

A Case Study on Pollutants Emission and Environmental Management Plan for Hot Mix Asphalt Plant

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ABSTRACT: The present paper describes various air pollution emissions during the production of asphalt concrete. A 120 MTH plant was taken as a case study for this purpose. A gas flow of 0.5 m³/s is emitted with CO (6 ppm), NO₂ (0.1 ppm), SO₂ (2 ppm) and other toxic gases (2.5 ppm). A dust emission of 1.2 mg/m³ is emitted and is controlled by dust settling chamber. A stack height of 15m is required for complete dispersion in the atmosphere based on CPCB guidelines. Noise pollution generated is around 80 to 90 dB, which is within the standard stipulated by Occupational safety and health administration, USA. Management strategies for Occupational health hazards associated with asphalt concrete production is also presented in this paper.

KEYWORDS: Pollutants, dust emission, Noise pollution

I. INTRODUCTION

During production of hot mix Asphalt for flexible pavement construction, a variety of environmental attributes to the atmospheric environment arises. Hot mix asphalt concrete has been universally accepted as standard surfacing material for heavy duty roads. It is a carefully proportioned mixture of coarse aggregates, Fine aggregates, mineral fillers if required and bitumen. Aggregate & bitumen are heated and then mixed in a unit called as "Hot Mix Plant". Hot mix offers greater resistance to shear stresses imposed by modern transport.

The present paper describes environmental issues raised during production and mixing of Bitumen concrete

A Case study of 120 metric tonnes per hour is taken under as a case study of M/S Bhoorathnam & Company, Lakshmiapuram, Ramachandrapuram (Mandal), Chittoor district, Andhra Pradesh.

1.0 Raw Materials Required for Asphalt Concrete Production

The Raw Materials required for production of 120 MTH Asphalt Concrete for about 10 hours a day is presented in Table-1

Table-1: Raw material requirement for 120MTH asphalt concrete

Sl.No	Raw Material	Unit	Quantity	Remarks
1	Aggregate of different sizes	Tonnes/day	1120	The plant works about 10 hours/ day under maximum production of hot-mix asphalt concrete
2	Bitumen	Tonnes/day	50.4	
3	Fillers (if required)	Tonnes/day	Sufficient quantity	
4	Fuel (oil)	Liters/ day	1000	

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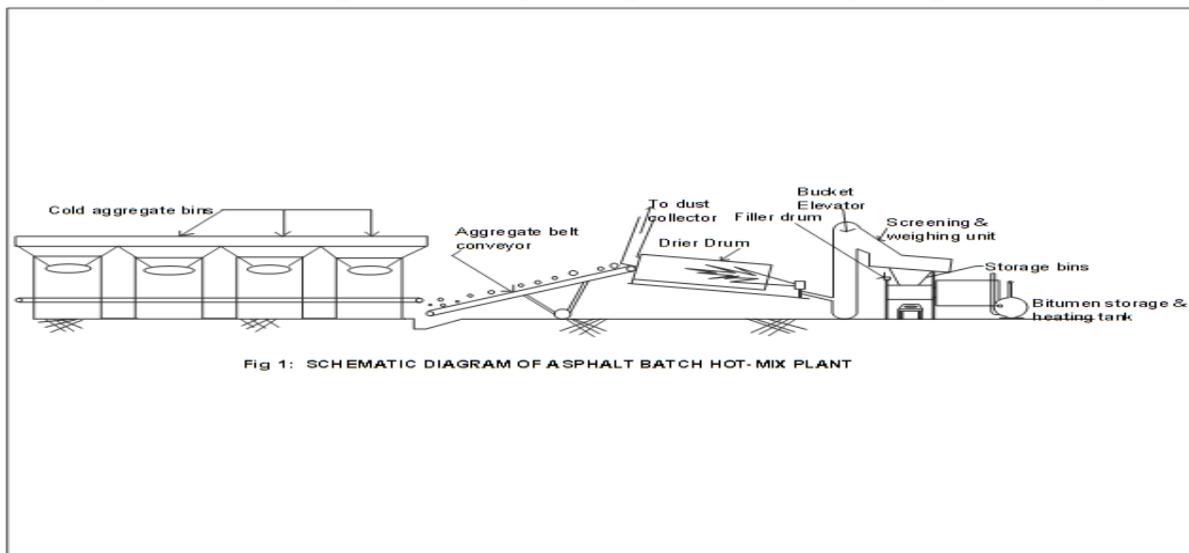
Adopted from: Kotaiah, 2014

II. ASPHALT CONCRETE PRODUCTION PROCESS

The hot mix asphalt plant consist of following sequential operations

- i) The cold aggregate is feed into the drier drum
- ii) The aggregate is heated-up in the drier drum with a burner (oil fired) fitted at one end of it. A dust collector in the form of bag filter is provided to the drier drum for air pollution control
- iii) The heated material is passed to the screens, where required sizes of aggregate are separated, throwing out the over sized stone chips.
- iv) The material now passes into weighing system, where each size of material is weighed and allowed them into mixer for mixing with bitumen in a desired proportion on volume basis
- v) Bitumen heated at a constant and desired temperature is pumped into mixer, which consists of automatic flow regulators for both aggregate and liquid bitumen. The binder percentage required is pre-set at the control console, and signals received by the ratio controller from the belt weigher will automatically adjust the binder feed rate to meet the mix specifications. Delivery rate of bitumen is also indicated in tones per hour (TPH) on the control console
- vi) The hot-mixed asphalt concrete is un-loaded into the waiting trucks for onward use in the highway construction.

A fully automatic centralized control panel with off-on push button indicator lights, gauges etc is provided inside the cabin. Operator from this cabin can operate all motors, burners, blower, belt conveyors etc and control the temperature and flow of aggregate, bitumen, filler material, mix storage gates etc. A schematic process flow diagram of asphalt batch hot-mix plant is presented in **Fig.1**



III. POLLUTION ASPECTS OF THE HOT MIX ASPHALT PLANT

3.1 Air Pollution

The major sources of air pollution in the hot-mix asphalt are (i) drier, and (ii) bitumen heating tanks. To get a proper heating effect to the aggregate in the drier, a draft is created by providing an inducted draft (ID) fan. This causes in carrying out much of the fine dust introduced with the aggregate. Experiments carried at by the Asphalt Institute (USA) on the emission of the dust from the driers is presented in Table-2

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Table-2: Dust Emissions from Drier of Asphalt Hot-Mix Plant

Sl.No	Item	Unit	Value
1	Gas flow	m ³ / Sec	0.51
2	Total dust concentration	mg/N m ³	9640
3	Suspected particulate matter	mg/N m ³	220
4	SO ₂ concentration	mg/N m ³	540
5	Rate of gas emission	m ³ /tonne	15.3
6	Rate of dust emission	Kg/tonne	0.1475
7	Rate of suspected particulate matter emission	Kg/tonne	0.0033
8	Rate of SO ₂ emission	Kg/tonne	0.0083

Adopted from: Research Report RR-75-1 (AI), 1975

The heating of bitumen to liquid state releases a lot of volatile organic gaseous products in the form of blue smoke emissions. These are vented off through a chimney into the atmosphere. Table-3 lists out some of the pollutants released during the heating of the bitumen to liquid state.

Table-3: Emission of air pollutants from Bitumen Heating Tanks

Sl.No	Item	Unit of measurement	Concentration
1	Carbon monoxide	ppm	6.00000
2	Nitrogen dioxide	ppm	0.10000
3	Sulfur dioxide	ppm	2.00000
4	Hydrogen sulfate	ppm	1.50000
5	Phenol	ppm	1.00000
6	Ozone	ppm	0.10000
7	Hydrocarbons (C1 -C14)	ppm	1.50000
8	Hydrocarbons (C2 -C6)	ppm	1.00000
9	Particulate matter	mg/m ³	7.20000
10	Poly nuclear aromatic compounds (total)	mg/m ³	0.00036
11	Vanadium, V2O5 fumes	mg/m ³	0.00010
12	Nickel and soluble nickel compounds (as Ni)	mg/m ³	0.00004
13	Cadmium fume	mg/m ³	0.00005
14	Lead and inorganic compounds	mg/m ³	0.00005

Adopted from: Mole, 1973.

3.2: Noise Pollution : Noise production in the hot-mix asphalt plant is created by collision or friction of (i) aggregate against aggregate, (ii) aggregate against metal surfaces, (iii) combustion of fuel in the burner, (iv) screening of aggregate material, (v) I.D. fan, (vi) mixer unit.

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Noise levels at asphalt hot-mix plant is presented in Table-4

Table-4: Noise Levels at Hot-Mix Asphalt Plant

Sl.No	Source of Noise Pollution	Noise levels dB (A)
1	Aggregate feeder	80-85
2	Drier drum	75-80
3	Screens	75-80
4	Mixer	80-90

Adopted from: Kotaiah, 2014

The noise levels at hot-mix asphalt plant ranges from 70 to 80 dB(A)

IV. MANAGEMENT OF POLLUTION IN HOT-MIX ASPHALT CONCRETE PLANT

4.1 Management of Air Pollution in Hot-Mix Asphalt Plant

The major source of dust pollution in the hot-mix asphalt concrete is the drier. The hot-mix asphalt concrete plant is a PERICAR & COMPANY make from Germany. The drier is provided with a baghouse filtration system (Fig 2) .It features the principle of Reverse Air Cleaning. This is done by using air from the atmosphere and utilizing the differential pressure in the system or cleaning with reversed hot gas. Dust is then dislodged from the filter bags exterior and collected with reversed hot gas. Dust is then dislodged from the filter bags exterior and collected at the base hopper and into filler bins. The filler storage bins are provide with metering system so as to feed the filler material to the asphalt concrete production process. Thus, most of the dust collected by bag-filters is utilized as filler material in the asphalt concrete production process.

With the efficient fabric dust collection system, a clean air emission of less than 22 mg/Nm³ is guaranteed. This works out to be the dust collection efficiency of bag filter system as 90.0 %. The emission rates of pollutants are calculated (based on the information in Table-2 and are presented in Table-5

Table-5: Emission Rates of Pollutants from Drier

Sl.No	Emission Source	Average emission rate (kg/ hour)	
		Dust	SO ₂
1	Inlet of the bag filter	0.396	0.9915
2	Outlet of the bag filter	0.0396	0.9915

Adopted from: Kotaiah, 2014

Required stack height for discharge of gaseous pollutants into the atmosphere is calculated and are as follows:

$$\text{Height of stack (meters)} = 14(Q)^{0.3}$$

Where Q = quantity of SO₂ emission, Kg/hour

$$H = 14 (0.9915)^{0.3} = 15 \text{ m approximately}$$

$$\text{Height of stack (meters)} = 74(Q)^{0.27}$$

Where Q = Rate of suspected particulate matter emission, tones/ hour.

$$H = 74(0.0000396)^{0.27} = 4.2 \text{ m approximately}$$

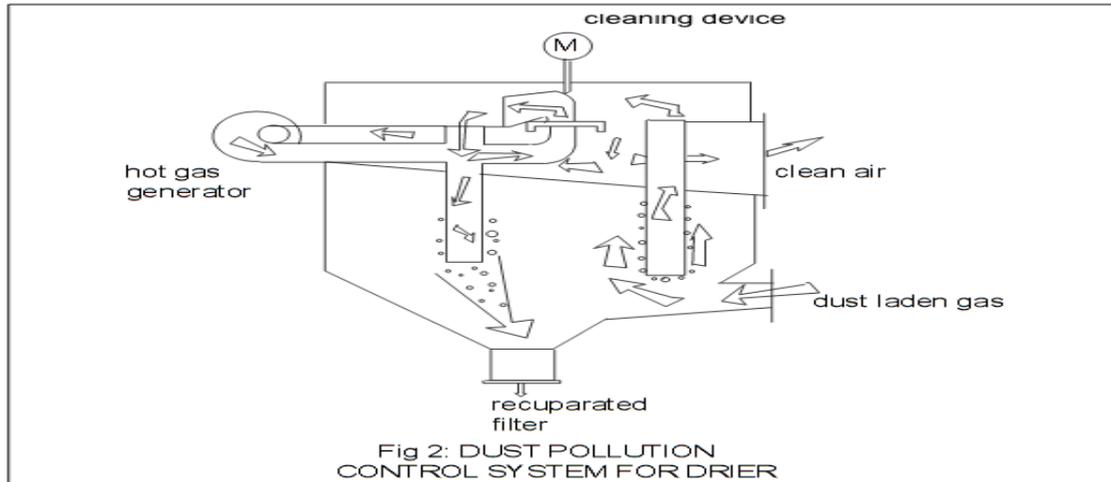
A Stack of 15 m height with internal diameter of 30cm is recommended for drier.

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In figure 2 the drier is provided with a bag house filtration system. It features the principle of Reverse Air Cleaning.

4.2: Management of Noise Pollution in Hot-Mix Asphalt Plant: Noise levels at hot-mix asphalt plant have shown (as presented in Table-4) that they are well below the tolerate noise standards under damage risk criteria for hearing loss occupational Safety and Health Administration (Table-6). This is due to the fact that elimination of noise created by the vibrating screen drum is fully enclosed in the screen cover which acts as a noise barrier as well as a dust cover.

Table-6: Damage Risk Criteria for Hearing Loss Due to Noise Pollution

Sl.No	Maximum allowable duration per day (hours)	Noise levels Db(A) (slow response)
1	8	90
2	6	92
3	4	95
4	3	97
5	2	100
6	1.5	102
7	1	105
8	0.5	110
9	0.25 or less	115

V. OCCUPATIONAL SAFETY AND HEALTH

There are toxic fumes or hazardous substance emissions in the asphalt concrete production units.

The following general steps will be taken-up in order to mitigate any occupational health hazards in the asphalt concrete production units.

- i) A control cabin will be provided at a convenient place, which is dust and weather proofed cabin for both aggregate and asphalt concrete production units.
- ii) Sprinkling of water at work environment in order to suppress the fugitive dust emissions due to mobility of vehicles and other machinery.
- iii) Heat insulation in hot surfaces like drier and bitumen tanks
- iv) Use of safety appliances such as ear-plug and helmets.
- v) Safety training to work personnel.
- vi) Installation of posters and slogans related to safety.

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VI. CONCLUSIONS

Based on the above case study following conclusions can be drawn:

- i) Toxic gases are generated during the heating mixing of the aggregate & bitumen
- ii) Tall stacks are provided to disperse the gases into the atmosphere such that the concentrations of these gases will be within the standards of ambient air quality.
- iii) Back filters are provided to arrest the dust emissions into the atmosphere
- iv) Screen drum is fully enclosed which acts as a noise barrier to keep the noise levels within the permissible levels stipulated by Occupational Safety & Health Association (OSHA) standards
- v) Occupational safety & Health precautions as suggested in the management plant largely mitigate the human health hazards.

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