ALL ABOUT TIRE RECYCLING

Dmitriy Yankovoy, Lev Bederov, Konstantin Ladygin, Semyon Stompel, Safe Technologies Inc.

Modern civilization is not able to exist without rubber goods, and only waste rubber, in particular tyres, we seem to be iniquity. Meanwhile, they can also be very useful to humanity as a source of energy.

When the Spanish conquistadors brought rubber to Europe, they did not know, as usual, all the consequences of its findings. Indeed, the first sample of rubber, sent to Europe in 1736, did not cause more noise and was shown upon as a curiosity, a thing that can erase the signs.

However, since then many years have passed, and humanity fully appreciated the benefits of rubber products. It can hardly be called an industry or simply human activity where rubber products were not used. Among them absorbers of various kinds, the sealing gasket and automobile tires, the production of which occupies more than 50% of the total world production of industrial rubber goods.

The reverse side of the mass use of rubber goods is avalanche growth of waste. According to the Discovery research group, the amount of used tires collected in the world is 60-80 million tons, and this figure is growing by 10 million tons each year. The global average processing of waste tires reaches a quarter of the total. This fact leaves a wide scope for entrepreneurship activity in the field of recycling of industrial rubber goods, as neither rubber goods nor the tires should not have been landfilled.

The tire laid in a landfill (often bypassing environmental laws), is decomposed in a natural way more than 100 years. Contact of the tire with water (rainfall) leads to leaching of toxic organic compounds (diphenylamine, dibutylphthalate, phenanthrene and etc.) into the soil. Tires landfills literally add the heat of fires, which are so common in hot weather. It is not easy to extinguish such fires as the calorific value of the tire exceeds a solid fuel boiler. For example, in 1983 during the fire at landfill in Rinehart, Virginia, contained 7 million tires, a cloud of smoke rose to a kilometer in height and spread over 80.5 km in circumference. Rivers of molten toxic hydrocarbons, toxic smoke columns that contain arsenic and lead (along with hundreds of other dangerous contaminates spruce) poisoned the neighborhood for 9 months until the fire were not blown out. However, ten years later, some tire dump in the United States accumulated 700-800 million of used tires.

Similar quite apocalyptic pictures prompted humanity to find a solution to the problem of disposing of used rubber goods. A special commission of the EU already in 2010 made recommendations on the development of methods of disposal for bringing rubber goods storage in landfills to 0%.

There are two basic ways of rubber treatment: mechanical and thermal. Thus, mechanical methods may include heating or cooling, but the temperature change in this case has an auxiliary character, as the purpose of mechanical processes is rubber crumb or the product that does not differ dramatically from the feedstock in chemical properties.

The aim of thermal treatment technologies is the use of energy potential of rubber. By the standards of the US one tire is equivalent to 7 gallons of oil.

Mechanical methods of rubber processing into crumb are quite promising. They provide the product, which is widely demanded in the market, practically without any additional treatment. Rubber crumb is obtained in the processing can be used as roofing material, in road construction, in the manufacture of shoes, automobile floor mats, and other rubber goods.

However, electromechanical method has several disadvantages, the first of which is energy consumption. 1 m for grinding tires requires from 500 to 900 kW of power. Furthermore, the coefficient of net operating time is small, no more than 50-60% (in view of high equipment amortization). A quick breakdown of the cutting equipment and the replacement of expensive knives (as required hardness of tool steel), together with low productivity results in very high cost of crumb rubber.

There are other ways of grinding: the method of "ozone knife" (mechanical grinding after exposure of ozone, which is a powerful oxidant) barodestruction method (chips under pressure destructed to liquid state and separated from the cord), a method of rotary disperser (fragments of tire forced through a slot screw). These methods are also characterized by high-energy consumption; in addition, the first two provides a crumb with strongly altered properties, which is not in great demand. Cryogenic crushing methods more difficult and require additional hardware.

Thus, the interest in the rubber goods treatment increasingly focuses on the technology of thermal destruction or pyrolysis, releasing the energy potential of rubber.

Pyrolytic processing lines, as well as mechanical boast of variety. The cost also ranges from 20 thousand up to several million euros that is the price per turnkey European plants, including the complete set of process equipment, including even components of the catalytic cracking unit to improve the quality of the fuel. Even in the face of strong demand for tires treatment and strong demand for the products of pyrolysis return on such a plant within national conditions is questionable.

On the other end there are cheap batch units of domestic production and often semihandicraft finishing. They allow getting out of the tires the residue, proudly referred to as “carbon black”, and low-quality fuel oil, whose properties vary from batch to batch.

Such plant looks like a vertical crucible (or several), where tires are loaded. Each crucible is closed and secured with 20 bolts on the perimeter, and then rise by a crane and placed in the combustion chamber. After joining another nozzle by 6-8 bolts to the contour of the plant the operation is begin. All batch type pyrolytic equipment runs roughly along the same cycle: during heating in the absence or lack of oxygen rubber is separated on different fractions of hydrocarbons that evaporate and leave as a steam. The vapor condenses in the heat exchanger. Volatile hydrocarbons is used for the maintenance of operation. As they say, cheap and nasty.

Unfortunately, it happens more often nasty. Pyrolysis is unsafe process and does not allow the free circulation. Even a small amount of air leaked into the reactor inevitably leads to an explosion of varying strengths. That is why crucibles taken out after the reaction by the same crane should be cooled few hours before unloading and loading a new batch of raw material. The advantages of such a facility with removable crucibles include only a relatively small cost and isolation process from the environment, while at the other end of the scale is the risk to personnel health and safety, low productivity, large size installations, irrationally organized working cycle, and so on.

Because of the need for cooling of the reactor at the end of each cycle, the performance of these systems is low, and the increase in productivity will inevitably lead to increase in the size of the plant, and to the risk of air entering through the connections that are constantly subjected to assembling and dismantling. In addition, vertical reactor, plus the need to remove a crucible from it by a crane requires a building height of not less than 8-10 m. Therefore, saving on the cost of equipment is not always clearly lead to financial gain.

An alternative is to install a horizontal reactor. Continuous Thermal Decomposition Plant is as an example. The main difference from the mentioned installations is not only compact and standardized sizes (plant is assembled in 1-3 standard containers with 95% factory readiness), but also in a continuous operation, eliminating the need for several hours of cooling.

Screws, isolated from the environment, as well as the whole process at Thermal Decomposition Plant, carry out the feedstock loading to the reactor. Control system with sensors continuously polls the process parameters and prevents air from entering any of the processing units of the plant. Thermal Decomposition Plant is energy efficient (since the largest modification of the plant, brand name UTD with a capacity of 800 kg/h consumes only 25 kWh of electricity) and energy ‘mnivorous’ that it can run on diesel, pyrolysis gas and pyrolysis fuel.

Together with a manufacturer of microturbines the specialists of Safe Technologies developed an electric production unit which generates the electric power from pyrolysis gas or pyrolysis fuel derived from tires on the described plant. Thus, one ton of the tire yields approximately 200-250 kg of pyrolysis gas and 400 kg of fuel, which can be used for obtaining of two megawatts of electricity. However, in some cases, different flow sheet is preferred, for example, the use of an intermediate stage, steam generation.

Plenty of plant offering is presented on the market due to sharply rising interest to pyrolytic equipment as the next logical step after incineration. Not all companies offering miracles have the means even to the elementary study of their own products, relying on trusting client. ‘Oxidative pyrolysis’, ‘multi-stage pyrolysis’ being, on the one hand, the full technological terms, on the other is often just words, to cover the lack of experience with elemental pyrolysis process. Pyrolysis is much more complicated than the already familiar incineration, and, most importantly, has far greater risk to the health of personnel in the case of ‘not brought to mind' equipment.

At the same time, it is impossible not to recognize the existence of the general positive trend of avoiding mindless destruction of secondary resources, manifesting itself in particular in the event of such a variety of plants based on pyrolysis. In a world of constantly emerging developments in this area, the term TDF (tyre-derived fuel) has long been the official. Companies like Klean Industries, which account for more than 500 completed projects in the field of energy production from secondary resources, have come close to making nanomaterial, such as fullerenes, from used tires.

Therefore, in a complex international situation and the emergence of successful implementation of domestic developments in the field of secondary energy is could not be more timely.