

Safer Alternative Release Agents and Cleaners for Industrial Parts Molding, Concrete Stamping and Asphalt Operations

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- Small nonprofit technical organization established in 1989
- Identifies, develops, tests and demonstrates safer alternatives in consumer product and industrial applications with focus on solvents
- Projects have led to reduction in use of hazardous substances in California by more than 100 tons per day

Background on Release Agents

- Release agents used to prevent certain materials from sticking to a substrate
- Release agents used today have high VOC content and may contain hazardous components
- Cleaning agents used for industrial molds have high VOC content and some of them are toxic

Research Description and Focus

- Project sponsored by EPA Region IX and the South Coast Air Quality Management District (SCAQMD) under EPA's PPG program
- SCAQMD interested in finding additional VOC reductions to prevent formation of smog
 - › Regulates half the stationary sources in California
 - › Has already developed stringent regulations in many applications

Research Focus Cont'd

- ◉ Original project addressed finding low VOC release agent and cleaning agent alternatives in two applications
 - › Concrete and concrete overlay stamping
 - › Industrial parts molding
- ◉ Later added another application
 - › Asphalt manufacturing and application

Background on Concrete and Concrete Overlay Stamping

- Contractors use stamp mats to stamp a pattern into concrete
- Mimics look of stone
- In concrete stamping, thick concrete is poured and the top is stamped
- In concrete overlay stamping, thin layer of concrete is poured over other substrate and stamped
- Almost all stamped concrete is also colored
- Four or five mats are used on a job and moved from one location in the stamped area to another

Concrete Stamping Cont'd

- Stamp mats will stick to concrete as it is curing
- Must use a release agent between the mat and the curing concrete
 - > Acts as a barrier to prevent sticking
- Release agents are either powder or liquid
 - > mineral spirits formulations which have high VOC content
- Generally add color packets during the stamping process for concrete stamping
- Often color the concrete later in concrete overlay stamping



Concrete Stamping Alternatives Testing

- Worked with two companies who supply products
 - › One for concrete stamping and concrete overlay stamping
 - › One for concrete overlay stamping
- Tested a variety of low VOC alternatives
 - › Water-based materials
 - › VOC exempt chemicals
 - › Low VOC content materials
- Water-based materials
 - › Not suitable for this operation because water is evaporating from the concrete surface during the curing process

Stamping Alternatives Testing Cont'd

- Exempt chemicals
 - › Tested several, including acetone, propylene carbonate, PCBT
 - › Some released well but tried to “clean” the concrete and removed color during stamping process
- Low VOC content materials
 - › Tested lubricant formulations, methyl esters (soy) and recycled vegetable oil (soy and canola)
 - › Soy and recycled vegetable oil released well but tried to “clean” the concrete and removed color
 - › Petroleum based lubricant was best alternative
 - Structurally similar to mineral spirits
 - Inert material that does not clean concrete
 - Worked effectively in limited testing



Stamping Alternatives Testing Cont'd

- ◉ Field tested Dodge Oil lubricant
 - > Worked well
 - > Does not compromise the appearance of colored concrete



Results of Stamping Alternatives Testing

- Colored concrete
 - › Dodge Oil lubricant is best product
- Uncolored concrete
 - › Four alternatives performed well
 - PCBT
 - Dodge Oil lubricant
 - WD 40 soy lubricant
 - Promethean Biofuels recycled vegetable oil
- Powder has been used for many years and is a viable option for both colored and uncolored concrete

Market Estimates for Concrete Release Agents

- VOC emissions estimates varied for South Coast Basin
 - › Range from 25,781 to 93,590 gallons per year for concrete stamping
 - › Range from 8,594 to 31,196 gallons per year for concrete overlay stamping
- Colored concrete estimates
 - › 85% of concrete stamping is colored during stamping
 - › 30% of concrete overlay stamping is colored during stamping

Annual Cost Comparison for Industrywide Release Agents for Concrete Stamping

Release Agent	Colored Concrete Stamping		Uncolored Concrete Stamping	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Mineral Spirits	\$419,107	\$1,521,428	\$169,118	\$613,910
Dodge Oil Product	\$523,149	\$1,899,118	\$211,101	\$766,311
WD 40 Product	NA	NA	\$589,185	\$2,138,784
PCBTF	NA	NA	\$526,566	\$1,911,473
Recycled Vegetable Oil	NA	NA	\$136,385	\$495,089

Cost Comparison for Mineral Spirits and Powder Release Agents

- Powder currently accounts for about 80% of release agent market
- Same coverage can be achieved with
 - › 30 pound bucket of powder which costs \$33.50 and
 - › Five gallon bucket of mineral spirits release agent which costs \$66
- Cost of using powder release agent is lower than cost of using any liquid release agent

Other Potential Options Examined by IRTA

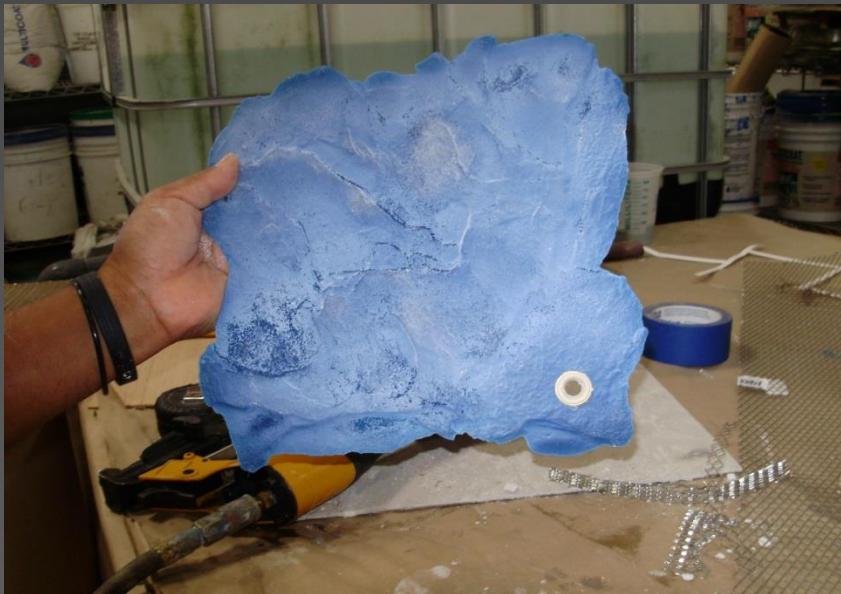
◎ Non-stick mats

- › Tested silicone pans and baking mats
- › Did not prevent sticking but could be easily removed
- › Not viable because must move mats over surface to be stamped quickly
- › Promising concept but many materials too flexible and must be rigid enough to be tamped down on surface

Other Options Cont'd

◎ Non-stick Coatings for Mats

- › Tested silicone and fluoropolymer non-stick coatings
 - Both coatings left some residue which is not acceptable
- › Tested NeverWet aerosol coating
 - Worked well for overlay mix which is stickier than plain concrete mix
 - Was not very durable
 - Would be comparable in cost if further field testing indicated it would last through a complete stamping job



Background on Asphalt Manufacturing and Application

- ◉ Asphalt is mixture of hydrocarbons called bitumens
- ◉ Found in natural deposits or is byproduct of petroleum industry
- ◉ Used for highway surfacing, airport runways, tennis courts and playgrounds
- ◉ Most asphalt is hot mix
- ◉ Applied by spreading and compacting

Background Cont'd

- Becomes sticky over time as it is worked
- Must use release agent in asphalt manufacturing plants on some equipment and on application equipment like tractor scoops, rakes and shovels
- Release agent widely used is diesel fuel which is a VOC
- Used by manufacturers, cities and counties and contractors



Asphalt Alternatives Testing

- Tested low VOC alternative with Escondido Asphalt for plant equipment
- Recycled vegetable oil
 - > Mixture of soy and canola oil
 - > Worked well and company converted

Annual Cost Comparison for Release Agents at Escondido Asphalt

Release Agent	Annual Cost
Diesel Fuel	\$16,575
Recycled Vegetable Oil	\$22,425

Asphalt Alternatives Testing Cont'd

- Tested two alternatives with city of Simi Valley for asphalt application
- Did not want to test vegetable oils so tested two petroleum based lubricants
 - > Worked acceptably

Annual Cost Comparison for Release Agents at Simi Valley

Release Agent	Annual Cost
Diesel Fuel	\$638
Holly 70	\$1,305
Bango 250	\$1,230

Testing Cont'd

- ◉ Tested two alternatives with private contractor
 - › WD 40 soy
 - › Promethean Biofuels recycled vegetable oil
- ◉ Both worked but preferred recycled vegetable oil

Annual Cost Comparison for Release Agents at Asphalt and Grading Paving Company

Release Agent	Annual cost
Diesel Fuel	\$2,550
WD 40 Product	\$14,904
Recycled Vegetable Oil	\$4,140



Background on Manufactured Parts Molding

- Parts made of various substrates are molded into desired shape
 - › Fiberglass, composite, concrete, polymers of various types
- Use master mold to make parts
- Must use release agent between mold and substrate so parts won't stick
- Three types of release agents
 - › Wax based release agents used historically for fiberglass and still used to some extent
 - › Liquid release agents
 - › Internal release agents

Background Cont'd

- ◉ Wax and liquid release agents generally based on mineral spirits
 - › Some release agents are water-based
 - › Internal release agents have no carrier
- ◉ Companies using wax based release agents must clean molds
 - › Generally use styrene which is a VOC and a carcinogen
- ◉ Some companies use VOC solvents to remove mold protectant

Project Testing

- IRTA worked with two companies using wax based mold release for fiberglass
- IRTA worked with other companies using liquid VOC release agents for fiberglass, concrete, foam
- IRTA worked with one company using aerosol VOC release agent for composite
- IRTA worked with one company using wax based mold release agent requiring cleaning
- IRTA worked with one company using VOC aerosols to remove mold protectant

Alternatives Testing

- ◉ IRTA worked with supplier to develop and test VOC exempt chemical liquid release agent
 - > PCBTF formulation
- ◉ IRTA tested water-based liquid release agent
- ◉ IRTA tested cleaners for
 - > Molds with wax based release agent
 - > Molds with mold protectant

Case Study-Boat Manufacturer

- Boat manufacturer with fiberglass hulls
 - › Used wax based mold release agent
- Tested water-based and PCBTF based liquid release agents
 - › Both worked effectively to make multiple parts

Boat Manufacturer Cont'd.

**Annual Cost Comparison for Liquid Mold Release Agents
for Boat Manufacturer**

Cost Component	Wax Mold Release Agent	Water-Based Mold Release Agent	PCBTF Mold Release Agent
Mold Release Agent Cost	\$2,550	\$1,510	\$2,207
Labor Cost	\$3,900	\$2,275	\$2,275
Total Cost	\$6,450	\$3,785	\$4,482



Case Study-Composite Aircraft Parts Manufacturer

- ◉ Makes phenolic impregnated decompression panels for aircraft
- ◉ Uses VOC aerosol release agent
- ◉ Tested alternative water-based aerosol and liquid release agent products
 - Aerosol product did not work effectively
 - Liquid release agent worked effectively

Composite Parts Cont'd.

Annual Cost Comparison of Mold Release Agents for M.C. Gill

Cost Component	Aerosol Mold Release Agent	Water-Based Mold Release Agent
Release Agent Cost	\$4,990	\$2,056
Total Cost	\$4,990	\$2,056



Case Study-Concrete Parts Manufacturer

- Makes precast concrete parts
 - › Barriers, supports for piers, utility vaults, reinforced pipe
- Used liquid release agent applied to steel molds with a hand pump sprayer
- Tested several alternatives
 - › Dodge Oil lubricant
 - › WD 40 soy
 - › PCBTF liquid release agent
 - › Propylene carbonate
- Plant manager provided smaller testing devices

Concrete Parts Cont'd

- ◉ Three alternatives were acceptable
 - > Propylene carbonate did not release
- ◉ Sister company converted to recycled vegetable oil

Concrete Parts Cont'd

Annual Cost Comparison of Mold Release Agents for Oldcastle Precast

Release Agent	Annual Cost
Grifcote FR-S-VOC	\$41,600
Dodge Oil Product	\$46,280
WD 40 Product	\$129,168
PCBTF Product	\$449,800



Case Study-Cleaning Wax Based Mold Release

- Tested with boat manufacturer
- Currently using styrene
- Tested range of alternative cleaners, cleaning methods
 - › PCBTF was only alternative that worked effectively
- Better option is to convert to liquid release agent making cleaning unnecessary



Wax Based Release Agent Cleaning Con't

Annual Cost Comparison of Cleaners for Boat Manufacturer

Cleaner	Purchase Cost
Styrene	\$250
PCBTF	\$795

Case Study-Cleaning Mold Protectant

- Company makes compression molded plastic parts for restaurant supply applications
- Uses internal mold release agent
- Metal molds must be protected from rusting with dry film mold protectant between runs
- Company uses hexane aerosol cans for cleaning off mold protectant

Mold Protectant Cont'd

- IRTA formulated and tested alternatives
- Two different exempt chemical blends in nonaerosol form
 - > Acetone/glycol ether
 - > Acetone/PCBTF
- Dry ice blasting
- Acetone/PCBTF blend worked well and dry ice blasting worked well



Mold Protectant Cont'd

Annualized Cost Comparison of All Cleaning Options for CAMBRO

Option	Annualized Cost
Hexane Aerosol Cleaning	\$56,174
Acetone/Glycol Ether Cleaning (five gallon pails)	\$22,914
Acetone/Glycol Ether Cleaning (drums)	\$11,454
Acetone/PCBTF Cleaning (five gallon pails)	\$34,681
Acetone/PCBTF Cleaning (drums)	\$26,020
Dry Ice Blasting (no system purchase, same labor)	\$3,546
Dry Ice Blasting (no system purchase, double labor hours)	\$7,113
Dry Ice Blasting (system purchase, same labor)	\$6,198
Dry Ice Blasting (system purchase, double labor hours)	\$10,680

VOC Emissions Estimates for Applications of Interest

Release Agent Inventory Estimates

Sector	Inventory (Tons Per Day)
Concrete and Concrete Overlay Stamping	0.32 to 1.17
Asphalt Manufacturing and Use	7.14
Parts Manufacturing	0.92
Total	8.38 to 9.23

Health and Environmental Issues

- Concrete rinsing
 - › Storm water regulations are zero discharge
 - › DTSC regulates releases to land
- Styrene and hexane toxicity
 - › Styrene is a carcinogen and hexane causes peripheral neuropathy
- PCBT potential toxicity
 - › Chemical exempted from VOC regulations many years ago
 - › Is widely used in many applications to comply with strict California VOC limits
 - › NCI cancer testing results available in 2015

Best Alternative Low-VOC Release Agents and Cleaners

Type of Operation/Activity	Alternative Option	Conditions
Concrete Stamping	Dodge Oil Product	All Concrete
	Recycled Vegetable Oil	Uncolored Concrete
	Powder Release Agent	All Concrete
Asphalt Manufacture And Application	Recycled Vegetable Oil	
Fiberglass Parts Manufacture	Water-Based Release Agent	
Composite Parts Manufacture	Water-Based Release Agent	
Foam Parts Manufacture	PCBTF Release Agent	
Concrete Parts Manufacture	Dodge Oil Product Recycled Vegetable Oil	
Fiberglass Mold Cleaning	Water-Based Liquid Release Agent	No Cleaning Needed
Metal Mold Cleaning	Dry Ice Blasting	

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