Generic Asphalt with Traditional Maintenance

Product Selection and Description

The design of an asphalt parking lot pavement is dependent on the projected weight of traffic, the soil conditions at the site, and environmental conditions. Common asphalt parking lots consist of between 5 cm and 10 cm (2 in and 4 in) thick Hot-Mix Asphalt (HMA), which contains, on average, 15 % Recycled Asphalt Pavement (RAP). RAP is obtained from the millings of HMA surface lots or roadways and is typically hauled back to the HMA plant for reuse. The HMA pavement material is typically placed over a 15 cm (6 in) crushed aggregate base. In colder climates, additional fill material that insulates against frost-susceptible soils may be added below the base aggregate. Maintenance of asphalt parking lots, over 50 years, typically involves a 3.8 cm (1.5 in) HMA overlay with tack coat at year 15 followed by a 3.8 cm (1.5 in) mill and HMA overlay with tack coat every subsequent 15 years. Each maintenance coat contains, on average, 15 % RAP.

For the BEES asphalt parking lot model, a 0.09 m^2 (1 ft^2) surface with 8 cm (3 in) thick paving is studied. The amounts of materials used are 16.4 kg (36.2 lb) of HMA, 30.6 kg (67.5 lb) of crushed stone, and 3 installments of the HMA maintenance at 7.7 kg (17.0 lb) each.

Flow Diagram

The flow diagram below shows the major elements of the production of this product system as it is currently modeled for BEES.

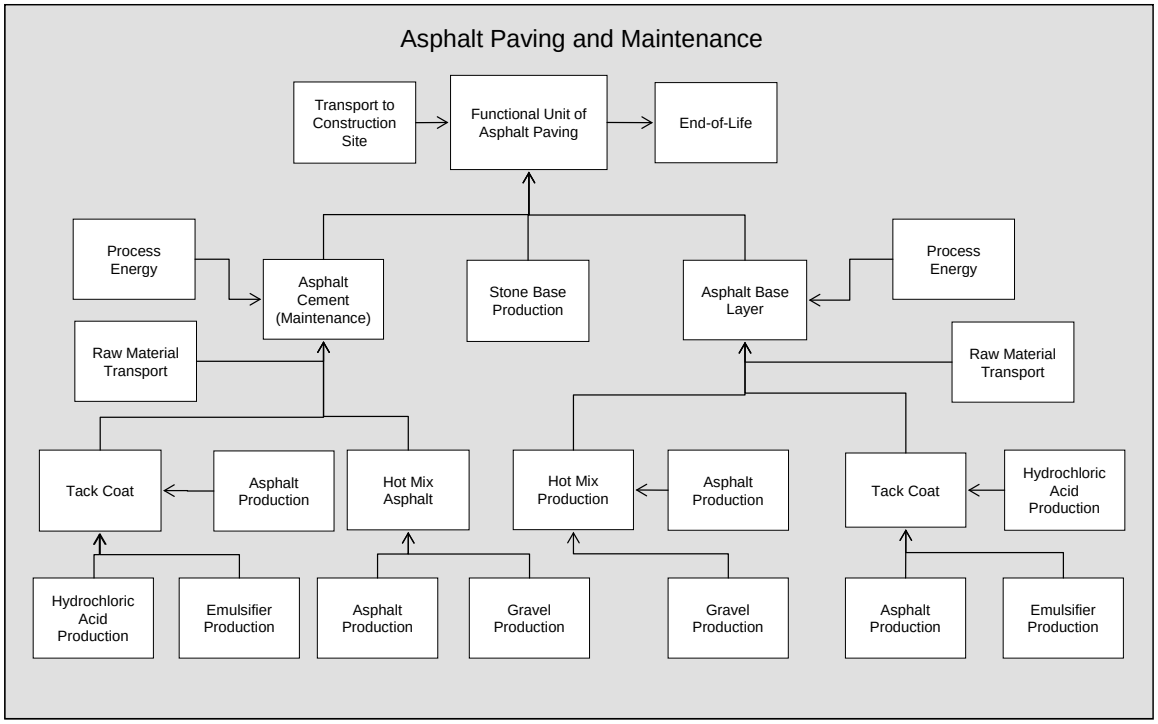

Figure 1: Asphalt Paving with Traditional Maintenance System Boundaries

Raw Materials

The composition of asphalt paving is shown in the Table below. The production of the raw materials required for both the pavement and its maintenance is based on data from both the U.S. LCI Database and the SimaPro database. The 15 % RAP in HMA reduces virgin asphalt binder use (by approximately 1 %) and reduces crushed stone (aggregate) amounts by approximately 14 %. The emulsifier is composed of asphalt with water and a small amount of surfactant.

Table 1: Hot Mix Asphalt Constituents

Constituent	*Mass Fraction (layer)*	*Mass Fraction (components)*
Hot Mix Asphalt	**99.5 %**	--
Gravel		81 %
Asphalt binder		4 %
RAP		15 %
Tack Coat	**0.5 %**	--
Asphalt		66 %
Water		33 %
Emulsifier		1.1 %
HCl		0.2 %

Manufacturing

Energy Requirements and Emissions. The energy requirements for HMA production are provided in the Table below, and represent a weighted average of requirements for production in counterflow drum (85 %) and batch mix (15 %) plants.

Table 2: Energy Requirements for Hot Mix Asphalt Production

Energy Carrier	*MJ/kg (Btu/lb)*
Diesel	0.017 (7.3)
Natural Gas	0.29 (124.7)
Total	**0.307 (132)**

Emissions from the production of the upstream (raw) materials and energy carriers are from the U.S. LCI Database. Emissions associated with the manufacture of asphalt are based on U.S. EPA AP-42 emission factors. The primary emissions from HMA production are particulates (PM) and volatile organic compounds (VOC); these are averaged on a weighted basis between counterflow drum (85 %) and batch mix (15 %) production technologies, as shown below.

Table 3: Emissions from Hot Mix Asphalt Production

Production Process	*PM g/kg (lb/ton)*	*VOC g/kg (lb/ton)*
Counterflow Drum	0.07 (0.14)	0.016 (0.032)
Batch Mix	0.0225 (0.45)	0.0041 (0.0082)
Weighted average	**0.0629 (0.1258)**	**0.0143 (0.02843)**

Transportation. Transport of the HMA raw materials to the production site is accomplished by trucking, over an average distance of 48 km (30 mi).

Waste. The manufacturing process generates no waste materials as all materials are utilized in the HMA pavement.

Transportation

Transport of HMA to the construction site by heavy-duty truck is modeled as a variable of the BEES system.

Installation

New asphalt pavements are placed directly on graded and compacted aggregate base or subgrade. A truck

carrying HMA paving material from the plant backs up to a paver and dumps the material into a hopper or a material transfer vehicle, which agitates the asphalt mix to keep the aggregate from segregating and to help ensure a uniform temperature. The paver lays a smooth mat of material, then a series of compactors make the material more dense. These compactors may include vibratory or static steel wheel rollers or rubber tire rollers. If multiple layers are placed or the parking lot is overlaid, the pavement surface is cleaned (typically by brooming) and then a distributor truck puts down a tack coat. The energy requirements for installation of an asphalt parking lot are provided in the following Table, with all diesel data based on the U.S. LCI Database.

Table 4: Energy Requirements for Asphalt Paving Installation

Installation Process	*Energy Carrier*	*MJ/ft^2*
Site Preparation and Stone Base Placement	Diesel equipment	0.7
Asphalt Binder Course Installation	Diesel equipment	0.96
Asphalt Wearing Course Installation	Diesel equipment	0.48
	Total	**2.14**

Use

The asphalt parking lot pavement is assumed to have a useful life of greater than 50 years with maintenance performed every 15 years. The maintenance of the parking lot with HMA is called resurfacing. The surface is cleaned and all unnecessary debris is removed. A tack coat is then applied by a distributor truck. Hot asphalt is then applied and compacted. The energy required for resurfacing is provided in the following Table.

Table 5: Energy Requirements for Asphalt Resurfacing

Maintenance Process	*Energy Carrier*	*MJ/ft^2*
Asphalt Resurfacing	Diesel equipment	0.72

After the initial resurfacing at year 15, all subsequent resurfacings begin with removal of 3.8 cm (1.5 in) of existing material, followed by an HMA overlay with tack coat containing, on average, 15 % RAP. The 3.8 cm (1.5 in) of milled material is returned to the HMA manufacturing process as RAP.

End of Life

At end of life, the product is typically overlaid rather than replaced if the land is going to remain in use as a parking lot. However, the HMA is generally removed and recycled if the land is going to be used for a different purpose.

References

Life Cycle Data

National Renewable Energy Laboratory (NREL): *U.S. Life-Cycle Inventory Database*. 2005. Golden, CO. Found at: http://www.nrel.gov/lci/database.

PRé Consultants: *SimaPro 6.0 LCA Software*. 2005. The Netherlands.

U.S. Environmental Protection Agency, "Hot Mix Asphalt Plants," Volume I: Section 11.1, *AP-42: Compilation of Air Pollutant Emission Factors*, (Washington, DC: U.S. Environmental Protection Agency, April 2004). Found at: http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf.

Industry Contacts

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