www.goldenbearoil.com

Tricor Refining

Producers of Golden Bear Preservation Products

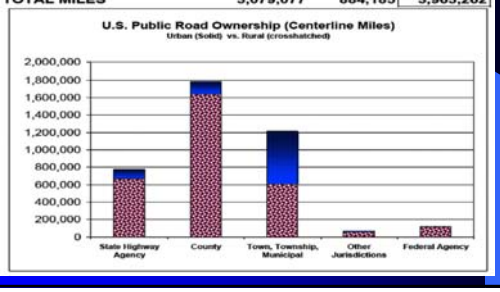
Welcome – Jim Brownridge – Marketing Manager Road Maintenance Products

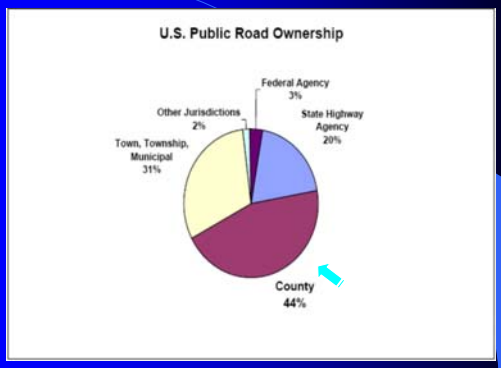
Rejuvenation of Recycled Asphalt Pavement in Rural Road Programs

U.S. Public Road Ownership (Centerline Miles)

http://www.fhwa.dot.gov/ohim/hs01/xls/hm10.xls (9-3-03 SRM - HIAM-20)

Jurisdiction Type	Rural	Urban	Total
State Highway Agency	665,093	110,481	775,574
County	1,637,616	144,065	1,781,681
Town, Township, Municipal	600,957	614,696	1,215,653
Other Jurisdictions	56,115	12,709	68,824
Federal Agency	119,296	2,234	121,530
TOTAL MILES	3,079,077	884,185	3,963,262





Reclamite® sealed 1979

Photo: 1994

Appearane 15years after application!

Clark County, Washington (Portland area)

Montana

Reclamite®

Sealed vs. Unsealed

Montana Yellowstone Park area

(photos from 1970,s)

Reclamite®

THIS PHOTO TAKEN AUGUST 2001

Rejuvenators can keep good roads in good condition

Rejuvenators can't correct

Faulty

Roads !!

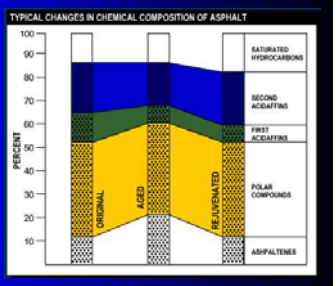
What is an asphalt rejuvenator?

Asphalt consists of two main fractions:
"asphaltenes" which are the hard brittle component, insoluble and not affected by oxidation and the highly reactive sub-fractions:
"maltenes" These maltenes are oily and resinous in appearance

How does an asphalt rejuvenator work?

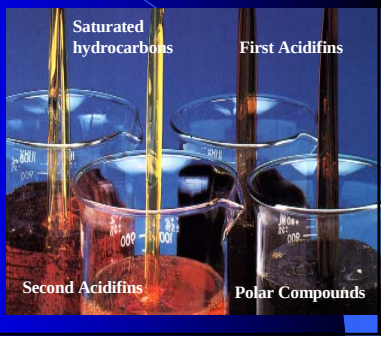
This relationship of maltene and asphaltene percentage becomes out of balance in the aging process. The component package hardens causing an imbalance with the asphaltines.

This aging process can start as early as initial hot plant production and continues through the pavement life cycle – the effects of time, weather, sunlight, etc.



How does an asphalt rejuvenator work?

An asphalt rejuvenator is a manufactured product which has the ability to absorb or penetrate into the pavement and restore those reactive components that have been lost due to oxidation



"Keys to a quality rejuvenator"

- **Proper base is essential. A napthenic or wax free base is ideal – the molecular make up offers more solvency or absorption and fluxing ability.**
- **Rejuvenators are manufactured as emulsions, typically 60-65% residual. They have the ability to "wet" the asphalt binder that is present**

Benefits of an Asphalt Rejuvenator:

1 Increases penetration value of the asphalt cement in the top portion of the pavement which extends the pavement's lifecycle.

2 Seals pavement against intrusion of air and water, thereby slowing oxidation, preventing stripping and raveling and protects the pavement in-depth.

3 Increases the durability of the asphalt in the top portion of the pavement by improving the chemical composition of the asphalt cement.

Tricor offers 2 emulsions for cold recycling

Emulsions:

- **Cyclogen® LE**
- **Cyclogen® ME**

2 Base Oils for Hot Recycling/Hot in Place Recycling

Cyclogen® L

Cyclogen® M

CYCLOGEN® LE & ME Emulsified Cold Recycling Agents

The base used in Cyclogen® LE must meet specifications for Cyclogen L and the base for ME must meet specifications for M.

Properties	Test Method	Typical Test	LE Min.	LE Max.	ME Min.	ME Max.
			Specifications			
Viscosity @ 25C, SFS	ASTM D-244	35.8	15.0 – 85.0		15.0 – 85.0	
Sieve, W %	ASTM D-244	0.01	0.10		0.1	
Residue, W %	GB or D-244	61.0	60.0		60.0	
Viscosity, 60 C, CST		450 (LE)	**200 – 500**	**2260 (ME)**	**1000**	**4000**
Pumping stability	GB method 1	PASS				
Emulsion coarseness, %w	Sieve test, ASTM D-244 2	0.1	0.1		0.1	
PH of Emulsion	D-244	5.4				
Sensitivity to fines, %w	Cement mixing, ASTM D-244	NIL	2.0		2.0	
Particle Charge	ASTM D-244	POS	POS		POS	

1 Pumping stability is determined by charging ~ 450 ml of emulsion into a one-liter beaker and circulating the emulsion through a gear pump (Roper 29.B2621) having a ¼" inlet and outlet. The emulsion passes if there is no significant separation after circulating ten minutes.

2 Test procedure identical with ASTM D-244 60 except that distilled water shall be used in place of two percent sodium oleate solution.

3 ASTM D-244 Evaporation Test for percent of residue is made by heating 50 gram sample to 149□C (300□F) until foaming ceases, then cool immediately and calculate results.

NNote: For gal/ton conversion use 242 gal/ton.

note: Data presented are typical.

RECLAMITE® Asphalt Rejuvenating Agent Specifications:

Tests	Requirements		Test Method	ASTM Min.		AASHTO Max.
Tests on Emulsion:				**D-244**		**T-59**
Viscosity @ 25□C, SFS				15		40
Residue, % w[1]	D-244 (mod)	T-59 (mod)		60		65
Miscibility Test[2]		D-244 (mod)	T-59 (mod)			No Coagulation
Sieve Test, % w[3]		D-244 (Mod)	T-59 (mod)	---		0.1
Particle Charge Test		D-244		T-5		Positive
Percent Light Transmittance[4]		GB		GB		30
Tests on Residue from Distillation						
Flash Point, COC, °C				D-92		T-48
				196		---
Viscosity @ 60□C, cSt				D-445		---
				100		200
Asphaltenes, %w				D-2006-70	---	1.0
Maltene Distribution Ratio				D-2006-70	---	
				0.3		0.6
PC + A1[5] / S + A2						
PC/S Ratio[5]			D-2006-70		--0.5	---
Saturate hydrocarbons, S[5]			D-2006-70		---	28

1ASTM D-244 Evaporation Test for percent of residue is made by heating 50 gram sample to 149□C (300□F) until foaming ceases, then cool immediately and calculate results.
2Test procedure identical with ASTM D-244 60 except that .02 Normal Calcium Chloride solution shall be used in place of distilled water..
3Test procedure identical with ASTM D-244 60 except that distilled water shall be used in place of two percent sodium oleate solution.
4Test procedure is attached.
5Chemical composition by ASTM Method D-2006-70
PC = Polar Compounds, A1 = First Acidaffins.
A2 = Second Acidaffins, S = Saturated Hydrocarbons.

Note: For gal/ton conversion use 242 gal/ton.

Note: Data presented are typical. Slight variation may occur from lot to lot.

Reclamite® Application - Nashville, TN – July, 2006

CYCLOGEN® Hot Recycling Agents Specifications

Property	Function and Purpose	ASTM Test Method	L	M
Viscosity @ 60□C, cSt	Asphalt viscosity adjustment in recycled mix.	D-2170	200-500	1,000-4,000
Flash Point, COC,□C	Handling precaution.	D-92	204 min.	232 min.
Volatility, IBP, □C	Avoidance of air pollution and hardening by evaporation.	D-1160 10mm	149 min.	163 min.
2% v, □C			191 min	204 min.
5%v, □C			210 min.	221 min.
RTF-C Weight Change, %w		D-2872	4.0 max.	2.0 max.
Compatibility, PC/S	Avoidance of syneresis.	D-2006-70	0.5 min.	0.5 min.
Saturates, %w	Compatibility with aged asphalt.	D-2007	28 max.	28 max.
Asphaltenes, %w	Compatibility with aged asphalt.	D-2006-70	1.5 max.	7.0 max
Chemical Composition (PC+A1)/(S+A2)	Durability of asphalt in recycled mix.	D-2006-70	0.4-0.8	0.6-1.0
RTF-C Ratio2		D-2872	2.5 max.	2.5 max.
Specific Gravity3	Calculations.	D-70	0.98-1.02	0.98-1.02

Tricor emulsions are typically used in 3 methods for cold recycle work:

1. **Surface application to RAP**
2. **Pugmill recycle**
3. **Cold in place recycle**

Typical application to RAP is ½ of 1% to 1 ½% by weight of mix of emulsion concentrate

Tricor uses a design procedure for determining recycling agent addition through years of performing recycle designs. This formula will arrive at the optimum demand for recycling agent in the mix.

The original asphalt content % (determined by extraction) is subtracted from the calculated recycling agent demand %

$$P = \frac{(4R + 7S + 12F) \times 1.1}{100}$$

P = Percent

R = Retained on #8 (2.36 mm) sieve

S = passing #8, retained #200 (.075 mm)

F = passing #200 (.075 mm)

(1.1 or 1.2 compensates for base or soil contamination in the mix)

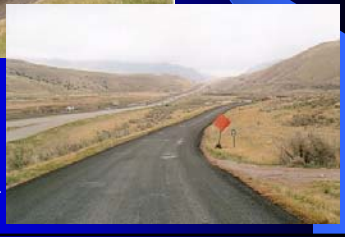
State of Montana and Canadian Experience with RAP in British Columbia

Surface application to RAP

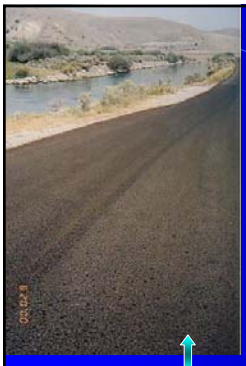
I-15 / I-90 south of Butte, Montana

Milled RAP is hauled to grade,windrow sprayed with rejuvenator

I-15 Butte, Montana



RAP compacted and surface sprayed with Cyclogen® LE



Finished appearance

Chip sealed the following spring

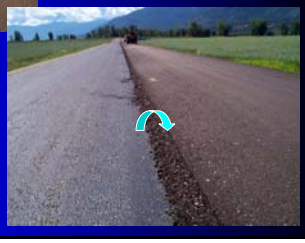
Pug mill application to RAP Rejuvenators restore durability to the RAP

- Durability being the interdependence between composition and aging
- Rejuvenators can return a desired consistency to the aged asphalt

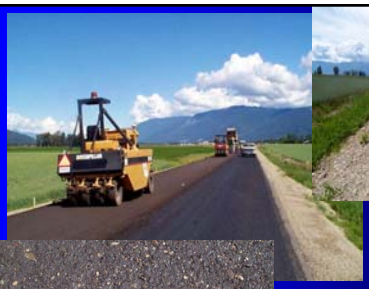
Creston, British Columbia – Pugmill / Paver Placement of RAP

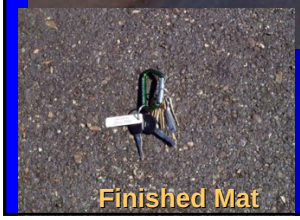
Cyclogen® LE addition 1% by weight of mix. 6.6 gallons/ton (30 L/MT) 1:3 dilution to achieve 4-5% moisture content in RAP mix

Creston, British Columbia (100 miles north of Coeur d' Alene, Idaho)



Paver application of RAP to 5 inches, compacted to 4 inches. Existing asphalt tacked with CSS-1





Finished Mat

Rubber tire roller compaction and finished appearance Creston, B.C.

Reclamite® Fog Seal 1:1 dilute

Creston, BC RAP Appearance

Creston, BC, finished appearance of RAP placed 3 months earlier

Stillwater County – Countryman Creek Road Columbus, Montana Pugmill / Grader Placed RAP

- Project Length: 3.6 miles
- RAP mixed through pug mill
- Reclamite® Mixed @ 1.5% /Wgt.
- Two 4" Lifts
- Compaction: 9 wheel trucks
- Fog seal Reclamite® @ .20gal. / sq. yd.
- temp. 75/90 sunny

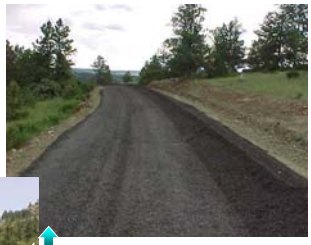
Stillwater County,
Columbus,
Montana MDOT
Milling Project
I-90

Pugmill addition of Cyclogen® LE recycling oil with RAP

Blading of RAP

Compaction using
rubber tire roller

Stillwater County
Montana



Grading and
Windrow

Finished appearance Springwater Road,
Livingston, Montana

Finished appearance, light sand applied as a blotter

Stillwater County
Montana

CIR – Cold in Place
Recycle – Hwy 93, Elko, BC
/ north of Eureka, MT

Cyclogen® LE addition 1% by weight of mix diluted 1:3 with water to achieve 4-5% moisture in the mix.

Addition: 8.8 gallons ton (40 L/ Metric Tonne)

Park Paving Ltd. June, Hwy 93, Elko, BC cold in place recycle – addition of Cyclogen® LE (southeastern BC – Fernie area.)

CIR Train:
Milling unit and
crusher

Paver Screed and Finished Mat
prior to compaction

Hwy 93,
southeastern BC,

Compaction and
finished mat
appearance

Product Cost
Hot Mix vs. Cold Mix with RAP

Hot Mix

- **Hot mix fob plant: $60ton.**
- **Place 2 inches compacted (216 lbs. X 14,080 sq. Yds <2000 lbs. = 1521 ton @ $60.00/ ton.**
- **$91,260 < 14,080 sq. Yds (24 foot mile) = $6.48 sq. Yd.**

Cold Mix

- **4 inches RAP compacted = 4x108 lbs. X 14,080 sq. Yds. < 2000 lbs = 3,041 ton.**
- **1.5% - 2% addition of Cyclogen® LE or ME = 46-61 ton concentrate diluted 1:1**
- **@ $520. ton ($2.15 gallon) = $23,920. - $31,720. = $1.70 - $2.25 sq. Yd.**

Cyclogen® L Penetration Values
Typical with addition of 0.1% by weight

Northern - Canada

- British Columbia south coast 80-100 pen. Grade asphalt is typically 60-70 pen out of the plant.
- Goal – is to restore to a minimum of 60 pen.
- Addition:

20 pen, add 0.5%.
40 pen, add 0.3%.
50 pen, add 0.2%.
60 pen, add 0.1%.
Below 20 pen, it is difficult to add enough recycle oil, but still adds workability to the mix.

Southern - US

- Addition:

20 pen. – 0.1% will add 2-6 pen. points.
20-45 pen. – 0.1% will add 7-10 pen points.
50 pen - 0.1% will add 11-16 pen points.

Thank You

Tricor Refining

Producers of Golden Bear Preservation Products

Tricor is a partnership of Ergon, Inc. and San Joaquin Refining, Inc.

Contact: Jim Brownridge

Phone: 661.393.7110

email: jimb@tricorrefining.com