resources, and improving quality and efficiency (Tseng et al., 2019; Romero-Gázquez and Bueno-Delgado, 2018). Industry 4.0 opens the possibility of mass customization, by the flexibility introduced in the production process, so companies can produce individualized products with reduced lead-time to market (Zhong et al., 2017; Hermann et al. 2015). The aim of this study is to broaden the discussion about Industry 4.0 beyond the technical approach that has dominated the academic literature, to present some opportunities Industry 4.0 has to improve customer life in a sustainable way, and to expand the discussion that sustainability should be considered more strategic in Industry 4.0.

The research was based on literature review to find in the academic documents, studies involving Industry 4.0, sustainability and customers. The search at Scopus and Web of Science database in Jan. and Feb. 2019, presented that 64% of the total number of the documents in Scopus and 59% in Web of Science database, were technical studies that dominate the academic literature. Using Scopus database, once again, in Jan. and Feb. 2019, we initially selected 216 documents that were used in this research.

To present some opportunities Industry 4.0 has to improve customer life in a sustainable way, we highlighted the Consumer in the analyses of sustainability. It is expected that by the high level of automation, the quality of processes and products can be improved (Tseng et al., 2019; Romero-Gázquez and Bueno- Delgado, 2018), reducing to a minimum the number of defective products. More efficient production processes means that water, energy and raw materials will be used in a rational scale and in an efficient way, reducing waste. By the other side, the quantity of energy to keep the companies running under the concepts of Industry 4.0 will be higher than other companies that do not have this degree of interconnection, but it is hoped that it will be compensate by a more rational use of energy in production. Circular or "closed-loop economy" can gain with Industry 4.0 technologies (Wagner, 2016). The smart products, the information provided in the QR code fixed on the products, or the sites of the companies, can provide valuable information on proper disassembly and recycling of the materials, assisting the progress of circular economy.

By the degree of importance that the circular economy gains with the scarcity of raw materials on one side and with the increase of the world population, or consumers on the other side, the sustainable development and sustainability are crucial to Industry 4.0.

With automation and IT, fewer people will be needed to work in the companies. New skills will be required; some professions will disappear, occurring functional unemployment, which happens when a person loses his job because he does not know a new technology or because he does not have the knowledge to perform a new function now required for his former job. It is important to train the team, or keep them trained; they already have the values and culture of the company, and will have lived the digital transformation of the company, potentially able to perform their new jobs in less time than new hired workers.

Companies shall focus on creating value for the consumer, and to be in closer contact with them. Consumers are each time more conscious, exchanging the experience of shopping with other consumers, facilitated by the social networks. The supply chain also should keep and enhance a more conscious and sustainable consumption standards (Wagner, 2016). To harness the full potential of interconnectivity provided by Industry 4.0, it is essential that the supply chain can adopt friendly technologies. The companies should consider developing the place where they are established, from an urban and economic perspective (Wagner, 2016), and also cultural, social and sustainable way. Companies that are concerned with local, regional or even global development tend to be respected by the consumers that see them with admiration.

Today customers demand personalized, ecological and non-expensive products, punctually at their doors (Gružauskas, Baskutis, Navickas, 2018). Customer satisfaction is fundamental factor for a successful business, so companies need to focus on the customer and follow consumer change (Bär, Herbert-Hansen, Khalid, 2018). The new technologies that make possible the digitalization of the production processes, Industry 4.0, and the smart products fruit of IoT provide new opportunities to the consumers, reducing waste and losses, in a sustainable way.

Although technical studies are dominating the research on Industry 4.0, and the significant problems with Industry 4.0, there are also opportunities to improve customer life in a sustainable way. Consumers habits are changing, they are more conscious about having more sustainable consumption patterns, so it is essential that sustainability should be considered more strategic in Industry 4.0, or these high-technological companies will not have anyone to sell their products.

Industry 4.0 brings social problems, such as unemployment perspective. Here we suggested some forms companies could have to help to overcome this negative perspective, such as provide training for team and non-team members, embracing social causes, where unemployed people could work, help local / regional / global development and others. We recognize that such an important subject should be treated in more depth, a limitation of this study, so we suggest for future research works to focus on this subject.

Keywords

Industry 4.0, sustainability, consumer, lifestyle, behavior

Column Leaching Test for the Evaluation of Immobilization of Toxic Elements in Modified Coal Fly Ash

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Abstract

Fly ash is produced in huge amounts by coal combustion process for power production. In Brazil, coal ash wastes are dumped in order to minimize their disposal and monitoring costs (UFRGS, 2000), which may, somehow, not avoid contamination on sites where they are deposited. In addition, storage of coal ashes in sedimentation ponds occupies large land areas, which could be used for other purposes, such as agriculture. Moreover, this type of disposal can generate various and serious environmental problems in the future.

Therefore, studies of leaching and stabilization of coal combustion by-products are necessary in order to avoid the contamination in soil, surface water, groundwater and, vegetation. It is well-known that this residue has high levels of trace dangerous elements such as As, Cr, Mo, Ni, Se, and others (Bhattacharyya, 2010; Depoi et al., 2008). Those elements tend to concentrate mainly on the fly ashes in smaller particle size (Izidoro et al., 2017). Some immobilizing agents have been used to prevent the leaching of the toxic elements in coal ash, for example, surfactants, iron sulfate and iron chloride III (Meng et al., 2000; Daniels et al., 2009; Bhattacharyya, 2010). In addition, Daniels et al. (2009b) reported that inorganic compounds, organic substrates (such as synthetic polymers), biochemical compounds (as biofilms) can also be used to immobilize trace elements from ashes.

Recent studies have shown that silicon-containing organic compounds (organosilanes) can be mixed with coal ash to form a nanocomposite with a hydrophobic surface, which can reduce the hydraulic conductivity of the ash and thus, alleviate the leaching capacity of toxic elements (Daniels et al., 2009; Daniels et al., 2009b).

Surfactants, similarly, can also modify the surface of the ashes, making it as a hydrophobic material to prevent the contact of its surface with the aqueous medium (Banerjee et al., 2006; Banerjee et al., 2006b).

The aim of the present work was to study the immobilization of the main toxic elements presented in coal fly ash by treatment ashes with immobilizing agents to reduce the possibility of environmental impacts of coal ash disposal. Laboratory leaching tests as column percolation tests were performed using fly ash modified with organosilane (OS) and quaternary ammonium surfactant (SF). A sample of coal fly ash from baghouse filter was collected at the Figueira coal-fired power plant located in ParanáState, Brazil. The quaternary ammonium salt, hexadecyltrimethylammonium bromide (HDTMA-Br, $CH_3(CH_2)_{15}N+(CH_3)_3Br$-; M.W. = 364,45 g mol-1) and organosilane ethoxytrimethylsilane (ETMS, $C_5H_{14}OSi$; M.W. = 118,25 g mol-1) were used for ash modification. Tests were carried out in triplicates with columns containing coal ash and soil collected in the Figueira Thermoelectric Power Plant region. The columns were filled with an upper and bottom layer of soil and a central layer of fly ash (untreated fly ash, OS treated fly ash or SF treated fly ash). The columns were percolated with synthetic acid rain simulating the precipitation that occurs in the region. Once per week, the percolate was added to the top of the columns and the leachate sample from each column was collected and subjected to argon plasma optical emission spectrometry (ICP-OES - Spectro, Model Arcs) for the determination of the elements Cr, Mo, As and Se. The total test duration was 4 weeks.

In the column with OS treated fly ash there was a considerable reduction in the concentration of As (67 %) and especially of Cr (~ 100%) in the leachate. After treatment with SF treated fly ash, concentrations of As and Cr of the leachates reduced approximately 30%. In both treatments, the concentrations of Mo and Se were also significantly reduced. The concentrations of all elements were lower than the concentrations in the leachate of the untreated ash tests. The results showed that both the organosilane and the surfactant can be used as immobilizers for the retention of toxic elements present in coal ash.

Keywords

coal fly ash, immobilizing agents, organosilane ,surfactant ,column percolation leachingx

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Reflection about the interrelation among the functions definition stage and the solutions definition stage in the integrated product development process (IPDP)

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Abstract

The search for competitive differentials in current industry has required conceptual changes in new product development processes. In this way, evaluating the product functions and associating them with its manufacturability aspects has been crucial for cost reduction and for obtaining a better balanced of the design regarding the value perceived by the customer and the real manufacturing costs to meet each of the functions. However, there are not relevant studies showing the current state of the art for methods that cyclically interact with the phases of an integrated product development process (IPDP) assessing the issues of product functions, perceived value by the consumer, solutions definition and manufacturing costs. The objective of this study is to seek the frontier of knowledge regarding methods and researches that specifically encompass the design phases that define the functions and phases that define the solutions of a new product in an engineering environment simultaneously. For this, a systematic analysis of the literature was proposed, in order to list the main