Bilfinger Tebodin

Car tires as a valuable raw material and energy source

Thermal demanufacturing transforms car tires into carbon, flue gas, oil, and steel. This will not only help the cement industry, but will also result in countless other applications. PRTI is bringing this technology to Europe. Bilfinger Tebodin assisted the company in adapting the technology to the high European norms and standards.

The tire market is almost literally dying from rejected or discarded product. One part was shredded into granulate and used on sports fields, until it was recently discovered that this might pose a threat to public health. The rubber tires had also been used on a large scale as fuel for the cement industry. Other disposal alternatives include burying the tires, burning them, or illegally dumping them at sea. In short, the way in which they are used now is far from sustainable.

As a result, a Dutch investment company decided to collaborate with the American company PRTI. The objective was to use PRTI's thermal decomposition technology to offer the cement industry an energy-efficient alternative. However, this is not restricted to cement, because other industries can also benefit from the raw materials.
For example, the oil can be used as ship fuel, the flue gas can be used as a source for electricity production, and the carbon is usable for batteries in electric cars.

Italian patent

Kees Onstein, CEO of PRTI Europe, describes the technique of thermal demanufacturing as a "black box", but one that turns car tires back into a number of valuable raw materials and fuels very efficiently. The United States has a car tire issue that is similar to Europe's," says Onstein. There is a surplus of used car tires and rejects from the tire industry. Unfortunately, it is not possible to make new tires out of these old ones, so the only thing left to do is burn them or shred them into granulate. Burning tires not only releases a lot of CO_2, but also many toxic substances such as heavy metals. Shredding requires a lot of energy, especially since the machines also have to cut the very strong steel in the tires. An additional problem is that there has to be a market for the granulate. Since the use of rubber granulate on artificial turf pitches has been halted due to possible carcinogenic properties, its price has fallen to a very low level."

The founders of PRTI searched for alternatives with fewer disadvantages and obtained an Italian patent. Onstein: "Pyrolysis would be an obvious technology for turning tires back into energy and raw materials. In practice, however, it appears that the tar deposits in particular are so large that the uptime of a reactor remains limited to 60%.
The search was better defined as one for a technology with high uptime, low emissions, and substantial benefits. It turned out that an Italian professor had already invented something in the 1980s that met these conditions."

The technology proved to be the best possible solution for the cement industry.
Onstein made an offer to one of the largest German cement manufacturers to build an installation on the site next to the factory. After it was announced that PRTI had plans in Europe, Bilfinger Tebodin travelled to PRTI's plant in Franklington, North Carolina, to take a closer look at the "black box" and the related environmental, health, and safety issues.

Validation and authorization process

The challenge was to validate the entire process. In a number of respects, American legislation is much more flexible than European legislation. The investors also wanted to make sure that the process really worked as PRTI said it did.

Kees Onstein:
"The reactors are now fully operational and have already processed more than two million kilos of tires."

Bart Luger:
"If you know how chemical and energy flows operate, you also know where the potential dangers are."

Investors called in Bilfinger Tebodin for this validation and the licensing process. "A process in which oxygen, fuel, and an ignition source come together in an uncontrolled manner is very risky," says Bart Luger, senior consultant of Process Integrity & Safety. Considering the process as a "black box" is therefore not acceptable in the world of process safety. It is essential to monitor and control the process and environmental variables in such a way that the risks become manageable."

The degree of risk is determined by the combination of the probability that a scenario can occur and the effect that it can have. Luger: "The effect of the uncontrolled ignition of highly flammable gases in a reactor has a high risk estimate. Fortunately, we were able to reduce the likelihood of such an incident actually taking place, thanks to an adapted design of the installation and the choice of process control systems."

Modifications

There are several risks that must be mentioned. In addition to safety requirements, the legislator also places restrictions on emissions into air or soil, also known as loss of primary containment. Luger: "We are dealing with European, German, and local legislation and the more you can take account of the legal requirements starting from the design stage, the simpler and cheaper the licensing process will be. In order to bring the design of the installation in line with environmental, safety, and occupational health and safety standards, the necessary modifications were implemented during various phases of the re-engineering process."

For example, flameless oxidation provides a unique opportunity to use the low-grade gas for the production of steam and electricity. "Electricity can be generated in this way, but you can also opt for heat instead. The cement factory where the system will be installed will supply heat to the local heating network. However, since the construction world is stagnant in winter, no cement will be made either. During these two months, the installation can supply the heat according to contract. An additional advantage of the flameless technique is that the temperatures are below the range in which nitrogen oxides are formed. This will prevent air pollution caused by flue gas emissions. Not to mention that, since the hydrocarbons contained in the gas are completely burned into CO_2, we are also reducing CO_2 emissions."

Using a hazard and operability study, the experts from the various disciplines expose the potential risks and make inherently safe design choices. At the same time, we continuously monitor the effect of the choices made for overall equipment efficiency (OEE, editor's note). This is called "OEE backcasting" and can save companies a lot of money, especially in the operational phase."

Unpredictable

The advantage of Bilfinger Tebodin's German parent company, Bilfinger, is that it is already familiar with German legislation and regulations. In order to increase throughput speed and accuracy, all disciplines work together from the outset, i.e. both the process and mechanical specialists as well as the electronics and instrumentation.
The compliance expert keeps an eye on things so that Bilfinger Tebodin can be sure that they do not need to make any modifications afterwards.

"Safety starts with insight into physical processes," says Luger. For example, this means that the mass balance must be in order. To put it simply, what goes in will somehow come back out again, as a product, as a by-product, or in the form of energy. If you know how chemical and energy flows operate, you also know where the potential dangers are. In the case of thermal demanufacturing, the process that took place in the "black box" was initially unpredictable. The installation of a control circuit in the reactor makes it possible to control safety-critical parameters such as temperature and oxygen level. By doing this, we tackle all phases of the process: first, we try to design the processes as safely as possible and, when this is no longer possible in the design, we take additional measures to restrict the consequences of any incidents to an acceptable level."

Five more sites

Once the designs have been approved, Bilfinger will also be able to take care of the EPCM portion if required. "We can provide an active plant with trained staff as well as a safety plan linked to asset management," explains Luger. "For example, this ensures that an overpressure valve is reliable and that it actually performs its function when required. The cement manufacturer has expressed its intention to equip another five sites with a thermal demanufacturing system. We also want to be sure that they can be operated safely, reliably, and efficiently."