Measuring Asphalt Binder Content
(*from the WSDOT Pavement Guide*)

The asphalt content and gradation test can be used for HMA quality control, acceptance or forensic analysis. The three major test methods, solvent extraction, nuclear and ignition furnace are discussed here. Each method offers a way to determine asphalt content from an HMA sample.

6.1.3.1 Solvent Extraction

Solvent extraction, the oldest of the three test methods, uses a chemical solvent (trichloroethylene, 1,1,1-trichloroethane or methylene chloride) to remove the asphalt binder from the aggregate. Typically, a loose HMA sample is weighed and then a solvent is added to disintegrate the sample. The asphalt binder/solvent and aggregate are then separated using a centrifuge (see Figures 5.21) and the aggregate is weighed. The initial and final weights are compared and the difference is assumed to be the asphalt binder weight. Using this weight and the weight of the original sample a percent asphalt binder by weight can be calculated. A gradation test can then be run on the aggregate to determine gradation. Today, the solvent extraction method is only sparingly used due to the hazardous nature of the specified solvents.

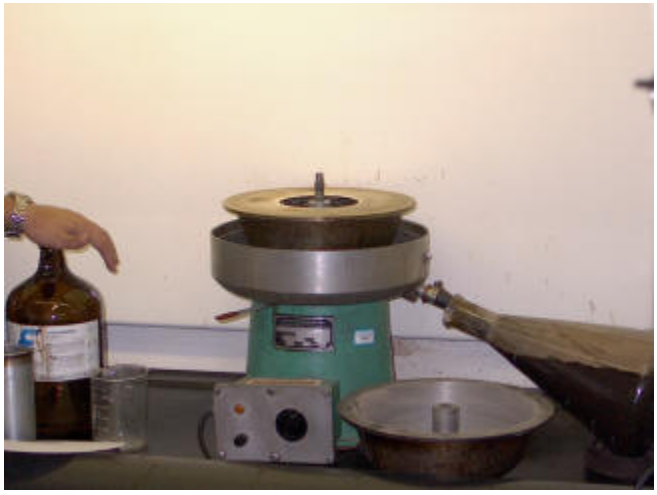

Figure 5.21 Open Centrifuge Used in Solvent Extraction

The standard solvent extraction test is AASHTO T 164 and ASTM D 2172: Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

6.1.3.2 Nuclear Asphalt Content Gauge

A nuclear asphalt content gauge (see Figure 5.23) measures asphalt content by estimating the actual number of hydrogen atoms contained within a sample. Similar in theory to a nuclear moisture content gauge used in construction, the nuclear asphalt content gauge uses a neutron source (such as a 100 μCi specimen of Californium-252) to emit high energy, “fast” neutrons, which then collide with various nuclei in the sample. Due to momentum conservation, those neutrons that collide with hydrogen nuclei slow down much quicker than those that collide with other, larger nuclei. The gauge detector counts only thermal (low energy) or “slow” neutrons

thereby making the detector count proportional to the number of hydrogen atoms in the sample. Since asphalt is a hydrocarbon, the more hydrogen atoms, the more asphalt. A calibration factor is used to relate thermal neutron count to actual asphalt content.

The nuclear asphalt content gauge offers a relatively quick (4 to 16 minutes depending upon desired accuracy) method for measuring asphalt content. Since the gauge actually measures hydrogen nuclei and then correlates their number with asphalt content, anything affecting the number of hydrogen nuclei in the sample can be a potential source of error. Because water contains a significant amount of hydrogen (H_2O), anything that adds moisture to the sample (e.g., moisture in the aggregate pores) is a potential error source (Black, 1994).

Figure 5.23: Nuclear Asphalt Content Gauge

6.1.3.3 Ignition Furnace

The ignition furnace test, developed by NCAT to replace the solvent extraction method, determines asphalt binder content by burning off the asphalt binder of a loose HMA sample. Basically, an HMA sample is weighed and then placed in a 538°C (1072°F) furnace (see Figure 5.24) and ignited. Once all the asphalt binder has burned off (determined by a change in mass of less than 0.01 percent over 3 consecutive minutes), the remaining aggregate is weighed. The initial and final weights are compared and the difference is assumed to be the asphalt binder weight. Using this weight and the weight of the original sample, a percent asphalt binder by weight can be calculated. A gradation test can then be run on the aggregate to determine gradation.

A correction factor must be used with the ignition furnace because a certain amount of aggregate fines may be burned off during the ignition process. The correction factor is determined by placing a sample of known asphalt binder content in the furnace and comparing the test result with the known asphalt binder content.

Figure 5.24: Ignition Furnace

Based on a limited National Center for Asphalt Technology (NCAT) study (Prowell, 2002), both traditional and infrared ignition furnaces, if properly calibrated, should produce statistically similar asphalt contents and recovered aggregate gradations.

The standard ignition furnace test is AASHTO T 308: Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method