In the south of the Netherlands lies Chemelot, a massive industrial chemical site which sprawls over 800 hectares and is home to more than 60 chemical plants. The meticulously managed site boasts a wealth of resources including a fire and safety department, two harbours, a campus and over 7000 staff working day and night. Sitech Services undertakes a range of services for a number of these plants, including maintenance and materials expertise. Stainless Steel World spoke to three of their resident experts: Dr. Carla Koopman, Technical Support Engineering Discipline Leader; Joëll Stassen, Manufacturing Services Maintenance Manager; and Peter Janssen, Senior Technical Support Engineering Corrosion & Materials.

Text by Joanne McIntyre, Photos © Sitech

One of the largest industrial chemical sites in Europe, Chemelot is home to sixty chemical plants, while the land is the property of DSM (see box ‘A brief history…’). Sitech provides both site services to all companies on the Chemelot site (e.g. fire brigade, security, infrastructure services) and manufacturing services like technical support, engineering and maintenance to a number of the chemical companies operating at Chemelot. Their large group of experts work as fully integrated staff members for the chemical companies, moving from plant to plant as required. Having been involved in maintenance and upgrading activities on site for over fifty years the team has a wealth of technical knowledge and experience to draw on. While some companies may
choose to employ their own individual experts, the advantages of using Sitech are significant. Firstly, the Sitech team encompasses every discipline required to maintain large-scale industrial chemical plants, covering a range of expertise few companies can afford to employ full time. Highly specialized experts in disciplines ranging from corrosion to materials science are available within the ‘pool’, which is on-hand 24/7. The historical connection is invaluable when it comes to problem solving; the team knows the plants intimately and is familiar with the processes and any past issues which have occurred.

**On-site expertise**
Carla Koopman is Discipline Leader in charge of Sitech’s Technical Support Engineering for the mechanical group. Experts within the group focus on a range of fields; materials & corrosion, static equipment, rotating equipment, and civil engineering. As one of the site’s Maintenance Managers, Joëll Stassen runs one of the maintenance shops and should he encounter a problem which his engineers can’t solve, he calls on the Technical Support Engineer group for assistance. Joëll: “The maintenance group includes technicians, maintenance planners, asset engineers and reliability engineers. They carry out the day to day maintenance in many of the plants here. Our group also carries out new projects, turn arounds, inspections, gives advice over the lifetime of the plants, undertakes NDT, etc. Some of the team members are dedicated to single plants that require experts familiar with the complex chemical processes taking place inside.”

With so many different chemical plants and processes on site (see box ‘A brief history of Chemelot’), the technical support group Corrosion and Materials also has specific expertise eg. chemical cleaning, water treatment, coatings, welding, NDT and corrosion in all kinds of plastics in-house.

“Currently Sitech employs 760 people, plus 100-150 flexi-workers who we can call on for specific projects. The maintenance department numbers around 380 people, with 60 - 70 technical support engineers/experts. Over the decades we’ve built up a thorough understanding of the problems which may be encountered in our chemical plants and how to solve any

![The huge Chemelot industrial chemical site, located in the south of the Netherlands, sprawls over 800 hectares and boasts more than 60 chemical plants.](image)

*(L to R): Peter Janssen, Joëll Stassen, and Dr. Carla Koopman from Sitech services.*
A brief history of Chemelot
Chemelot (formerly known as DSM) is made up of two parts: the Chemelot Industrial Park and Brightlands Chemelot Campus, with the total site area covering 800 hectares. Located in Geleen, near the city of Maastricht in the Netherlands, the first coke plant was opened on the premises of the Dutch State Mines (DSM) in 1929 followed by plants for fertilizer, ethanol and phthalic anhydride. After WWII plants for the production of raw materials for plastics, resins, and synthetic fibers were added. From the 1970s the emphasis gradually shifted to fine chemicals (food ingredients, pharmaceuticals and agrochemicals). In 2002, DSM sold all petrochemical activities – roughly half of the site - to the Saudi Arabian company SABIC. DSM remains the owner of the land but today many of the chemical plants are independently owned. Major users of Chemelot Industrial Park include Royal DSM, SABIC Europe, EdeA, Borealis, Carbolim, Polyscope Polymers, IENOS ChlorVins, LANXESS, LVM, Nano Specials, Cymaco, OCI Nitrogen, Basic Pharma and Intetek. The Japanese Sekisui S-lec and the Indian Techno Force Solutions recently joined the site.

Plants on site produce naphtha (crackers), polymerization, ammonia, nitric acid, fertilizer, melamine, caprolactam, acrylonitrile and there is also a factory for performance plastics. LANXESS is a synthetic rubber factory and Sekisui S-Lec a resin factory.

Research into bio-materials is carried out at the Chemelot Campus by Maastricht University, Aachen University and the Technical University of Eindhoven, in collaboration with companies such as SABIC, DSM and LANXESS.

Plant Integrity Database
Much of the critical expertise so essential to the safe and efficient running of the industrial chemical plants on site lies with the Sitech team rather than the chemical companies themselves, explains Peter, who is Senior Technical Support Engineer. “We have over 50 years of experience in maintaining and upgrading these plants. All of this operational history and information is stored in a Plant Integrity Database. This is essentially based on an inspection program and includes all the materials, media and failure mechanisms for every plant. The entire lifetime history of each plant is easily available and searchable. Even failure analyses undertaken by external experts are stored in the Database because any external expertise must be hired through our organization. It’s a great system that stores every piece of data ever obtained, for the entire life time of the plants.”

Corrosion resistant alloys essential
“The most corrosive media on site are acids, such as nitric and sulphuric acid,” explains Peter. “There are several ammonia plants here at Chemelot and high temperature problems can be an issue for these. In the plant producing acrylonitrile (a feedstock for acryl fibers) we used to encounter cyanide stress corrosion cracking, which prompted the asset owner to change from carbon steel to stainless steel. The urea/melamine plants also present a very corrosive environment operating under high temperatures and high pressures. The process of making melamine from urea produces carbamate which can result in ammonium carbamate corrosion and the production of urea itself also produces carbamate.”

“Carbamate is extremely corrosive and necessitates the use of a lot of corrosion resistant alloys such as high austenitic steel X2CrNiMoN25 22 2, duplex X2CrNiMoN22 8 3 and Safurex”, which is a super duplex, (see box ‘The invention of Safurex”). In the melamine plant corrosion resistant materials like duplex nickel alloys, titanium and zirconium are also used. So essentially all the plants here use corrosion resistant alloys.”

Corrosion under insulation (CUI) is a big issue for the chemical industry. A recent example is the discovery of chloride stress corrosion cracking of stainless steels in one of the plants, normally not an issue on the Chemelot location. “The cause was traced back 25 years to a fire training session during which cooling water was sprayed on the equipment and in the insulation, explains Peter. “The water concentrated under the insulation and 25 years later we had to replace two large pieces of equipment due to the resulting chloride stress corrosion cracking.”

The Sitech team’s involvement with a chemical plant at Chemelot begins from the moment the plant is planned, at which stage they provide advice on material selection. “For instance a new ammonium sulphate plant recently opened on site,” explains Carla, “and we were able to draw on

Photos L to R show increasing detail of stress corrosion cracking in a 3m diameter gasket seating block manufactured from Grade 5 Titanium with a wall thickness of 50mm. Grease contaminated with fluorides was found to be the culprit.
our experience with the old plant which had experienced a lot of corrosion problems. Sulphate had entered the concrete and caused severe corrosion in the steel reinforcing. For the new plant we were involved in the material selection process and recommended alternative CRAs resistant to atmospheric corrosion and thus remove the need for coatings."

“Some plants at Chemelot now use large amounts of duplex,” explains Peter, “particularly for urea or melamine and nitric acid applications. For a sulphuric acid plant we would specify a material such as Sandvik SX (UNS S32615) which is a high silicon containing austenitic stainless steel developed exclusively for use in concentrated sulphuric acid. For some applications we’re also switching from metals to plastics.”

Aging plants & obsolescence
A large part of the Sitech team’s work involves managing the aging plants on site and advising on lifetime extensions. Joëll explains: “Life time extension programs normally fall within the scope of our reliability engineers. Corrosion is just one part of this process because we also need to consider rotating equipment and the valves and controls involved. We’ve had a great contribution to a book that is published by the Dutch Institute World Class Maintenance which is a reference model for the lifetime extension of technical assets.”

“Later this year we will start a lifetime extension of an ammonia plant utilizing expertise from across our technical support engineering group and experts from a wide range of disciplines. The main focus will be on material and corrosion although the civil and rotating engineering department will also have an important task to fulfil. The amount of work involved in a project depends on each individual plant. Extensions are always very time consuming because every piece of equipment and length of pipeline must be examined, the remaining lifetime determined and a replacement horizon identified.”

With over 60 chemical plants operating on the Chemelot site, obsolescence of equipment is an important issue. “It’s something we deal with on a daily basis,” explains Joëll. “The last lifetime extension I was involved in was for the Borealis plant, where 20-30% of the total equipment was obsolete. Obsolescence can affect rotating equipment such as pumps or valves, as well as control or safety systems. If a manufacturer can no longer service equipment we evaluate the risk and plan what actions need to be taken. The greatest risk

The invention of Safurex®
At the beginning of the 1990s Chemelot’s founding company DSM worked together with Sandvik Materials Technology and urea manufacturer Stamicarbon to invent Safurex®, a high-performance duplex stainless steel. In 1997 Safurex was applied in a high-pressure stripper at a DSM urea plant. Gradually its use spread to other Stamicarbon urea equipment and in 2002 it became standard in the synthesis process. Safurex® is now a standard material for Stamicarbon urea plants and has effectively replaced X2CrNiMoN 25 22 2. It eliminates all known active forms of corrosion that occur in the urea plant. For high-pressure urea applications it outperforms alternative and expensive metals like titanium and zirconium.
is that we can no longer maintain the equipment which means it must be replaced. As an example there are some pumps on site which were manufactured in-house many years ago when this was still a 100% DSM owned location. Nobody can make these anymore!"

“The aging of standards can also be an issue,” adds Peter. “We have our own DSM standards which were developed many years ago. The older plants on site were built according to these standards so installing new equipment now is difficult. All of the paperwork needs to be updated and sometimes the materials used need to be changed, so compatibility with new standards is an issue. Introducing a new material into existing equipment can lead to corrosion if two materials are incompatible. These are all risks that need to be assessed before any changes are implemented. Furthermore, depending on the high pressure equipment used in a plant we may need to get government approval to make changes, for safety reasons.”

Contamination = corrosion

With so many chemical processes on location, some material failures are to be expected. “A particularly noteworthy case occurred within one month of a new melamine plant starting up,” explains Peter. “We were called in to investigate leakage in the gasket seating block, which was manufactured from Grade 5 Titanium. The gasket measured 3 meters in diameter with a thickness of 50mm. We knew from experience that the process conditions alone shouldn’t have been corrosive, yet stress corrosion cracking had occurred. From a materials point of view it was an intriguing case to investigate! Identifying the problem was difficult because the corrosion didn’t make sense from a process point of view. After three months, tests on a deposit found on the gasket seating lock allowed us to identify that grease applied by the manufacturer to the gasket seating had caused the failure. The grease contained fluorides which, at high temperature, cause stress corrosion cracking in titanium within a matter of hours: in this instance it was progressing at a speed of several millimetres per day. When the gaskets were being fitted on the flange a technician grabbed some grease to ease the pieces together; through simple lack of knowledge the wrong type of grease was used. The failure led to the plant being shut down for the duration of the investigation and until this critical piece could be replaced.”

“Educating people on how to handle CRAs is an ongoing task,” explains Peter. “For instance we have to tell contractors not to use glues containing chlorides which will cause stress corrosion cracking on stainless steel. We do provide training but it’s still a recurrent problem. An example of this is stickers applied to stainless steel pipes: if the glue contains chlorides corrosion will occur under the stickers at high temperatures. It seems obvious but people often don’t realize that they can introduce failure mechanisms through simple mistakes. Another example is the use of marker pens containing chlorides which are used to write numbers on piping. After ten years or so we see cracks appearing. So while you may expect the chemical process to cause the corrosion issues, sometimes it’s actually external factors such as human error.”

Availability & quality issues

The Sitech team reveal that while they would like to use more exotic CRAs, availability can be an issue. Joëll explains: “Large equipment is not a problem, but small amounts of piping are sometimes difficult to obtain in the right material because the manufacturers only want to sell large batches. Peter adds: “One material which is difficult to source is 304L (material code 1.4306) which must be ‘Huey tested’ in accordance with ASTM A262 practice C or ISO 3651/1 (boiling 5 x 48 hours in concentrated nitric acid to calculate the corrosion
It’s very difficult to obtain the right corrosion rates and, while higher austenitic materials could replace it, they are also hard to source.” Lead times also present a challenge for the team. “Delivery times have worsened: it’s not uncommon to wait 9-12 months for small volume orders. The problem is a combination of low demand and the small amount we want. Sometimes we’re forced to use a less corrosion resistant material with a greater wall thickness and inspect it after 2 years instead of 4 years. Although we work with preferred manufacturers when necessary we have to search for anyone who can supply certain materials. In our experience manufacturers can only deliver special metals when they receive enough orders to produce an entire batch, which can take a long time.”

“Having the wrong material delivered seems to be a worsening problem as well,” continues Joëll. “We have to carry out more controls on incoming material and we’ve seen a drop in quality across the board. If the wrong material is delivered and installed it could lead to a serious accident. We’ve had instances where the material and the documentation delivered don’t match.” Peter adds: “The trend to use increasing amounts of scrap in the production of CRAs can also present a serious issue. This results in varying rates of minor contaminants, such as sulphur, in the materials which in some of our chemical processes can cause serious corrosion complications. In one of our plants we can’t use materials containing any level of molybdenum, so we specify 304L. However almost all the materials delivered now contain it, and even at very low concentrations such as 0.3% molybdenum causes poisoning of catalyst.”

**About Sitech**

Sitech provides two main kinds of services: park site services and manufacturing services. The Chemelot park site services include the fire brigade, medical care, security, infrastructure services, waste water treatment plant, and are delivered to all businesses on the Chemelot site. Sitech also provides manufacturing services to nine of the plant unit businesses within the Chemelot Industrial Park. Sitech operates fully independently as a cost centre – it has no profit target – to optimize the plants it works for. It operates 7 different maintenance shops and offers synergies and cost efficiency by supporting plants with shared expertise and knowledge 24/7. The Sitech team includes experts in a wide range of materials disciplines with over fifty years of experience in the maintenance and operation of chemical plants.