



Economic evaluation of recycling acidic sludge project of reprocessing industries to bitumen (A case study)

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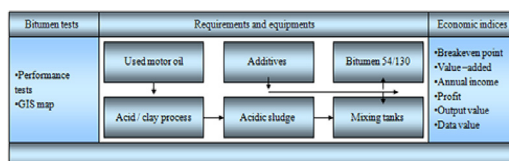
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HIGHLIGHTS

- The acidic sludge contains unsaturated compounds which are non-polar and asphaltene.
- Acidic sludge is a by-product of used motor-oil reprocessing industries as a hazardous waste material.
- It was found that bitumen 54/130 from acidic sludge recycling in the best conditions.
- The studies of technical and economical view-point were indicated the economic success of this project.

GRAPHICAL ABSTRACT



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ABSTRACT

Reprocessing operation of used motor oil encompasses the dewatering, heating and distillation processes. This procedure yields about 15 barrels of AS per 100 barrels of used motor oil as hazardous waste material, which can be effectively recycled. Experimentally present study involved mixing AS samples and additives together using a high shear mixer in order to achieve to the main objective of study that was economic evaluation of recycling the AS to bitumen. The products so obtained were evaluated using performance tests and in correlation with economical indices enacted in an industry. The results indicated that the bitumen produced, had the highest softening point temperature with a penetration degree of 54/130. The products were also found to be useful in building and road construction in different regions of Iran and the technical and economical view-point evaluation had shown the indices values such as value-added percent, profit, annual income, breakeven point, value-added and output value to be 68.2%, \$249 552, \$248 370, \$131, \$285 134 and \$132 521 respectively. A low breakeven point about 14.7% and the time of return on investment about 1.05 (13 months) were indicative of the economic success of this project.

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Nomenclature

AS	Acidic sludge
CAS	Concentrated acidic sludge
ASTM	American Society for Testing Materials
kcal	Kilo-calories
SBS	Styrene–Butadiene–Styrene
SBR	Styrene–Butadiene–Rubber
L	Liter
XRF	X Ray Fluorescence
API	American Petroleum Institute
AOAC	Association of Official Analytical Chemists
SHRP	Strategic Highway Research Program
TS	Temperature Susceptibility
SP	Softening Point
PI	Penetration Index
PG	Performance Grade
dmm	Deci millimeter
CST	Centistokes
VB	Vacuum Bottom
WL	Weight Loss
VOCs	Volatile Organic Compounds
Wt%	Weight percentage
GIS	Geographic Information System
kWh	Kilo watt hour
hp	Horse Power
kJ	Kilo joules

1. Introduction

With regard to the role of industrial sector in the economic development and its priority for promoting and fortifying other sectors to establish job opportunities, we need to survey this sector through its indices (Dietsch and Lozano-Vivas, 2000). Zhang et al. (2003a) indicated that day by day, the price of motor oil will dramatically increase as the motor oil production companies cannot meet the growing demand due to global deficiency of oil, overconsumption and overpopulation. Thus, increase and enhancement in motor oil consumption will also lead to rise in used motor oil generation in the near future. Hassanpour and Mohammadi (2012) reported that the best management practice in order to compensate the high demand of motor oil consumption is the recovery of used motor oil in Iran. According to the database of Iranian industry organization, there are more than two hundred recycling units of used motor oil by acid/clay process currently in Iran (Rahman et al., 2008). The AS is a by-product from this process which is refused as a hazardous waste material (Jonidi and Hassanpour, 2013). Hassanpour et al. (2013) noticed that reducing the quantity of AS with eco-friendly recycling practices is a suitable management practice which can be undertaken. The modern recycling techniques involve sophisticated sciences and complex technologies which are not economically viable. Another practice which is worth mentionable is the incineration of the AS and efficient utilization of the energy obtained from its combustion. It has been estimated that thermal value of AS incineration is about 4000 kcal/kg (Kolmakov et al., 2007; Dai et al., 2009). AS encompasses unsaturated compounds, which are non-polar and asphaltene in nature, its composition is analogous to bitumen (Kolmakov et al., 2006; Kavak et al., 2010; Eterigho and Olutoye, 2008). Hassanpour et al. (2013) reported that environmental and health hazards of AS were considerably reduced by modification and neutralization practices. In order to utilize of the AS as a raw material for producing bitumen, some amendments should be done on it. In the physical modification materials such as bentonite, polyethylene, ethylene vinyl, ethylene vinyl acetate, SBS and other forms of these polymers are applied (De Azeredo, 2009; Zare-Shahabadi et al., 2010). Bentonite has also been found to be as one of the most effective additives. It is used as a filler, stabilizer and concentrating agent in the bituminous materials (Williams, 2005). SBS has thermoplastic and elastic properties (Ouyang et al., 2005; Kok and Çolak, 2011).

Keeping the number of reprocessing industries in view, along with the quality of motor oil and quantity of AS produced, it is indispensable to focus on the performance of these industries and the sustainable development aspects. Krajnc and Glavic (2005), discussed on the definition of sustainability encompasses the environmental performance, societal responsibility and economic evaluations. Powell and Snellman (2004) explained the knowledge economy as production and services in terms of knowledge-intensive activities that assist to an accelerated stage of technical, scientific progress and quick obsolescence. Fagerberg (2000) reported that growth and development of industries have a prominent and significant role to achieve stable and rapid economic progress and development with exports having a positive impact on the industries (Easterly, 2002).

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