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Development circumstances of four recycling industries (used motor oil, acidic sludge, plastic wastes and blown bitumen) in the world

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ABSTRACT

The conspicuous global challenges that we are departing towards them today comprise to be addressed in the multifaceted frameworks of economy, society, environment and technology. In recent years, the consensus of demanding for sustainable development and its implementation has been unanimously posed. Along with this affirm, high added value, knowledge-based, competitive sustainable manufacturing and business excellence have been widely scrutinized as a prominent enabler and handler especially in recycling industries sector. Current review survey encompasses the development circumstances of four major recycling industries in Iran and over the world. Thus, evaluation of the individual techniques exploited in the four recycling industries indicated that employed processes had the lowest economic outlay and the highest revenue in comparison to other technologies. Additives can be utilized as raw materials for production of economically valuable bituminous products. The recycling and converting processes are not only cost-effective, but they also descent the environmental risk to a large level, using new techniques to zero. Economic indices, business excellence score and the quality of the obtained products represented that these processes support sustainable development of industries.

1. Introduction

Recycling of waste materials in developing and civilizing countries is growing and it is driven by economic necessity associated to poverty and environmental protection. Recent surveys revealed that successive PSW and used motor oil recoveries dominate all other kinds of wastes recycling started since 1960. While only a fraction of the total plastic wastes are being recycled in many western countries, around 95% and 75% of the PSW appear to be recycled in developing countries. However, the quality of the successively recycled products in terms of their physical appearance, products properties, health hazards are in serious argues [1,2]. Numerous small recycling industries of plastic wastes, blown bitumen and used motor oil have been currently implemented heedless to economic assessments, modern technologies and facilities are developing and maturing day by day in Iran and over the world. On the other hand, the aforementioned industries have properly employed commensurate and sumptuary technologies for recovering, treating, and recycling of wastes from disposed products and pay attention to the number of existing industries in developing countries and the world, quality of obtained products and quantity of usages, it is indispensable focusing on the performance, economic, and the SD aspects of these industries [2]. Jonidi and Hassanpour [3] reported that in the Europe, about 25 industries deal with used oils recovery. Typical recovery processes are maturing in many countries like Germany (7 units), Italy (5 units), France, Spain, Denmark, Iran, Poland, Slovakia and Greece. Modern industries are constructing and implementing in many of countries (France, Germany, Italy, and Spain). It has been estimated about 200 recycling industries (small industries) of used motor oil in Iran and about 400 recovering industries in the USA, Canada, Tunisia and Saudi Arabia. These statistics are also extendable for other aforementioned industries [4]. On the other hand, with regard to existing massive quantities of wastes and residuals of oil and AS generated by processes implemented in above-named industries, miscellaneous organic components especially VOCs, it is indispensable identifying the modern technologies and practices so that remove, recovery and remediation from the pollutants and by-products, fortifying and promoting the performance and BE in order to achieve the SD for recycling industries of used motor oil, AS, blown bitumen and plastic wastes. For instance, Poli et al. [5] reported that high quantities of plastics refused to the environment are ingested by lots of sea turtles that made a serious problem to them and environment in Paraíba, Northeast Brazil. Jonidi and Hassanpour [3]

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Nomenclature

AS	Acidic sludge
ASTM	American Society for Testing Materials
ABS	Acrylonitrile Butadiene Styrene
BE	Business excellence
BES	Business excellence score
Cst	Centistokes
CSFs	Critical success factors
CFCs	Chlorofluorocarbons
CVD	Chemical Vapor Deposition
D mm	Deci millimetre
DBD	Dielectric-Barrier Discharge
EMAC	Ethylene-Methyl Acrylate Copolymer
EPR	Ethylene Propylene Rubber
EEA	Ethylene Ethyl Acrylate
EVA	Ethylene Vinyl Acetate
EPS	Expanded polystyrene
EFQM	European Federation for Quality Management
GIS	Geographic Information System
HDPE	High Density Polyethylene
HIPS	High Impact Polystyrene
KBEM	Kanji's Business Excellence Model
LDPE	Low Density Polyethylene
NBR	Nitrile Butadiene Rubber
OE	Organizational excellence
PSW	Plastic solid wastes
PI	Penetration Index
PG	Performance grade
PE	Polyethylene
PAHs	Polycyclic Aromatic Hydrocarbons
PCDFs	Polychlorinated dibenzofurans
PVC	Polyvinylchloride
PP	Polypropylene
PS	Polystyrene
PB	Poly-butylene
PBT	Polybutylene theraphalate
PEBA	Polyether Block Amide
PET	Poly-ethylene terephthalate
PI	Polyisoprene
PMP	Polymethyl Pentene
PU (ether)	Polyurethane
PA	Polyamides
PC	Polycarbonates
PVDC	Poly-vinylidene chloride
PVDF	Polyvinylidene fluoride
PEST	Polyester textiles
PMMA	Polymethyl methacrylate
PVD	Physical Vapor Deposition
SD	Sustainable Development
SBS	Styrene - Butadiene – Styrene
SP	Softening point
SHRP	Strategic Highway Research Program
SBR	Styrene–Butadiene–Rubber
SAN	Styrene Acrylo Nitrile
TDA	Thermal de-asphalting
TFE	Thin Film Evaporation
TVOCs	Total Volatile Organic Compounds
USA	United States America
VOCs	Volatile organic compounds
wt%	Weight percentage
WL	Weight loss

estimated that AS is a by-product from used motor oil reprocessing industries, which thousands tons of this sludge are disposed into the environment as a hazardous waste material in Iran and all over the world daily.

SD as a concept is a description to many different interpretations. It can be as a simple, complex description or as we like to establish that, but the indispensable thing is that it besets individuals, industries, and governments to embed indisputable decisions, which safeguard a common future. It is an all-encompassing approach that engulfs and underpins the future of the planet. The intense stream of wastes concerning loss and dissociation of natural resources, pollution, resource inequality, and climate change enables arisen focus on the demand to protect the environment. Against the background of a restricted sources of raw material supply, and an understanding of the true impact and long-term effects of the polluting of our environment, science has revealed to the world that significant aspects enquires to be taken to discuss with the consequences of industrial performances in terms of economy cycle, society satisfaction, environment protection and technology development [6]. Economic assessment comprises the variety of deals about the investments and outlays for recycling industries and underpins closely the employed capital. The major outlays can be divided into organization and control costs incurred by the offices, wastes collecting expenditures and operational investments associated to final storage facilities prior to recycling investments. Cost computations are based on detailed estimates that reflect typical investment costs, interest rates, transportation costs, materials, equipment and fixed, working costs and etc to set up and start operation [2,7,8]. In present research was used of economic indices such as value-added percent, profit, annual revenue, breakeven point, time of return on investment, value-added, output value. By the way, Marchetti and Errazu [9] have also studied the economic indices such as productivity, raw material usage, economic competitiveness and environmental impacts of processes in a certain industry. Bradley and Thompson [10] surveyed on the relationship among oil revenue and many of key macro-economic variables, crude oil revenues with output, expenditures of consumer, unemployment, and stock.

It is indispensable to realize BE, because potentially causes to success of an industry via development and implement a practice for performance measurement criteria beyond the presentation of financial views. By the way, Hassanpour [11] has reported the trend of SD using KBEM in used motor oil industries. According to the development and establishment numerous aforementioned industries and its priority to society, planet, environment and economic it is indispensable figuring out to the connection and relation among four recycling industries and main factors of SD. On the other hand, we all live on the same planet and share a common fate. Fig. 1 represents the dependence and coherence among the multifaceted frameworks so that identify the concepts in SD. The main objective of present study was survey of development circumstances of four recycling industries (used motor oil, AS, blown bitumen and plastic wastes). To achieve to this purpose, requirements of the industries were surveyed upon available and environmental and new technologies.

2. Technology

The recycling industries of used motor oil are utilized to retrieve of used motor oil generated in light and heavy vehicles. The acid/clay practice is so popular process in lots of developing countries because of so many economic advantages and other benefits. Plastic wastes and blown bitumen recycling industries actually have main role to decrease the plastic wastes quantity through of the wastes flow as a pioneer industries in consumption of plastic wastes, used motor oil and AS [2,12,13]. According to the announcement of Iranian industry organization, about 200 reprocessing plants (acid/clay process) of used motor