Bay Area Emission Testing of Asphalt-Rubber

PCCAS

Reno, NV

April 2, 2002

Why the tests were conducted:

- Severe blue smoke problems at a hot plant in November 2000,
- The rubber was thought to be unique to the smoking problem,
- The data from other tests in other states was not acceptable to the Bay Area,
- The Bay Area asked.

What has happened:

- A partnership developed between BA AQMD, CALTRANS, NCAPA, NCRACTC, and RPA
- Series of joint meetings to discuss the issues and identify action items
- Immediate action items – best mgt practices, provide extra training, tarp loads, odor maskants
- Plan developed to test hot plants producing RAC during summer 2001.

Scope of Testing Program

- CARB Method 429 - Poly Aromatic Hydrocarbons (PAH)
- Modified Method 5 – Determination of Particulate (BTEX)
- Test during production of Conventional AC and RAC in triplicate at two hot plants
- Testing will occur during normal production runs
- The Question - Do hot plants need additional permitting for RAC production?

Testing Plan

Plant Type	Capture Point	Operator	Rubber Blender	Location	Testing Date
Drum w/coater	Truck Load-out	Dutra	FNF	Richmond	Sept 8-11
Drum counter flow	Stack	MVR	ISS	Sunol	Oct 9-11

Items of Interest

- A-R has been produced in the Bay Area since 1976
- A-R Hot mix typically uses 3% more binder per ton mix
- A-R Hot mix is typically placed at reduced thickness
- Conventional AC production rates 23 TPH higher (approximately 10 %)
- Tire Material has a flash point between 550 - 650 degrees F
- Permits are not currently modified to account for the use of modified binders.
- No complaints were registered last summer.

Recent Emission Studies

- Michigan DOT 1994
- TTI 1995
- EPA 2000

Evaluation of Exhaust Gas Emissions and Worker Exposure from Asphalt Rubber Binders in Hot Mix Asphalt Mixtures

Kathryn O'C. Gunkel

Wildwood Environmental Engineering Consultants, Inc.

Michigan Department of Transportation

1994

Quantified Emissions From Seven Mixtures

- Control 1 – 85/100 Pen AC 30% RAP
- Control 2 – No Rubber, No RAP
- Control 3 – No Rubber, 20% RAP
- RBR 1 – Wet Process, No RAP
- RBR 2 – No Rubber, 20% RBR RAP
- RBR 3 – Wet Process, 20% RBR RAP
- RBR 4 – Dry Process, No RAP

Let’s look at these two

- Control 2 – No Rubber, No RAP
- RBR 1 – Wet Process, No RAP

Operating Data/Conditions/ Measurements	Control 2	RBR 1
HMA Production Rate (tons per hour)	351	357
Dry Aggregate Rate (TPH)	330	333
Asphalt Cement Added (%)	5.75%	6.84%
Materials moisture content	4.17%	5.21%
Fuel Consumption (gal/hr)	655	690
Exhaust Gas Temperature (F)	311	324
Mix Temperature (F)	296	316
Sample Volume (SCF)	46.501	42.823
Sample Volume (cu. m)	1.317	1.213
Exhaust Gas Moisture (%)	27.0%	29.3%
Stack Temperature (F)	260	271
Actual Exhaust Gas Flow (ACFM)	89,540	95,450
Dry Exhaust Gas Flow (DSCFM)	47,076	47,836
Dry Exhaust Gas Flow (DSCMM)	1,333	1,355

The Operating Conditions Are Similar

Continuous Emissions Measurements and Method 18 Results	Control 2	RBR 1
CO2, %, Orsat Result	5.79%	6.02%
O2, %, Orsat Result	12.75%	12.10%
N2, %, Orsat Result	81.46%	81.88%
Carbon Dioxide (CO2)	6.00%	6.48%
Oxygen (O2)	12.87%	12.18%
Carbon Monoxide (CO) PPM	430.5	259.5
Nitrogen Oxides (NOx) PPM	139.3	124.4
Sulfur Dioxide (SO2) PPM	74.4	76.7
Non Methane Total Hydrocarbons (NMTHC) as Carbon PPM	225.5	183.0
Methane (CH4) as measured PPM	27.7	10.6
Methane as Carbon PPM	20.7	7.9
Total Hydrocarbons (THC) as Carbon PPM	245.1	191.3
NMTHC as Carbon PPM	225.5	183.0

The Emissions Are Similar

PAH Emissions Measurements (lbs/hr)	Control 2	RBR 1
Acenaphthene	0.0018	0.0021
Acenaphthylene	0.0022	0.0026
Anthracene	0.0003	ND
Benzo Anthracene	0.0002	ND
Chrysene	0.0003	ND
Fluoranthene	0.0030	0.0024
Fluorene	0.0051	0.0055
Naphthalene	0.0502	0.0622
Naphthalene, 2-Methyl-	0.0578	0.0788
Phenanthrene	0.0120	0.0141
Pyrene	0.0030	0.0022
Cumene	0.0056	0.0069
o-Cresol (2-Methylphenol)	0.0029	0.0011
m-/p-Cresol (3-/4-Methylphenol)	0.0052	0.0058

The Emissions Are Similar

Conclusions

- Rubber does not contribute significantly to any increase in undesirable compounds.
- The base asphalt and burner fuels will cause greater changes in emissions than rubber.
- Soft asphalt cement appears to result in increased emissions of BTEX.
- It is highly unlikely that an allowable fence-line concentration limit based on an annual averaging period would be exceeded.

Recycling Crumb Rubber Modified Asphalt Pavements

Crockford, W.W., Makunike, D., Davison, R.R., Scullion, T. and Billiter, T.C.

Report FHWA/TX-95/1333-1F.
Texas Transportation Institute
May 1995

TTI Conclusions

"…the material is recyclable and that the recycled material, if properly designed and constructed, should have acceptable long-term performance."

"…air quality does not seem to be any more severe a problem than it is with conventional asphalt."

"…the effect of CRM on emissions may be relatively small in comparison to the effects of other variables."

HOT MIX ASPHALT PLANTS EMISSION ASSESSMENT REPORT

December 2000

Emissions Monitoring and Analysis Division
Office of Air Quality Planning and Standards
United States Environmental Protection Agency
Research Triangle Park, NC
and under contract, by:

Midwest Research Institute
Kansas City, MO and Cary, NC
EPA Contract Number 68D-98-027
and
Eastern Research Group, Inc.
1600 Perimeter Park
P.O. Box 2010
Moorisville, NC
EPA Contract Number 68-D7-0068

HOT MIX ASPHALT PLANTS EMISSION ASSESSMENT REPORT December 2000

Downloads can be made from:

http//www.epa.gov/ttn/emc/asphalt.html

Bay Area Test 2001

- Units of measure for emissions = Pounds/Ton
  - Hot Plants are permitted in tons per year
  - EPA's Compilation of Air Pollutant Emission Factors (AP-42) provides relevant emission factors from asphalt plants in units of "pounds per ton"
- Samples with non detects set at zero.

	Average Production Rate (tons per hour)	
	Conventional	Asphalt Rubber
Dutra	206	185
MVR	336	307

	Temperature of Product (degrees F)	
	Conventional	Asphalt Rubber
Dutra	318	335
MVR	311	318

	Particulate Emissions (pounds per ton)	
	Conventional	Asphalt Rubber
Dutra	**0.0013**	**0.0015**
MVR	**0.0025**	**0.0030**
AP42	**0.0330**	**0.0330**

Measured particulate emissions at the Dutra facility cannot be compared with AP-42, because AP42 only provides particulate data from the main plant stack (which exhausts emissions from the aggregate dryer).

Sampling Point of Load Out Area

Blue Smoke

Any Other Emissions Captured?

	Reg 2-1-316 Threshold (lb/year)	Toxic Potency Index			
		Dutra		MVR	
		Conv.	AR	Conv.	AR
Benzene	6.7	1.90E-07	5.12E-06	6.32E-06	5.40E-06
Toluene	39,000	5.77E-11	1.99E-09	5.20E-10	4.64E-10
Xylene	58,000	0	1.42E-08	3.40E-10	8.93E-10
1,3-Butadiene	1.1	0	0	5.00E-06	6.20E-06
Naphthalene	270	4.89E-08	5.35E-08	1.16E-08	2.17E-08
Benz(a)anthracene	0.044	2.73E-08	0	0	0
Total Toxic Potency Index		2.66E-07	5.19E-06	1.13E-05	1.16E-05

MATERIAL INFORMATION BULLETIN
("ESSENTIALLY SIMILAR" TO FORM OSHA 20
MATERIAL SAFETY DATA SHEET)

PRODUCT NAME: RAFFEX 170-ACB CODE: 3143
CHEMICAL FAMILY: PETROLEUM, HYDROCARBON
CHEMICAL NAME:
CAS NO. 64742-11-6, HEAVY NAPHTHENIC DISTILLATE SOLVENT EXTRACT

TYPICAL COMPOSITION: HEAVY NAPHTHENIC DISTILLATE SOLVENT EXTRACT 100%

EXPOSURE STANDARD, ACGIH TLV & OSHA - OBSERVE 5 MG/M3 (CUBIC METER OF AIR) FOR MINERAL OILS

PHYSICAL DATA

INITIAL BOILING POINT, 'F: 550 SPECIFIC GRAVITY (H2O=1): 0.95
VAPOR PRESSURE (MMHg): 0.1 PERCENT VOLATILE, (% BY VOL.): NA
VAPOR DENSITY (AIR=1): NA EVAPORATION RATE (ETHYL ETHER=1): <1
SOLUBILITY IN WATER: NIL
APPEARANCE AND ODOR: BLACK LIQUID WITH LITTLE OR NO ODOR

FIRE AND EXPLOSION HAZARD DATA

		LEL	UEL
FLASH POINT - COC, 'F: 420	FLAMMABLE LIMITS:	NDA	NDA

EXTINGUISHING MEDIA: FOAM, WATER FOG, DRY CHEMICAL, CO2
SPECIAL FIRE FISHTING PROCEDURES:
DO NO ENTER CONFINED FIRE SPACE WITHOUT PROPER PROTECTIVE EQUIPMENT INCLUDING SELF-CONTAINED BREATHING APPARATUS. SEE HAZARDOUS DECOMPOSITION PRODUCTS.

REACTIVITY DATA

STABILITY (THERMAL, LIGHT): STABLE
INCOMPATABILITY (MATERIALS TO AVOID): MAY REACT WITH STRONG OXIDIZERS.
HAZARDOUS DECOMPOSTION PRODUCTS: NORMAL COMBUSTION FORMS CARBON DIOXIDE AND WATER VAPOR, AND MAY PRODUCE OXIDES OF SULFUR AND NITROGEN: INCOMPLETE COMBUSTION CAN PRODUCE CARBON MONOXIDE.
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

Dutra	Emission Factor (pounds per ton)		
	Conv.	AR	AP-42 (Batch Mix)
Benzene	1.27E-06	3.43E-05	2.80E-04
Toluene	2.25E-06	7.75E-05	1.00E-03
Ethyl Benzene	0	7.37E-06	2.20E-03
Xylene	0	8.26E-04	2.70E-03
1,3-Butadiene	0	0	Not Avail.
Naphthalene	1.32E-05	1.45E-05	3.60E-05
2-Methylnaphthalene	1.12E-05	2.15E-05	7.10E-05
Acenaphthylene	3.43E-07	3.99E-07	5.80E-07
Acenaphthene	1.05E-06	1.63E-06	9.00E-07
Fluroene	6.61E-07	1.37E-06	1.60E-06
Phenanthrene	1.28E-06	1.83E-06	2.60E-06
Anthacene	4.09E-07	5.04E-07	2.10E-07

Dutra	Emission Factor (pounds per ton)		
	Conv.	AR	AP-42 (Batch Mix)
Fluoranthene	6.15E-08	4.00E-08	1.60E-07
Pyrene	2.78E-07	1.64E-07	Not Avail.
Benz(a)anthracene	1.20E-09	0	4.60E-09
Chrysene	7.55E-09	2.55E-09	3.80E-09
Benzo(b)fluoranthene	0	0	9.40E-09
Benzo(k)fluoranthene	0	0	1.30E-08
Benzo(e)pyrene	5.56E-09	2.82E-09	Not Avail.
Benzo(a)pyrene	0	0	3.10E-10
Perylene	1.51E-09	0	Not Avail.
Indeno(1,2,3-c,d)pyrene	0	0	3.00E-10
Dibenz(a,h)anthracene	0	0	9.50E-11
Benzo(g,h,l)perylene	0	0	Not Avail.

MVR	Emission Factor (pounds per ton)		
	Conv.	AR	AP-42 (Drum Mix)
Benzene	4.23E-05	3.62E-05	3.90E-04
Toluene	2.03E-05	1.81E-05	1.50E-04
Ethyl Benzene	0	3.20E-06	2.40E-04
Xylene	1.97E-05	5.18E-05	2.00E-04
1,3-Butadiene	5.50E-06	6.82E-06	Not Avail.
Naphthalene	3.12E-06	5.87E-06	9.00E-05
2-Methylnaphthalene	7.78E-07	1.60E-06	7.40E-05
Acenaphthylene	1.71E-07	1.01E-07	8.60E-06
Acenaphthene	1.66E-08	1.86E-09	1.40E-06
Fluroene	5.27E-08	3.68E-08	3.80E-06
Phenanthrene	1.09E-07	8.02E-08	7.60E-06
Anthacene	1.19E-07	4.79E-09	2.20E-07

MVR	Emission Factor (pounds per ton)		
	Non-rubberized	Rubberized	AP-42 (Drum Mix)
Fluoranthene	8.28E-09	4.04E-09	6.10E-07
Pyrene	1.16E-09	3.52E-09	Not Avail.
Benz(a)anthracene	0	0	2.10E-07
Chrysene	0	0	1.80E-07
Benzo(b)fluoranthene	0	0	1.00E-07
Benzo(k)fluoranthene	0	0	4.10E-08
Benzo(e)pyrene	0	0	1.10E-07
Benzo(a)pyrene	0	0	9.80E-09
Perylene	0	0	8.80E-09
Indeno(1,2,3-c,d)pyrene	0	0	7.00E-09
Dibenz(a,h)anthracene	0	0	Not Avail.
Benzo(g,h,l)perylene	0	0	4.00E-08

SUMMARY

Measured emissions of particulate and specified toxic compounds during production of Asphalt Rubber were not significantly greater, if greater at all, than the emissions during production of Conventional Asphalt. Also, measured emission rates of particulate and toxic compounds were consistently lower than the emission factors indicated in EPA's AP-42 emission factors for asphalt plants.

CONCLUSION

- These data indicate that emissions from the production of Asphalt Rubber are not significantly different than those from the production on Conventional Asphalt.
- AR is one of many types of “asphalt”; and emissions from its production are not dissimilar to the emissions from the production of conventional asphalt.
- Therefore, existing production plants in the Bay Area that are permitted to produce asphalt, should be permitted to produce rubberized asphalt.

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- Mike Justice – Justice and Associates