SUSTAINABLE RECYCLING INDUSTRIES

Recovering Iron from used Tyres

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The Issue

Each year, some 1.5 billion used car and truck tyres are discarded globally.[1] While the general public might expect waste tyres to be treated responsibly and safely, this is not always the case. In many countries where there is no extended producer responsibility (EPR) supported waste management system (including the obligation to take back)[2] in place or access to required technology to properly recycle used tyres available, they are disposed of, dumped[3] in open yards, into the rivers or seas, next to the roadside, or much worse even-burned in an uncontrolled manner in the open.

What motivates unsavoury and unsafe burning practices is the fact that tyres contain metals, such as iron to meet the demands of the extremes of heat and cold environments, high speed, and abrasive road conditions[4]. Although tyres obviously are made up of rubber (both natural and synthetic) they also contain a surprising amount of steel.

Steel is used in tyres in steel belts and as such twisted or braided into strong cables that are embedded in the rubber to give tyres their strength. The burning allows (with limited efficiency) for the iron (Fe), steel's main component, to be recovered. The iron is then sold as an important source of income for workers subsisting from rudimentary forms of recycling "such as open burning" to recover some metals in an environment largely devoid of any safe or sound economic opportunities. Moreover, the burning of tyres at low uncontrolled temperatures creates harmful (toxic)emissions, mostly evident as black, thick, acrid smoke clouds that threaten both human health and the environment.

Understanding, quantifying and subsequently monitoring the environmental impact regarding air, water and soil pollution and on human health, i.e. respiratory problems or cancer caused by burning tyres in an unsafe and unsound manner can help decision-makers to develop the required legal and policy frameworks that ensure safe and sound iron recovery.

The Environmental Footprint of Burning Tyres

The methodology and dataset used to measure the environmental footprint of tyre burning was developed in partnership between the World Resources Forum's Sustainable Recycling Industries Programme (www.sustainable-recycling.org) and ecoinvent – the latter an organisation specialising in providing data for life cycle assessment studies (www.ecoinvent.org).[5]

The dataset developed represents the recovery process and focuses on iron (in the form of steel) obtained from the open burning of used tyres. The environmental footprint calculations are based on the composition of a typical passenger car tyre that contains 11.5% iron (Fe) as well as smaller quantities of zinc (Zn) and manganese (Mn).[6]

Harmful greenhouse gases namely carbon dioxide (CO_2) and methane gas (CH_4), as well as sulphur dioxide (SO_2) and nitrogen oxides (NOx), are produced from the burning process.

This uncontrolled thermal incineration process also produces multiple cancer-causing toxic gases, such as polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls) (PCBs), as well as particulates (<2.5 microns in size) as part of the residual ash. Particulates are tiny air-borne particles that when breathed in can trigger asthmatic attacks and damage the respiratory system.

Ecoinvent estimated that approximately 1.72 kg of CO2-equivalent are emitted per kg of tyres that are burned to recover about 0.1 kg of iron. This means that in order to obtain 1 kg of iron from burning tyres, 17.2 kg of CO2-eq is emitted. In terms of greenhouse gas emissions, this is equivalent to driving a typical passenger diesel car for about 56 km.

In addition to these harmful airborne emissions, the soil on which the burning and ash formation takes place is also contaminated from absorbing elements contained within the ash-including zinc (Zn), manganese (Mn), sulphur (S) and silicon (Si). Ash exposure to water (e.g. in form of rains) forms acidic leachates that further pollute any receiving soils or water ways.

What is Good Practice?

There are several treatment alternatives available to responsibly recycle tyres (and therefore greatly reduce the risk of any unwanted side effects regarding impacts such as greenhouse gas (GHG) emissions, soil/water contamination, human health issues) while providing optimal economic benefits.

First and foremost, tyres can be processed for recycling by mechanically shredding and grinding them to produce what is known as 'rubber crumb'. The rubber crumb can then be used for a variety of purposes including: flooring; football pitch surfaces; gravel substitute; rubber tiles for children's outdoor play areas; footwear; as a modifier in recycled asphalt pavement; and as an aggregate in Portland cement concrete. Some cement plants also recover the heat energy from burning used tyres in high temperature-controlled gas kilns (1000–1200 °C) by using tyres as a fuel replacement. Although the net environmental benefit of this last practice remains open to debate. In addition, through a process called pyrolysis, used tyres can be reprocessed into fuel gas, oils, solid residue (called 'char'), and low-grade carbon black. Pyrolysis also produces activated carbon, and after further oil-removal and ash-removal processing, it can produce commercial grade carbon black, which can be used to make colour master batch, colour paste, oil ink and as addictive in plastic and rubber products.[7] The steel that is recovered from the mechanical shredding and processing of the tyres can also be sold for use by car manufacturers and steel refineries.

Most importantly- by recycling tyres, the rubber and steel they contain are recovered as resources available for new production instead of getting lost in a landfill site. Furthermore, their use in recycling reduces the demand for natural and synthetic rubber, the mining of iron ore, as well as the related emissions and pollution impacts linked to primary resource extraction.

Measuring and actually reducing the environmental footprint caused by the open and uncontrolled burning of tyres (combined with understanding what good practice looks like), provides a number of potential benefits, in particular to reduce harmful emissions to the atmosphere and to protect workers' health. However, this will only happen if decision-makers act to enable, enforce and improve the legal and policy frameworks to ensure responsible tyre recycling. Improvements in the policy and operational spheres are needed and there is a role for ALL stakeholders in the tyre recycling chain that needs to be fulfilled -since even an

existing strong regulatory environment can only deliver benefits when there is collaboration between the public sector, private sector and civil society. [1][2][3][4][5][6][7]

[1] BBC http://www.bbc.com/autos/story/20140802-discarded-tires-tread-again
[2] ISO IWA 19:2017. Guidance Principles for the Sustainable Management of Secondary Metals
[3] Dumped and/or poorly stored tyres also contribute to the spread of diseases such as malaria, dengue, chikungunya and yellow fever that are transmitted by mosquitoes that breed in water that collects in discarded tyres.
[4] http://www.wrap.org.uk/sites/files/wrap/2%20-%20Composition%20of%20a%20Tyre%20-%20May%202006.pdf
[5] The dataset is publicly available on ecoinvent website www.ecoinvent.org
[6] Ecoinvent (2018). Working title: Life Cycle Inventories of Worst Practices in Secondary Metal Recovery. 16 pages
[7] https://www.linkedin.com/pulse/uses-carbon-black-we-got-from-tire-pyrolysis-jack-hao