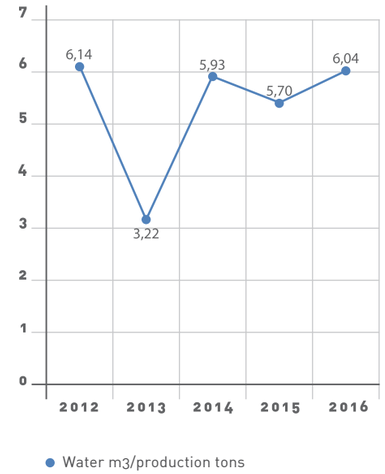
ATMOSPHERIC POLLUTANT EMISSIONS





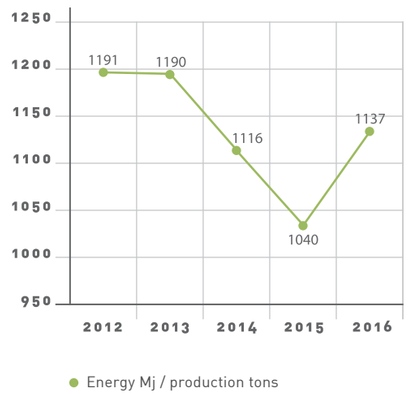


WATER CONSUMPTION



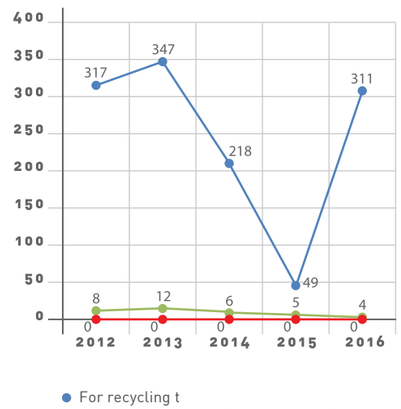
ENERGY CONSUMPTION

The consumption value presented in this energy graphic is specific consumption, this is, energy unity by ton. In this case, in 2015, we produced more than in 2016 (a shutdown year) and so the specific energy consumption is higher if we produce less.

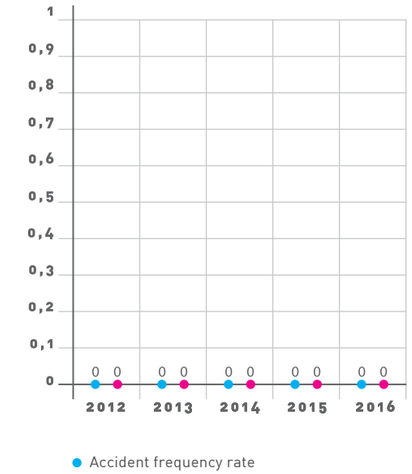


SOLID WASTES

2016 was a shutdown year and we produce more waste when we execute shutdown activities in the plant, for example, generating scrap, which has a big impact in the final figures (a big weight).



SAFETY



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TREKKING BIORIA