International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 5 Issue 2, February - 2021, Pages: 28-31

Linear Model To The Determination Of Bitumen Specific Gravity As A Baseline In Construction.

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Abstract: *All existing roads, even the best made and designed ones, become deteriorated over time, mainly because of traffic loading and severe weather conditions. In the move to raise the aim of advancing the basic bitumen performances, many blends with various modifiers have been analyzed and studied by researchers. Optimal bitumen content analysis is the principal objective with foamed bitumen mixture design. Conversely, bitumen mix design methodologies with foamed bitumen are still under investigation. In this paper, an integral way of determining the optimal bitumen compositions in terms of their specific gravity at room temperature (25^oC) has been developed with a model. The model [Bitumen quantity (mg) = 52162 (specific gravity) + 5.061] at R^2 of 0.9990. This model could enable the bitumen contents value for estimation before the experimental and field applications as it gives a clear direction to touch of refinement meeting the technical requirements. This approach is anticipated to reduce resources for time and materials that may be required during the mix design procedure. However, experimental validations are suggested at the initial stage of the analysis.*

Keywords: Bitumen, specific gravity, hydrocarbons, road paving, petroleum tar and ASTM.

1.0 INTRODUCTION

The entire world has witnessed acute energy challenges that induced the depreciation of social infrastructures and economical status of most nations. Construction of modern roads with improvement in technology is practically difficult with the crises in terms of energy shortages and cost as required in the reaction or blending of bitumen-asphalt combinations [1]. Crude oil deposits that were formed when organic carbon material decays are refined through a distillation process that heat up the oil mixture within a large tank. Then the vapors that are produced at varying temperatures with a high concentration of compounds of hydrocarbons with higher combustibility are collected [2]. Hydrocarbons are resources with organic nature characterized by a bond between hydrogen and carbon which made up the primary products from the refining of crude oil includes diesel, gasoline, and other high octane fuels [3]. When organic solvents and engine oils have been refined out of the raw petroleum a tar blend comprises residual hydrocarbons and with a high level of natural bitumen which is technically refined for further applications [3]. Precisely, the highest fraction of bitumen is being utilized by the construction sectors, as a product constituent with road surfacing especially. Outstanding hydrophobic parameters along thermoplastic behavior present it for arrays of uses [4]. At elevated temperatures, which are between 100 and 200^{o}C, bitumen behaves as a viscous liquid, which enables it to be blended with a secondary component as desired. It remains inactive at room temperature, although as a solid and durable hydrophobic material [5]. The percentage of bitumen being applied for road construction is conventional bitumen; that is why it is often known as paving grade. Current evaluations put the world utilization of bitumen at roughly 102 million tons each year and about 85 percent of the refined bitumen is utilized as black-top for the development of roads [6]. An extra ten percent of worldwide production of bitumen is applied in material applications, with the excess 5% for fixing purposes in pipe coatings, paint and sealants [7]. Bitumen is accessible in a range of evaluations as it is utilized across the world with characterizations for applications and environment end-use. They are generally founded on a progression of standard test techniques that characterize their properties like hardness, consistency, solvency, and sturdiness [3], [8].

Bitumen has a softening point which is a component of thickness and the consistency of around 240 degrees Fahrenheit which is sufficiently high to be securely adopted in road construction without a lot of energy [9]. In some regions, temperatures can ascend to a point that will turn the substance thick, but since of the layers of total stone, streets can in any case bear high temperatures without reshaping. In light of the low dissolving purpose of black-top bitumen, it is not difficult to warm the black-top up as a feature of a black-top reusing measure.

In the course of road-making, the old black-top material can be blended with new bitumen to make a new and similar solid black-top material as these hydrocarbons are cement and structure solid bonds with strong surfaces when at a low temperature [3]. An approach that validates the theoretical

background in estimating the density of bitumen as established by standard (ASTM) for effective road application will serve purposes when coming to characterization against the classical approach with the limitation of errors.

2.0 METHODOLOGY

The classical approach to the determination of the Specific gravity test on bituminous materials rests on ASTM designation: D 70-76 standards. Here alternative online-based approaches that will automatically estimate the density of a known bitumen sample using a pycnometer to house the sample. 3.0 Results and discussion Figure 1. Bitumen specific density stages with pycnometer.

3.0 RESULTS AND DISCUSSION

Table 1. Standards for testing bitumen properties.

Properties/Tests	Units	Limit	Test Method
Density at 25 °C	Kg/m^3	1010–1060	ASTM D70 or D3289
Penetration at 25 °C	Mm/10	60–70	ASTM D5
Softening point	°C	49–56	ASTM D36
Ductility at 25 °C	cm	100 min	ASTM D113
Loss of heating	wt%	0.2 max	ASTM D6
Drop in penetration after heating	%	20 max	ASTM D5
Flash point	°C	232 min	ASTM D92
Solubility in trichloroethylene	wt%	99.0 min	ASTM D2042
Spot test	-	Negative	AASHTO 102
Viscosity at 60 °C	p	2000 ± 400	ASTM D2171
Viscosity at 135 °C	cst	300 min	ASTM D2170
Test on Residue From Thin Film Oven Test (ASTM D1754)			
Retained penetration (TFOT)	%	54 min	ASTM D5
Ductility (25 °C), 5 cm/min, cm after TFOT	cm	50	ASTM D113
Viscosity at 60 °C	p	1000 max	ASTM D2171

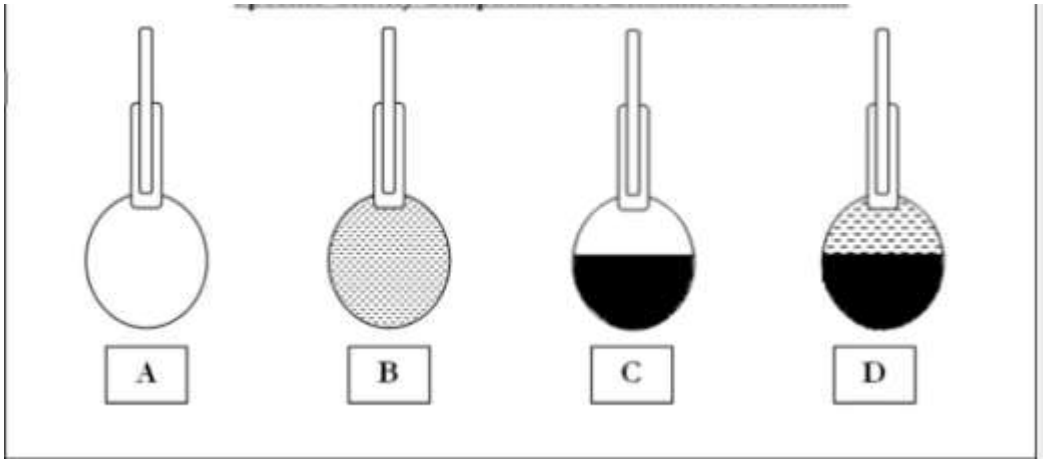

Figure 1. Bitumen specific density stages with pycnometer.

Where,
A = mass of Pycnometer (+ stopper)
B = mass of Pycnometer filled with water
C = mass of Pycnometer partially filled with bitumen
D = mass of Pycnometer + bitumen + water

Table 2. Bitumen density estimations

A (mg)	B =P + W (mg)	C= P + B (mg)	D=P + B + W (mg)	Specific gravity (mg/l)	Bitumen (mg)
22277	74151	22287	22338.87	0.0002	10
		22377	22428.87	0.0021	100
		22477	22528.87	0.0041	200
		22577	22628.87	0.0058	300
		22677	22728.87	0.0077	400
		22777	22828.87	0.0096	500
		22877	22928.87	0.0116	600
		22977	23028.87	0.0135	700
		23077	23128.87	0.0154	800
		23177	23228.87	0.0174	900
		23277	23328.87	0.0193	1000

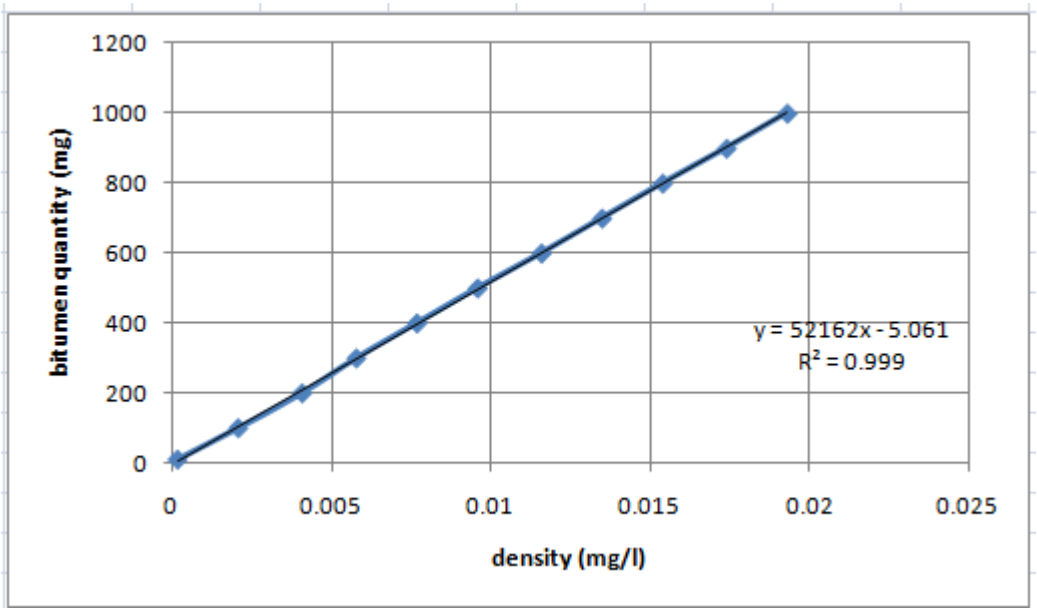

Figure 1. The plot with the quantity of bitumen to its specific gravity

Explicitly gravity is the main actual property of a material. The average specific gravity of all bituminous material is imperative to the investigation of structural designing and technology. The particular gravity of a material is essentially the proportion of the unit weight or thickness of such material with a similar volume of standard liquid usually water at a particular temperature. Hence, this virtual experimental technique successfully defined a linear relationship or model between the weight of the bitumen within the pycnometer and the expected specific gravity at a standard condition of 25oC room temperature. Therefore, at any point of characterizing bitumen in terms of its specific gravity, a model; such as this can be adopted.

4.0 CONCLUSIONS

The specific density is an essential property normally required in categorizing binders as needed in construction. Occasionally, there has to be converted to volumes with the bitumen concrete mix process design, where the application of specific gravity is involved. It is also employed in determining the origin of bituminous products with the relative or specific gravity within the range of 0.97 and 1.02. Logically, this implies that any impurities will raise the value range of the bitumen-specific gravity. Thus, this aids in the quantitative removal of other mineral contaminations in bitumen. The alternative method developed in the present paper for calculating the specific density of raw bitumen as physical properties of the bituminous aggregate is an innovative approach. Calculating the bitumen-specific gravity by this model may avoid the lengthy cumbersome process and error-prone technique over time. However, experimental validations are strongly necessary for future investigations of the generated model and to study other factors aside from temperature that could affect the physical parameters of bitumen

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