Quest Journals
Journal of Architecture and Civil Engineering
Volume 7 ~ Issue 11 (2022) pp: 102-105
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Bio-Bitumen: A Game-Changing Material In The Pavement Industry

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ABSTRACT: *A potential replacement for scarce crude oil is bio-oil, which is made from biomass. The two major techniques used to turn biomass into bio-oil are hydrothermal liquefaction and flash pyrolysis. Based on present technology, the cost of producing bio-oil from biomass is rather high, and the primary difficulties are the low yield and poor quality of the bio-oil. A significant study has been put into enhancing biomass-based bio-oil production. The current state of scientific and technological efforts to increase bio-oil output and quality is reviewed, with a focus on research into bio-oil upgrading. The environment suffers from the manufacturing of the bio-oil used to make biodiesel. The article also discusses how bio-oil is produced from various biomass sources and how it is used in bitumen. Building an infrastructure that is clean and kind to the environment may be accomplished by recycling and using bio-oil as a bitumen alternative.*
KEYWORDS: *Bio-oil, Bio-mass, Hydrothermal liquefaction, pyrolysis, Bitumen.*

***R**eceived 12 Nov., 2022; **R**evised 24 Nov., 2022; **A**ccepted 26 Nov., 2022 © The author(s) 2022.*
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I. INTRODUCTION:

Crude oil is distilled to generate a material known as bitumen. Bitumen is frequently used in the construction sector, particularly for roads and highways, and is well-recognized for its waterproofing and adhesive characteristics. Through the process of distillation, the heavier bitumen is left behind while the lighter components of crude oil, such as gasoline and diesel, are removed. Deposits may also naturally accumulate at the bottom of old lakes where decomposing organisms have been exposed to heat and pressure.

As previously mentioned, bitumen is a naturally occurring substance that may also be produced by distilling crude oil. Additionally, the phrase is used to describe oil sands or partially consolidated sandstone comprising a naturally occurring blend of sand, clay, and water saturatedwith an exceptionally dense and viscous type of petroleum.The item has a variety of contemporary uses. It is frequently used in road paving and is typically intended for industrial applications. The majority of roads in the United States are either built of bitumen or a mixture of bitumen and aggregates, like concrete. Bitumen is also often used for waterproofing. For instance, it was frequently used to waterproof buildings' walls, boats,ies, and other marine vehicles.Traditional petroleum bitumen, a byproduct of the refining of crude oil, is extensively employed in the paving business. However, the hunt for environmentally friendly ways to make bitumen alternatives has been prompted by steadily declining crude oil sources and tightening environmental restrictions. One of the innovative approaches put forward by experts is the creation of bio-bitumen, a replacement for bitumen made from renewable and ecologically acceptable biomass feedstock. Bio-oils made from biomass sources are frequently used in current research to create bio-bitumen. Based on their qualities, which heavily rely on their sources and manufacturing methods, bio-oils can be used as extenders, modifiers, and perfect replacements for bitumen.Pavement specialists are searching for new materials to improve the pavement and increase economic advantages through a thinner design. In the asphalt binder sector, bio-oils are often used as asphalt modifiers (10% asphalt replacement), asphalt extenders (25-75% asphalt replacement), and direct alternative binders (>100% asphalt replacement).

In this paper, the preparation of bio-bitumen based on the different sources of bio-oil, the production process of optimized bio-bitumen, and the properties of the bio-oil from different sources are evaluated to determine which is the major constituent in the bio-bitumen**.**

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II. LITERATURE REVIEW:

Zhaojie Sun et al. (2016), This study examined the chemical, physical, and mechanical characteristics of an asphalt binder that has been treated with bio-oil made from used cooking oil. Many inferences may be made from the results presented the major components of bio-oil are aromatics, resins, and saturates. Bio-oil has more saturates and resins and fewer asphaltenes and aromatics than 40/60 penetration-grade asphalt. Additionally, when control asphalt and bio-oil are combined, hardly any chemical reactions are seen. The inclusion of bio-oil reduces the asphalt binder's softening point and viscosity and boosts its penetration and ductility. The separation tendency test results of bio-oil modified asphalt show thatbio-oil and control asphalt has high compatibility under static heated storage circumstancestyluble. At medium and high temperatures, the inclusion of bio-oil reduces the complex model and raises the phase angle for the asphalt binder, which might reduce the control asphalt's deformation resistance and elastic recovery performance.The inclusion of bio-oil reduces stiffness and raises the asphalt binder's m value at low temperatures, indicating a good stress relaxation characteristic. This also aids in improving the binder's resistance to thermal cracking [1].

Zhaojie Sun et al. (2018), This research described a chemical process for producing biobitumen from bio-oil made from used cooking oil. The equivalent ideal bio-bitumen manufacturing method was investigated. The results and conclusions drawn from them can be derived are Bio-oil can be produced from waste cooking oil, Based on free radical polymerization, bio-bitumen is high molecular weight bio-oil from low molecular weight bio-bitumen weight. The most effective method for producing bio-bitumen developed from cooking oil waste is converted into bio-oil using a mixture of the bio-oil, initiator, and accelerator solutions. with a mass ratio of 100:1:2, reacting for two hours at 100 °C.The bio-bitumen is produced by waste-derived bio-oil. The chemical synthesis process of making cooking oil is a promising alternative to conventional petroleum. According to the economic study, the generated bio-bitumen is a little more expensive than basic bitumen. But using bio-bitumen to partially replace base bitumen would result in a more ecologically friendly infrastructure with little increase in cost [2].

EkinhanEriskinet al.(2017),To create sustainable pavement, waste frying oil (WFO) was added to the binder at three different rates (1%, 3%, and 5%). The objective of this study reduced the quantity of optimal bitumen added to the HMA and substituted frying oil for other waste materials in the HMA mixes. So, one of the main objectives of the article was to reduce the cost of building. Therefore, the main objective of this study is accomplished by lowering the ideal binder concentration from 5.125% to 4.575%. The difference of 0.55% is the most observable amount, and the bitumen loss is greater when the WFO rate is taken into account. WFO enhances penetration value while lowering the softening point in the bitumen. Therefore, employing high-PG bitumen in cooler places may be solved by using WFO conclusion, WFO is a good material for improving the self-healing capacity of bitumen by lowering the softening point, increasing the usage of high-PG bitumen in colder zones, and making the road pavement sustainable [3].

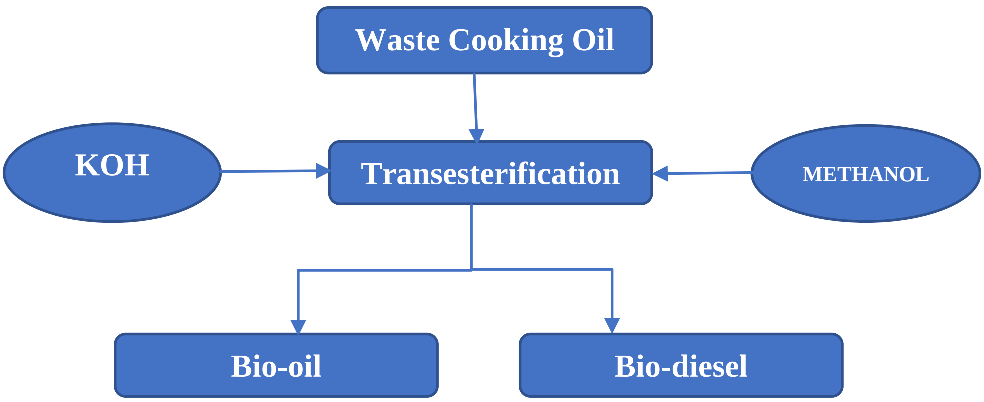
IlefBorgholet al.(2018), an Analog of bitumen, including elastomers, was effectively produced by hydrothermal liquefaction of Spirulina sp. leftovers. This investigation confirms the potential of microalgae leftovers as a renewable feedstock for the manufacture of bio binders for road building. Interestingly, even if temperatures between 240 and 260 °C are most suitable for the creation of bio-bitumen, temperatures between 300 and 350 °C are typically advised for the development of microalgal biofuel Maintaining high-molecular species in this specific application is crucial n since they appear to serve a similar function to asphaltenes and resins in petroleum-based binders. Research is now required to analyze how the microalgae strain affects the composition of the HTL water into a fraction and to explain how the distribution of the components' molecular weights affects the viscoelastic characteristics. Once the leading candidates for microalgae residues have been identified based on their efficacy to evaluate the technology's economic feasibility for road paving, several factors will need to be taken into account the process' scaling-up, research on bio-bitumen aging, life-cycle analysis, and the process overall cost in comparison to petroleum distillation [4].

Daquan Sun et al.(2017), The OBA, a sustainable paving binder with high WCOR content, was created as a successful alternative to replace petroleum-based asphalt. Next, many rheological experiments were carried out on the high-temperature and low-temperature characteristics of OBA binder properties. The OBA mixture was then assessed to show that applying it to pavement would be feasible.SBS-MA modified asphalt and PEN 70 base asphalt was Utilized to evaluate the performance of the binder and mixture in comparison with OBA, the key findings were summed up as follows, the formula uniform design technique was used to find the optimal OBA blending percentage, which was set at 33.3% WCOR, 31.8% HAP, 30.3% HR1, 4.6% R-LDPE, and externally 4% L-SBS. Based on the results of the high-temperature grade, frequency sweep, and viscous flow tests, OBA demonstrated comparable high-temperature performance with SBS-MA and was significantly superior to PEN 70. The findings of the FTIR test demonstrated that OBA had a unique chemical makeup, including acids and esters produced by the addition of WCOR. The OBA combination outperformed the SBS-MA mixture in low-temperature performance and had similar rutting resistance and water stability but was considerably better than the PEN 70 mixture. The manufacture and assessment of OBA with a high WCOR concentration were the main subjects of this investigation. It offered hope for the management of waste in paving materials [5].

Ellie H. Finiet al. (2016),Therefore, using numerical analysis and practical testing, this work investigates the low-temperature rheological properties of asphalt binders modified by bio binders derived from four distinct biomass types (swine manure, maize stover, wood pellet, and miscanthus pellet). Each modified specimen was put through a three-point bending test using BBR equipment at a range of 12 to 24 °C. The lowest service temperature was observed for asphalt modified with a bio binder made from swine manure, followed by WP, CS, and MP, which were tested using the Superpave procedure. The specimen changed with CS was found to have the greatest dissipated energy ratio, followed by BB, WP, and MP. The damping ratio and dissipated energy ratio were calculated using the fractional viscoelastic model. Also calculated for each specimen was the crossover temperature, which revealed that CS had the lowest crossover temperature, followed by MP, BB, and WP. This study compared the performance of four biomodified asphalt binders at low temperatures to evaluate its major goal [6].

Zahra Sotoodeh-Nia et al.(2019), In this work, the possibility of using a bio-additive made from crude tall oil (BM-1) and a bio-material made from soybeans (BM-2) as rejuvenators in the manufacturing of asphalt mixes containing 50% RAP was assessed. BM-1 received a 6% binder content addition to the RAP, whereas BM-2 received a 3% binder content addition. The following is a summary of the research's major findings: The BM-1 addition was able to keep the high-temperature grade at the same level while improving the low-temperature qualities by one grade when compared to the control blend with no additive. While the high-temperature characteristics were reduced by one grade, the BM-2 additive was able to restore the low-temperature grade to the same extent as BM-1. According to the DeltaTc parameters for 1PAV-aged (20 h) binders, the inclusion of BM-1 and BM-2 can greatly enhance the relaxation capabilities of the aged RAP binders. This study's key finding is that high RAP content in asphalt mixes is feasible as long as the right additives are used to revitalize the RAP binder that has degraded and restore its rheological qualities while producing combinations with improved attributes [7].

Ran Zhang et al. (2018),The thermal storage stability of bioasphalts with varied bio-oil contents was examined at various storage temperatures in this work. By incorporating 10, 15, 20, 25, and 30% bio-oil into 70# petroleum asphalt, a total of five different bioasphalts were created. At five different temperatures 120, 140, 160, and 180 °C the bioassays were statically kept for 48 hours. To assess the thermal storage stability, samples were taken from the top and bottom parts. The softening point test, rotational viscosity test, DSR test, and FTIR test were used to examine the physical parameters, rheological properties, and functional group composition. Following discussions and test findings, the following conclusions were drawn, Bioasphalts were separated following thermal preservation. The lower part had a higher softening point, viscosity, and anti-rutting factor than the top section. Physical segregation and chemical events, such as carbonation reactions, interactions between the oligomers, volatilization of aromatic compounds, and others occurred, as shown by an analysis of rheological characteristics and functional groups. It is advised to keep the bio-oil content below 25% and the storage temperature below 160 °C [8].



III. CONCLUSIONS:

- The bio-oil can be derived from the waste cooking oil by the process of transesterification which can be prepared economically.
- The most effective way for producing the bio-bitumen is from the bio-oil derived from waste cooking oil. Out of all production processes transesterification gives an efficient way to generate bio-oil.
- Many inferences can be drawn fromcomponents of bio-oil are aromatics, resins, and saturates.

- Therefore, the review of the progress of this area is important for providing the necessary information for assessing the feasibility of the varied process for the application of bio-oil in a comparative manner.
- These aspects of conventional bitumen have an impact on both people and the environment, and it is a no n-renewable resource that is running out very quickly.
- This highlights the need for an alternative binder that can reduce the negative impacts of conventional bitu men while still addressing bitumen's future requirements, such as sustainability and the circular economy for the development of pavement.
- This review study focuses on the characterization of biomass in terms of an investigation of its industrial, elemental, structural, and fractional content.
- In addition to these biomass sources and their upgrading methods, the conversion techniques or preparation processes used to produce bio-oil and bio-bitumen from various biomass forms, practical application, and life cycle inventory were reviewed, and their effects on physical, mechanical, rheological, and chemical properties were studied.

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