Effect of using engine oil waste on the characteristics of asphalt binder

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Summary
Recycled asphalt mixtures (RAM), which are obtained by mixing reclaimed asphalt pavement (RAP), virgin bitumen and mineral additives, grant a range of advantages, consisting of useful resource recycling, rate reductions in costs, and decreased terrible environmental impacts. However, more than one organizations have expressed issues about the utilization ratio of RAP. The principle feature of this learn is to describe and evaluate materials of modified asphalt binder mixes by the use of Fourier Transform Infrared Spectroscopy (FTIR).

This study aims to analyze the effect of waste fuel oil WFO on the characteristics of asphalt binder using Fourier transform infrared FTIR spectroscopy.

The findings of the treatise indicate that the good validity will add a lot of waste oil. This also offered a method for developing oils to create new rejuvenating agent to achieve complex synergism etc. In addition, the waste cyclic consumption and protection of the environment would be realized.

Introduction
Various techniques are used to examine the execution of bituminous binder, such as Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscope (SEM), and X-Ray Diffraction (XRD) [1-3]. Among these techniques, FTIR is well known to analyze oxidizing The ageing impacts of oxidation on chemical composition, and it presents records related to pattern absorption of illumination by infrared radiation (IR), usually between 400 and 4000 cm\(^{-1}\) rates. It also makes use of the factor that molecular bonds attract IR lighting at resonant fees attributable to their shaking [4]. The structure of materials is the basis for the selection of the IR energetic bond, but the structure of materials, since it brings under the molecular groups. The bituminous binders belong to the functional group
carbonyl and the group sulfoxide. Those sets are molecular sets process. Changes in chemical sets lead to rheological character modifications. These modifications can advance chemo mechanical coupling [5, 6]. A complete look about of asphalt binder used to be carried out the use of FTIR, which hyperlinks chemical structure and mechanical conduct. Underneath the FTIR analysis, samples were tested for two tests mechanical and chemical. A complete evaluation of acquired FTIR spectra is added in this study. This investigation is based on a round-robin paper, this look at linked to asphalt binder is not capable to suggest sensitive strategies to analyze FTIR spectra, whilst it is the most reproducible of all great methods. Furthermore, improving reproducibility, the impact of short-term ageing temperature on oxidative acceptance for the duration of short- and long-term ageing used to be examined. Oxidation reception is calculated by changing bands of carbonyl (C = O) and sulfoxide (S = O), [7].

With the ageing of asphalt pavement, massive amount of reclaimed asphalt pavement (RAP) are produced. Virgin bitumen and mixture materials are non-renewable, and their expenses have significantly accelerated; as a result, RAP desires to be recycled greater efficiently to minimize combination prices and bad environmental impacts. At present, most agencies allow the use of solely 10–25% RAP in recycled asphalt mixtures (RAM), which significantly contributes to a low rap usage rate and without delay diminishes the monetary benefits of RAM, Hence, growing the RAP ratio in RAM might be significantly beneficial for promoting the application of RAP; moreover, gratifying the overall performance necessities of RAM with an excessive RAP content is an indispensable issue that wants to be addressed [8–12]. Most highway agencies suppose that the mixing case of virgin and RAP binders in RAM is complete, most highway agencies suppose that the mixing case of virgin and RAP binders in RAM is complete, however this
assumption is not relevant to RAM with excessive RAP contents. To date, many research has explored the impact of excessive RAP contents on RAM [13–17].

The impact of WEO is regularly produced each of the negative and desirable effects to the pavement where the suitable quantity of waste oil relies upon on the constituent of aged mixture material. The excessive stiffness of mixture additionally requires excessive quantity of waste oil. In cold mix, it was once mentioned that the overall enactment used to be affected such as stability, strength and weakening the connecting among mixture and bitumen. but, in hot asphalt mixture where the oil became incorporated into the rap, provided a reduction in stiffness and, consequently, increased forward cracking resistance. The amount of waste oil, temperature, And RAP are superb to present extensive have an impact on at the overall performance properties. Consequently, these factors are a fascinating which will be usefully explored in further sustainable studies [18].

**Materials and Methods**

Samples of this study were previously prepared for the same purpose but in a different research approach that follows traditional methods [unpublished paper]. In this context, 20-30 penetration grade asphalt cement was collected from Qayyarah refinery factory.

**Table 1: Physical characteristics of the used asphalt cement**

| Property       | Symbol | ASTM Specification | Test Condition and Units                        | Qayyarah Asphalt Before Addition |
|----------------|--------|---------------------|------------------------------------------------|---------------------------------|
| Penetration    | P3     | ASTM D-5            | 25 ºC,100 gm, 5sec, 0.1 mm                      | 20                              |
| Softening Point| SP     | ASTM D-36           | Ring & Ball Method                               | 59.5 ºC                         |
### The wasted fuel oil (WFO) can be obtained and collected from different sources such as a two shops around Ramadi and Haditha city after used for several hundred kilometers into engine.

### Table 2: Waste Oil Properties

| Properties                  | Used ASTM method | Test result |
|-----------------------------|------------------|-------------|
|                            |                  |             |
| Density                     |                  | Fresh oil  | Burned oil |
| dynamic viscosity by used rotational at 135°C | D92              | 25 Cp      | 12.5 Cp    |
| Flash Point (C)             | D92              | 210°C       | 168°C      |

| Ductility | D | ASTM D-113 | 25 °C, cm | 95 cm |
| Specific Gravity | Sp. Gr. | ASTM D-70 | 25 °C | 1.06 |
| Flash point | FP | ASTM D-92 | Cleveland, °C | 285 °C |
| Viscosity By used Rotational Viscosity | V1 | 135°C, CP | 18.45 Cp |
|                            | V2 | 165°C, Cp. | 539.5 CP |
| Fire Point | FP | ASTM D-92 | Cleveland, °C | More than 900 °C |
| Fire Point (C) | D92      | 217 C | 185 C |
|---------------|----------|-------|-------|
| Kinematic Viscosity by using U-TUBE | 29.12 CST | 6.72 CST |
|               | ........  | 5.763CP |
Table 3 FTIR structures and working Groups [10]

| Compound Name          | Functional Groups | Spectrum Range ($cm^{-1}$) |
|------------------------|-------------------|-----------------------------|
| Alkanes                | C-H               | 650-910                     |
| Butadiene              | HC=CH             | 965                         |
| Sulfoxide              | S=O               | 1030                        |
| Aromatic Hydrocarbons  | C-H, CH2 and CH3  | 1375-1530                   |
| Carbonyl               | C=O               | 1700                        |
| Aromatics              | C= C              | 1600                        |
| Saturated Hydrocarbons | C-H               | 2850-3000                   |

Results and Discussion

The FTIR test uses infrared spectroscopy to know the chemical components of asphalt. The following forms showed the hydrocarbon components of virgin asphalt and asphalt after adding the percentage of the waste, where we observe through the form 0 %add 3% did not affect the asphalt components either additives 6% And 9% rise in saturate asphaltene content and reduce aromatic dose, concentration of carbonyl and sulfoxide for that asphalt. but the colloidal configuration hasn’t changed. This shows that asphalt is safe for burning and mixing.
Figure (4-1) the FTIR test before addition WFO
Figure (4-2) the FTIR test after addition 3% of WFO

Figure (4-3) the FTIR test after addition 6% of WFO
**Figure (4-4) the FTIR test after addition 9% of WFO**

**Conclusions**

It was discovered the addition of waste engine oil might to growth saturate, resins, asphaltene and reduce aromatics dosage intensity of carbonyl and sulfoxide for that asphalt, however it's no longer changed have the identical structure. Moreover, there was an appropriate oil content to the asphalt condition and real creation requirements. Too much oil content would effect on different properties of asphalt. the use of the waste engine oil supports and improves the residences of asphalt in cold climates.
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