



TCE Introduction Metal Finishing Forum



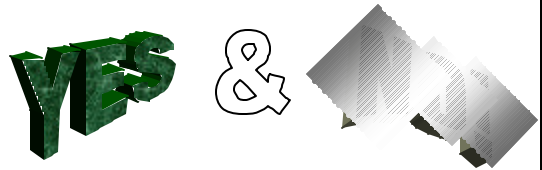
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What is TCE?????



- ❑ A GREAT METAL CLEANER???
- ❑ A FABULOUS VAPOR DEGREASER???
- ❑ AN EXCELLENT SOLVENT???



Also, It Is...



- ❑ A man-made chlorinated solvent = C_2HCl_3
- ❑ A potentially dangerous health hazard
- ❑ Identified as a **high priority substance** by TURA
 - **Made the list because:**
 - ❑ It was determined to be especially TOXIC
 - ❑ It was used in sufficient quantity in MA
 - ❑ Viable alternatives DO exist for most applications

MA TURA Filer Statistics



1990	2001
❑ 41 Facilities filed	❑ 17 Facilities filed decrease of 58.5%
❑ Use=3,651,227	❑ Use=1,393,981 decrease of 61.8%
❑ Byproduct=2,389,120	❑ Byproduct= 289,004 decrease of 87.9%
❑ Releases=1,309,960	❑ Releases=94,856 decrease of 92.7%

MA Industry Sectors with Environmental Releases



Rank	Industrial Sector	Pounds
1	Fabricated Metal Products	26,424
2	Textile Mill Products	26,150
3	Electronic & Other Electric Equipment	17,707
4	Industrial Machinery & Equipment	14,235
5	Primary Metal Industries	11,500
6	Electric, Gas, & Sanitary Services	1,070
7	Chemical & Allied Products	775
8	Wholesale Trade Nondurable Goods	250

Scorecard TCE Data (TRI) 2001

TCE Target Organs



- ▣ Brain – headache, depression, coma
- ▣ Heart – irritability, sudden death
- ▣ Liver – acute chemical hepatitis cirrhosis
- ▣ Kidney – tubular injury
- ▣ Skin - dermatitis

Cirrhosis <http://www.osh.doh.govt.nz> & Dermatitis



Sources of TCE Exposure



Potential Exposure Routes

- **Breathing vapors** at work, near a factory that makes or used TCE, off gassing from consumer products (adhesive, paint etc...)
- **Ingestion** by eating contaminated food
- **Direct skin contact** such as bathing or washing in contaminated water or direct
- **Drinking contaminated water** (wastewater)

Potentially 400,000 U.S. workers exposed annually (TCE fact sheet Lowell Center 2003)

TCE Usage Patterns



- **80% = Vapor degreasing**
 - Fabricated metal parts
 - Some textiles
- 5% intermediate product in organic chemicals or pharmaceuticals
- 5% solvent for dry-cleaning, pre and post spotting and chemical extractor
- 10% exported
(EPA 2004)

Workplace Exposure Limits



- OSHA
 - PEL = 100 ppm TWA 8-hr wk shift
 - 200 ppm not to be exceeded during any 15 min. work period
 - 300 ppm for 5 minutes in any 2-hour work period
 - NIOSH
 - REL = 25 ppm TWA 10-hour work shift
 - ACGIH
 - REL = 50 ppm TWA 8-hour work shift
 - 100 ppm as STEL (Short Term Exposure Limit)
- Odor threshold of 110 ppm = TO LATE!!

TCE Hazard Summary



ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Inhaled, acts as CNS depressive & exposure can cause dizziness, unconsciousness, visual disturbances, nausea & vomiting.	Repeated contact can cause irritation, blistering, roughening and cracking of exposed skin.	It may cause mutations & possible impaired fetal development.
Exposure can result in skin irritation and corneal injury	Repeated exposure can cause memory loss, headache, depression and weakness in the arms and legs.	There is evidence that TCE causes lung kidney & liver cancer in animals.
GI absorption is rapid if ingested and can produce CNS depression. Aspiration onto lungs can cause chemical pneumonia	Drinking or ingesting large amounts may cause liver and kidney damage, impaired immune function.	It may cause lung and liver cancer.
Very high levels can cause irregular heartbeat which can be fatal.	Breathing for long periods of time may cause impaired heart function, unconsciousness & death	

Environmental Fate



- Volatile & evaporates quickly into **air** during cleaning operations. Can break down into phosgene, a known lung irritant
- Precipitation carries TCE to **groundwater** & listed as # 1 contaminant of groundwater.
- In **soil** can filter downward into ground and drinking water supplies & contaminate
- Atmospheric lifetime 1-2 weeks
- Persistence in soil & ground water is longer & can have a half life up to 10 months

TCE Grant- TURI/OTA EPA



- TURI/OTA EPA Grant
 - 1 year (with hope to extend)
 - Identify more users
 - Fully test and report on viable drop in replacements
 - Identify non filer users (cleaning)
 - Make first contact (mailing)
 - Inform of health hazards & viable process specific alternatives
 - Offer **FREE** technical assistance



Alternatives to Trichloroethylene

Surface Solutions Laboratory
Drop-In Solvent Alternatives

Identified Drop-In Solvents



- Identified 20 alternative drop-in solvent degreasers
- Five Classes of Chemicals
 - Hydrochlorofluorocarbon
 - Hydrofluorocarbon
 - Hydrofluoroethers
 - Bromopropane
 - Volatile Methylsiloxanes
 - Dichloroethylene

Class	Base Chemical
1	Chlorinated hydrocarbon*
2	HCFC
3	HFC
4	HFE
5	nPB
6	Volatile Methylsiloxanes
7	Dichloroethylene

* Replaced Solvents

Health Comparison

Chlorinated Solvents

Perchloroethylene

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Single exposures can cause CNS effects such as dizziness, headache, sleepiness, confusion, nausea, difficulty speaking and walking.	Long-term exposure may cause liver and kidney damage.	US Dept of Health & Human Services says reasonably anticipated to be a carcinogen.
High- level exposure may cause vomiting, unconsciousness & death	Prolonged and repeated exposure may cause dermatitis.	Animal testing has linked high exposure to liver and kidney cancer as well as also leukemia.
Not considered a significant skin irritant but prolonged exposure with undiluted liquid may cause skin irritation.	Increased health risks for people with pre-existing skin disorders and impaired renal or liver function.	NIOSH recommends handling it as a possible carcinogen
An eye irritant causing pain, redness and general inflammation.		

Chlorinated Solvents

Methylene Chloride

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Eyes, nose throat and skin irritant that may cause rash coughing & shortness of breath.	Long-term exposure can damage the brain causing memory loss, black outs, poor coordination & personality changes.	Causes cancer in humans & laboratory animals
High levels can affect CNS and cause sluggishness, mental confusion, sleepiness, light-headedness, dizziness & headache.	Higher exposures may damage liver and kidney. Repeated exposures can also cause bronchitis	In animals causes cancer of lung, liver, breast & salivary glands.
Breaks down in body to CO, which decreased blood's ability to carry oxygen resulting in fatigue, shortness of breath and chest pain.	Can irritate lungs, aggravate pre existing heart disease, cause irregular heartbeat, palpitations & rapid pulse	In humans studies show increased risk of cancer of the pancreas & male sterility
Repeated skin contact can cause irritation, thickening and cracking of skin	Repeated exposures can also cause bronchitis with cough, phlegm and/r shortness of breath	

Chlorinated Solvents

Trichloroethylene

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can affect you when breathed in.	May cause a skin allergy.	It may cause mutations (genetic changes).
Contact can irritate and burn the skin and eyes.	Repeated exposure can cause memory loss, headache, depression and weakness in the arms and legs.	There is evidence that TCE causes cancer in animals.
Exposure can cause lightheadedness, dizziness, unconsciousness, visual disturbances, nausea and vomiting.	May damage the liver and kidneys.	It may cause lung and liver cancer.
Very high levels can cause irregular heartbeat which can be fatal.	Repeated contact can cause irritation, blistering, roughening and cracking of exposed skin.	

HydroChloroFluoroCarbon

AGC Chemicals - AK-225

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can cause eye and skin irritation and redness	Prolonged inhalation exposure can cause hepatitis, heart irregularities or death	May cause liver cancer
Exposure can cause shortness of breath & confusion	Shows liver enlargement in animal tests	
High acute exposure can cause unconsciousness, cardiac irregularities and be fatal		

HydroFluoroCarbon

DuPont - Vertrel CCA, MCA, Heavy Duty Degreaser C, Flux Remover C

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can cause eye & skin irritation, pain, redness and swelling. May also cause blurred vision.	Prolonged inhalation exposure can cause liver & lung damage	Not listed as a carcinogen by IARC, NTP, OSHA or ACGIH
Exposure can cause shortness of breath, confusion, dizziness and weakness	May cause heart muscle damage, chemical pneumonia and pulmonary edema	
High acute exposure can cause unconsciousness, cardiac irregularities and death		

HydroFluoroEther

3M - Novec HFE 7100, 7200 & 71DE

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can cause eye and skin irritation, swelling, itching, drying and blurred vision	Prolonged exposure could cause cardiac sensitization and CNS depression	No available information
Inhalation exposure can cause respiratory irritation such as cough, running nose, throat pain and headache		
High acute exposure can cause CNS depression, dizziness, drowsiness, slurred speech, slowed reaction time & unconsciousness		

N-Propyl Bromide

EnviroTech - Ensolv, Ensolv A; Petroform - Lenium GS, ES; Kyzen - Metalnox M6960

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can cause eye and skin irritation and redness	Prolonged exposure may cause lung, liver and kidney damage	No available information
Ingestion of a large amount can cause abdominal pain, nausea and vomiting	Extended skin exposure may lead to pain, cracking and dermatitis	
High inhalation can cause respiratory tract irritation, CNS depression and anesthetic effects		

Volatile Methyl Siloxanes

Dow - OS 10, OS 20, OS 30

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Can effect you when breathed in or ingested	Over exposure to skin can cause de-fating and drying of skin leading to dermatitis.	Insufficient information available
Can cause eye and skin irritation and redness	Repeated ingestion can cause internal injuries	
High levels of exposure can cause dizziness, disorientation & shortness of breath		

Dichloroethylene

PPG Industrial - VersaTran

ACUTE EFFECTS (SHORT TERM)	CHRONIC EFFECTS (LONG TERM)	CANCER HAZARDS
Short term inhalation exposure can cause CNS depression causing drowsiness, tremors, loss of coordination, dizziness, weakness	Prolonged exposure may cause de-fatting of skin & dermatitis	Not listed as a suspected carcinogen by NTP, IARC or OSHA
Longer exposures may cause nausea, headache and vomiting		
Skin, eye and respiratory tract irritant		
Ingestions may cause mouth & GI tract irritation. Aspiration into lungs can cause potentially fatal chemical pneumonia & pulmonary edema		

Solvent Comparison

Type	1	1	1	2	3	3	3	3	4	4	4	5	5	5	5	5	5	5	6	6	6	7		
Product	Perchloroethylene	Methylene Chloride	Trichloroethylene	Asahiklin AK 225	CCA	MCA	Hexa-Cluor Fluor Remover C	Flux Remover C	HFE 7100	HFE 71DE	HFE 7200	Ensolv	Ensolv A	Lenium CP	Lenium IS	Lenium OS	Metalnox M6960	Solvon@ PB	Solvon@ IP	OS 10	OS 20	OS 30	VersaTran	
Vapor Pressure (mm Hg)	15.8	395	69	262	498	464	488	488	203	383	109	139	139	150	111	111	112	139	139	42.2	3.9	0.43	338	
Latent Heat (cal/g)	50.1	70.9	57	34.8	47	43.3	+45	+45	26.7	48	30	50.0	50.0	50.0	50.0	50.0	50.0	50.0	200	200	200	221		
Surface Tension (dynes/cm)	22.3	28.2	29	16.2	18.8	15.2	18.8	18.1	13.6	15.6	13.6	25.9	25.9	25.9	25.9	25.9	25.9	25.9	24.2	15.2	16.5	17.3	27.5	
Boiling Point (°C)	121	40	67.2	54	37	39	37	36	81	41	76	70	67	54	68	71	71	71	80	100	152	194	47.0	
Flash Point (°C)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	-3	34	57	2.2	
Ozone Depletion Potential	0.005	0.007	0.007	0.03	0	0	0	0	0	0	0	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0	0	0	0	low
Global Warming Potential												0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0	0	0	low	
Flammability	-9	9	-9	370	676	806	low	low	200	160	55	0.002	0.002	0	0	0	low	low	low	low	low	low	low	
TSC (ppm)	NA	NA	NA	NA	530	530	519	580	NA	NA	NA	333	333	360	1250	1300	1099	1330	1330	NA	NA	NA	NA	
SNAP Approved	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Pending	Pending	Pending	Pending	Pending	Pending	Pending	Pending	Yes	Yes	Yes	Yes	
MB Value	90	136	125	31	35	78	75	10	27	5	129	129	+126	+126	+126	+126	+126	+126	125	125	16.6	15.1	134	117
Exposure Level (ppm)	25	25	50	100	200	200	200	200	200	200	200	NE	NE	25	25	25	25	100	100	200	200	200	200	

NA = Not applicable
NE = Not established

Summary of Comparison to TCE

- Vapor Pressure
 - 17 have higher VP
- Latent Heat
 - 8 have lower LH
- Surface Tension
 - 18 have lower ST
- Boiling Point
 - 17 have lower BP
- Flash Point
 - 16 have same FP
- Ozone Depletion Potential
 - 10 have lower ODP
- Global Warming Potential
 - 5 have lower GWP
 - 9 have similar GWP
- Volatile Organic Content
 - 19 have lower VOC
- SNAP Approval
 - 12 have SNAP
 - 8 are pending SNAP
- Kari-Butanol Value
 - 8 have higher or equal KB
- Exposure Levels
 - 14 have higher TWA
 - 2 of these may be changed to lower

Better Than or Equal to TCE

For getting into hard to reach places, recovery and environmental impact

Out of the 11 Categories

Heavy Duty Degreaser C	10	Ensolv	7
Flux Remover C	10	EnsolvA	7
CCA	9	LENIUM GS	7
MCA	9	Metalnox M6960	7
HFE 7100	9	LENIUM CP	6
HFE 71DE	9	LENIUM ES	6
HFE 7200	9	OS 10	6
Solvon@ PB	8	OS 20	6
Solvon@ IP	8	OS 30	6
Asahiklin AK 225	8	VersaTran	6

Methylene Chloride	7
Perchloroethylene	4

Performance of Alternatives

Contaminants Removed

- Conducted over 20 experiments
- 11 Contaminants

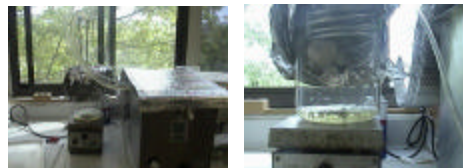
Soil 1	Oil - Soltex Polyisobutylene (9003-24-6)
Soil 2	Oil - Cargill, Inc AP 60 Canola Oil (120962-03-0)
Soil 3	Oil - Nisseki SAS 40 (27776-01-8, 612-00-0, 103-29-7, 101-81-5)
Soil 4	Oil - C.P. Hall Co Plashall ESO (8013-07-8)
Soil 5	Oil - Castrol Industrial North America Castrol Quench G quench oil (64742-55-8, 64742-65-0, 8052-42-4)
Soil 6	Coating - Rochester Midland Corp RI 780 Rust Preventive coating (8052-41-3, 95-63-6)
Soil 7	Paint - Varnish Mix Cooper Creek Chemicals Cooper Black Tank Paint (64742-89-8, 8052-42-4, 108-88-3); Sherwin Williams Co V74B2 Black Asphaltum (64742-89-8, 64742-88-7, 8052-42-4)
Soil 8	Oil - Exxon Mobil Vacmul O3D (64741-44-2)
Soil 9	Cutting fluid - Houghton International Cut-Max 135 (64742-52-5, 64741-96-4)
Soil 10	Oil - Lanson Oil Co Vanish 6912 (64742-48-9)
Soil 11	Oil - Houghton International Cindol 3401 (64742-46-7)

Cleaning Soils 1-4 on Aluminum via Immersion Cleaning

Product	Soil 1	Soil 2	Soil 3	Soil 4
Asahikin AK 225	94.0	73.3	97.1	84.3
CCA	97.3	86.4	86.8	85.0
MCA	97.2	78.1	74.0	75.1
Heavy Duty Degreaser C	90.3	87.3	95.7	98.1
Flux Remover C	99.7	98.4	97.5	98.3
HFE 7100	9.3	53.6	99.6	52.0
HFE 71DE	97.4	86.5	77.8	80.6
HFE 7200	19.1	55.6	101.6	58.8
Ensolv	99.7	99.6	99.2	99.6
EnsolvA	99.8	99.7	99.2	98.5
Metalnox M6960	97.7	100.0	100.1	99.6

Cleaning Soils 1-4 on Aluminum via Vapor Degreasing Cleaning

Product	Soil 1	Soil 2	Soil 3	Soil 4
Ensolv	100.0	99.9	99.4	100.0



Cleaning Soils 5-7 on Steel via Immersion Cleaning

Product	Soil 5	Soil 6	Soil 7
Asahikin AK 225	97.3	95.2	33.8
CCA	95.7	96.8	32.1
MCA	92.7		
Heavy Duty Degreaser C	91.3		
Flux Remover C	96.2	95.7	22.4
HFE 7100	90.5		
HFE 7200	98.6	98.7	10.6
Ensolv	97.9	94.9	97.2
EnsolvA	98.5	97.1	98.5
Metalnox M6960	98.3	91.7	98.8
Solvon® PB	99.5	97.8	99.7
Solvon® P	98.4	97.0	98.6

Cleaning Soils 5-7 on Steel via Vapor Degreasing Cleaning

Product	Soil 5	Soil 6	Soil 7
EnsolvA	99.6	100.1	99.1
Metalnox M6960	99.6	99.7	99.7
Solvon® PB	99.6	99.9	97.3

Cleaning Soils 8-11 on Silver via Immersion Cleaning

Product	Soil 8	Soil 9	Soil 10	Soil 11
Asahikin AK 225	96.0	98.3	83.6	93.8
CCA	97.8	89.7	94.4	98.8
MCA	78.3			
Heavy Duty Degreaser C	58.2			
Flux Remover C	34.4			
HFE 7100	93.5	90.4	95.5	98.4
HFE 7200	89.2	88.8	79.1	
Ensolv	96.4	97.9	92.3	94.7
EnsolvA	97.0	99.4	80.0	
Metalnox M6960	96.4	100.3	82.9	98.7
Solvon® PB	99.7	100.8	93.1	99.9
Solvon® P	98.3	99.8	93.2	100.0
OS 10	98.5	99.7	99.5	99.8
OS 20	97.3	99.9	98.0	100.8
OS 30	97.8	99.1	95.9	94.7

Summary of Immersion Testing

Product	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5	Soil 6	Soil 7	Soil 8	Soil 9	Soil 10	Soil 11
Asahikin AK 225	94.03	73.28	97.10	84.32	97.32	95.23	33.81	96.05	98.34	83.56	93.78
CCA	97.25	86.38	86.82	84.95	95.72	98.78	32.11	97.80	89.74	94.36	98.83
MCA	97.15	78.13	74.03	75.08	92.69			78.31			
Heavy Duty Degreaser C	50.31	87.33	95.69	98.09	91.27			58.23			
Flux Remover C	99.66	98.42	97.45	98.29	96.82	95.73	22.36	34.42			
HFE 7100	9.25	53.58	99.58	52.00	90.53			93.48	90.42	95.47	98.36
HFE 710E	97.39	86.46	77.77	80.56							
HFE 7200	19.05	55.64	101.57	58.75	98.62	98.67	10.60	89.20	88.81	79.06	
Ensolv	99.73	99.62	99.21	99.64	97.86	94.85	97.19	96.44	97.86	92.30	94.71
Ensolv A	99.81	99.74	99.15	98.47	98.45	97.12	98.47	96.56	99.41	80.05	
LENIUM CP											
LENIUM ES											
LENIUM GS											
Metalnox M6960	97.88	100.01	100.06	99.56	98.33	91.74	98.76	96.44	100.26	82.92	98.68
Solvon® PB					99.45	97.82	99.71	99.67	100.82	93.09	99.92
Solvon® IP					98.39	97.00	98.55	98.35	99.82	93.21	99.95
OS 10								98.45	99.68	99.50	99.75
OS 20								97.29	99.89	97.98	100.73
OS 30								97.85	99.14	95.88	94.68
VerisaTitan											

Summary of Vapor Degreasing

Product	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5	Soil 6	Soil 7	Soil 8	Soil 9	Soil 10	Soil 11
Asaphidin AK 225											
CCA											
MCA											
Heavy Duty Degreaser C											
Flux Remover C											
HFE 7100											
HFE 71DE											
HFE 7200											
Ensohv	99.98	99.88	99.43	99.98							
Ensohv A					99.58	100.08	99.10				
LENUM CP											
LENUM ES											
LENUM OS											
Masahol M8860					99.83	99.06	99.70				
Solvent® PB					99.81	99.91	97.26				
Solvent® IP											
OS 10											
OS 20											
OS 30											
VersaTrian											

Next Steps

- Fill in the blanks
- Test on wider contaminant base
- Identify additional alternatives and test

Contact Information

Vendor	Product	Address	City	State	Zip	Number	Website	Contact	Distributor
AGC Chemicals	Asaphidin AK 225	1201 Water Ridge Parkway	Charlotte	NC	105217	704.326.7607	www.asaphidin.com		
DuPont	CCA	886 John Downey Drive	New Britain	CT	06051	888.595.4625	www.dupont.com		
DuPont	MCA	Woodward Park, 1 Park Drive Unit 9	Westford	MA	01586	978.692.2468 x206	www.asaphidinonline.com	Jeffrey Copson	Asaphidin Products Inc.
Micro-Care Chemical Products	Heavy Duty Flux Remover C	555 John Downey Drive	New Britain	CT	06051	888.595.4625	www.dupont.com		
Micro-Care Chemical Products	Flux Remover C	3M Center, Building 223-62, Drive Unit 9	Westford	MA	01586	978.692.2468 x206	www.asaphidinonline.com	Jeffrey Copson	Asaphidin Products Inc.
3M	HFE 7100	3M Center, Building 223-62, 04	St. Paul	MN	55144	800.833.0345	www.3m.com/fluids		
3M	HFE 71DE	3M Center, Building 223-62, 04	St. Paul	MN	55144	800.833.0345	www.3m.com/fluids		
3M	HFE 7200	3M Center, Building 223-62, 04	St. Paul	MN	55144	800.833.0345	www.3m.com/fluids		
Enviro Tech International	Ensohv	2525 West LeMayne Avenue	Melrose Park	IL	60160	708.343.4641	www.ensohv.com	Scott Aulnicks	
Enviro Tech International	Ensohv A	2525 West LeMayne Avenue	Melrose Park	IL	60160	708.343.4641	www.ensohv.com	Scott Aulnicks	
Parabrom	LENUM CP	2415 Lyndale Road	Fernandina Beach	FL	32034	904.281.6238	www.pdchem.com		
Parabrom	LENUM ES	2415 Lyndale Road	Fernandina Beach	FL	32034	904.281.6238	www.pdchem.com		
Parabrom	LENUM OS	2415 Lyndale Road	Fernandina Beach	FL	32034	904.281.6238	www.pdchem.com		
DOV	OS 10	South Saginaw Road	Midland	MI	48698	800.246.2461	www.dovcoating.com		
DOV	OS 20	South Saginaw Road	Midland	MI	48698	800.246.2461	www.dovcoating.com		
DOV	OS 30	South Saginaw Road	Midland	MI	48698	800.246.2461	www.dovcoating.com		
Kycon	Metalox	445 North Commercial Street	Manchester	NH	03101	603.622.2600	www.kycon.com	Charles Pflanz	
Polyvosts	Solvent® PB	563 Leonard Street P.O. Box 70	Waterbury	CT	06725	203.796.4821	www.solvon.com	Chris Carizzo	Hubbard Hall Chemical Co.
Polyvosts	Solvent® IP	559 Canal Street	Lawrence	MA	01840	800.658.4843	www.solvon.com	Hidene Gerson	Tech Spray Laundry Edge Electronic
PFG Industrial	VersaTrian	One PPP Place	Peabody	MA	01972	800.243.6774	www.pfgindustrial.com		



Alternatives to Trichloroethylene

Surface Solutions Laboratory
Effective Products for Replacing TCE

SSL Testing



- Worked closely with over 20 companies trying to replace TCE in cleaning applications
- A wide range of industries are represented by these companies
 - Aircraft
 - Electronics
 - General Mfr
 - Metal working
 - Optical
 - Plating

Contaminants Removed



- Conducted over 100 experiments
- 11 Contaminant types
 - Abrasives
 - Buffing Compounds
 - Coatings
 - Fluxes
 - Grease
 - Inks
 - Paints
 - Cutting Fluids
 - Lubricants
 - Oils
 - Waxes

Abrasive cleaning has been performed for ceramics parts for a company that manufactures parts for the semi-conductor industry.



Company Name	Product Name	Classification	Contaminant Specifics Info
Amex Corporation	Safety First	Semi-Aqueous	Abrasive - Aluminum Oxide
Brulin Corporation	Formula 815 GD	Alkaline Aqueous	Abrasive - Boron Carbide
Innovative Organics Inc	Amberclean L 12	Alkaline Aqueous	
LPS Laboratories	LPS Precision Clean	Alkaline Aqueous	
National Diagnostic	Opti Clear	Terpene	
US Polychem Corporation	PolysprayJet 790 XS	Alkaline Aqueous	

Buffing compound removal has been conducted for brass and some silver parts for a metal working shop and a light manufacturer.



Company Name	Product Name	Classification	Contaminant Specifics Info
Calgon Corporation	Geo Guard 2215	Alkaline Aqueous	Buffing compound
Chrisal USA Inc	Super CMF 240	Alkaline Aqueous	Buffing compound - Anchor Chemical Co, Anchor Spin G-10
International Products Corp	Micro 90	Alkaline Aqueous	Buffing compound - Jackson Lea Antique Buffing compound LM-12 (8000-70-8,1344-28-1,409-21-2,1309-37-1)
Magnaflex	Daraclean 282 GF	Alkaline Aqueous	Buffing compound - Matchless Metal Polishing Co, 516 Tripoli Compound
Oakite Products	Inproclean 3800	Alkaline Aqueous	Buffing compound - Matchless Metal Polishing Co, Z-230 Buffing Compound (7429-90-5)
US Polychem Corporation	Polyspray Jet 790 P	Alkaline Aqueous	Buffing compound - The Lea Manufacturing Company Learok 2-B-111 - Abrasive, Fatty acids, Glycerides and petroleum wax/oil mix-silica dust (14808-60-7)

Coatings cleaning for a tool manufacturing company have been conducted on steel surfaces using immersion.



Company Name	Product Name	Classification	Contaminant Specifics Info
AWChesteron	278 Super Solv	Petroleum Distillate	Coating - Rochester Midland Corp R1 780 Rust Preventive coating (8052-41-3, 95-63-6)
Dynamold Solvents Inc	DS 108	Petroleum Distillate	
Gemtek Products	SC Aircraft & Metal Cleaner	Alkaline Aqueous	
Metabolix Inc	Metabolix E3HB	Ester	
Oakite Products	Inproclean 3800	Alkaline Aqueous	
Solvent Kleene Inc	D Greeze 1000	Petroleum Distillate	

One request has come to SSL for replacing TCE for **flux** removal. The company manufactured brass bellows.



Company Name	Product Name	Classification	Contaminant Specifics Info
Church & Dwight	Armaklean E 2002	Alkaline Aqueous	Flux - Kester Solder 1544 Rosin Solder flux (64-17-5, 78-92-2, 8050-09-7)
Oakite Products	Inproclean 4000 T	Terpene-Organic	

Grease removal has been investigated for two industry types, a musical instrument manufacturer and a tool maker. Brass, ceramics & steel parts were cleaned using immersion and/or ultrasonic energy.



Company Name	Product Name	Classification	Contaminant Specifics Info
Alconox Inc	Liquinox	Alkaline Aqueous	Grease - Hibrenia Way Apiezon M1
Calgon Corporation	Geo Guard 2215	Alkaline Aqueous	
Gemtek Products	SC Aircraft & Metal Cleaner	Alkaline Aqueous	Grease - Valvoline wheel bearing grease
International Products Corp	Micro 90	Alkaline Aqueous	
Metabolix Inc	Metabolix E3HB	Ester	
Oakite Products	Inproclean 3800	Alkaline Aqueous	
Sky Products Company Inc.	Cleaner #10	Alkaline Aqueous	

Two companies were assisted for **paint/ink** cleaning. A ceramic capacitor/electronics manufacturer and a tool making company requested help cleaning plastic and steel pieces. Cleaning was performed using an immersion process.



Company Name	Product Name	Classification	Contaminant Specifics Info
AWChesteron	278 Super Solv	Petroleum Distillate	Ink
Brolin Corporation	Compliance	Caustic	Paint
Chrisal USA Inc	Super CMF 240	Alkaline Aqueous	Paint - Varnish Mix Cooper Creek Chemicals Cooper Black Tank Paint (64742-89-8, 8052-42-4, 108-88-3); Sherwin Williams Co V74B2 Black Asphaltum (64742-89-8, 64742-88-7, 8052-42-4)
Dynamold Solvents Inc	DS 108	Petroleum Distillate	
Gemtek Products	SC Aircraft & Metal Cleaner	Alkaline Aqueous	
Metabolix Inc	Metabolix E3HB	Ester	
Solvent Kleene Inc	D Greeze 1000	Petroleum Distillate	

Oil removal was the largest contaminant field being cleaned with TCE. Eight companies utilized the lab's services for parts made from steel, carbon steel, stainless steel, aluminum, brass and ceramics. Immersion, ultrasonic and other mechanical agitation systems were used to aid the alternatives.



Company Name	Product Name	Classification	Contaminant Specifics Info
AGA Chemical	AK 225	HCFC	Cutting Fluid
Amex Corporation	Safety First	Semi-Aqueous	Cutting Fluid - Steco Corp, Tap Magic Protap (112-80-1, 112-629)
AW Chesterton	278 Super Solv	Petroleum Distillate	Lubricant
AW Chesterton	KPC 820 N	Alkaline Aqueous	Lubricant - ITW Fluid Products Power Stamp II diluted 5:1 with water
Bio Chem Systems	Bio T 300 B	Terpene-Semi-Aqueous	Lubricant - New England Industrial Lubricants Neilcut 333
Bio Chem Systems	Green Stuff (6325)	Alkaline Aqueous	Lubricant - W.A. Wood #30 Lube Oil
Bruhin Corp	Formula 815 GD	Alkaline Aqueous	Oil
Calgon Corp	Geo Guard 2215	Alkaline Aqueous	Oil - 90 Wt Geat Oil

Dynamold Solvents Inc	DS 108	Petroleum Distillate	Oil - Castrol Industrial North America Castrol Quench G quench oil (64742-558, 64742-65-0, 8052-42-4)
Ecolink	Vortex	Semi-Aqueous	Oil - Clover Grease Lapping Oil
Fine Organic Corp	FO 2085 M	Alkaline	Oil - Exxon Kutwell 40 (64742-52-5, 64742-53-6)
Gemtek Products	SC Aircraft & Metal Cleaner	Alkaline	Oil - Hubbard Hall Inc, Metal Guard 270
Innovative Organics Inc	Amberclean L 12	Alkaline	Oil - ITW Safetap
International Products Corp	Surface Cleanse930	Neutral	Oil - ITW Safetap
Kyzen Corp	Metalnox M6314	Alkaline	Oil - Metal Preserving Oil
LPS Laboratories	LPS Precision Clean	Alkaline	Oil - Metal working fluids
MacDermid	ND 17	Alkaline	Oil - Milacron Cimperial 1070
Magnaflux	Daraclean 232	Alkaline	Oil - Park Chemical Corp Haze Quench Oil
Magnaflux	Daraclean 282 GF	Alkaline	Oil - Precision Finishing Inc, Chemtrol 229

Oil Cleaning (cont).



Magnaflux	Daraclean 283	Alkaline	Oil - Quenching oil (64742-54-7, 64742-56-9, 8052-42-4)
Metabolix Inc	Metabolix E3HB	Ester	Oil - Spartan Chemical MOAC 2945 Coolant (64742-52-5, 64742-53-5, 63449-39-8, 68608-26-4, 68918-91-2, 8002-26-4, 111-46-6, 107-41-5, 4719-04-4)
National Diagnostic	Opti Clear	Terpene	Oil - Speed Fam Industrial Applications Vehicle 210
Oakite Products	Inproclean 2000	Alkaline	Oil - Speedfam #210 Oil-Based Vehicle
Oakite Products	Inproclean 3800	Alkaline	Oil - Water Soluble Oil

Oil Cleaning (cont).



Oakite Products	Inproclean 4000T	Terpene-Organic
Sky Products Company	Cleaner #10	Alkaline Aqueous
Solvent Kleene Inc	D Greeze 1000	Petroleum Distillate
Solvent Kleene Inc	D Greeze 500 LO	Organic
Today & Beyond	Beyond 2001	Alkaline Aqueous
Twin Rivers Corp	Methyl Ester 1618	Ester
US Polychem Corporation	PolysprayJet 790 P	Alkaline Aqueous
US Polychem Corporation	PolysprayJet 790 XS	Alkaline Aqueous
Warren Chemical Co	Sea Wash 8 New	Neutral Aqueous

Four companies from the electronics and metal working sectors were using TCE to remove **wax** from aluminum, brass, ceramics, copper, glass and steel surfaces. Cleaning performed with manual wiping, immersion and /or ultrasonic energy.



Company Name	Product Name	Classification	Contaminant Specifics Info
AG Environmental Products	Canola Gold CE110	Ester	Wax
Bio Chem Systems	Bio T 200 A	Terpene	Wax - Aremco Crystalbond 509 (25610-19-9, 107-21-1)
Bio Chem Systems	Bio T 300 B	Terpene-Semi-Aqueous	Wax - Beeswax
Calgon Corporation	Geo Guard 2215	Alkaline Aqueous	Wax - Roger Reed 6816 Wax, Naturally occurring organic and neutral materials
Dynamold Solvents Inc	DS 108	Petroleum Distillate	Wax - Roger Reed 93114 Wax, Hydrocarbon waxes
Florida Chemical Company	Citrus Burst 7	Terpene	Wax - Roger Reed 98033 Wax, Hydrocarbon waxes

Wax Cleaning (cont.)



Florida Chemical Company	D-Limonene	Terpene	Wax - Roger Reed 98045 Wax, Hydrocarbon waxes
National Diagnostic	Opti Clear	Terpene	Wax- Zopher Mills Inc No 1563 Wax (mixture of waxes and resins)
Oakite Products	Inproclean 2000	Alkaline Aqueous	
Oakite Products	Inproclean 3800	Alkaline Aqueous	
Pentone Corporation	Citrikleen XPC	Terpene-Semi-Aqueous	
Solvent Kleene Inc	D Greeze 500 LO	Organic	
Universal Photonics	Uni Clear	Terpene	

Summary of Alternative Testing



Class	# of Products
Alkaline Aqueous	23
Caustic	1
Ester	3
HCFC (also tested as drop in)	1
Neutral Aqueous	2
Organic	1
Petroleum Distillate	3
Semi-Aqueous	2
Terpene	5
Terpene-Organic	1
Terpene-Semi-Aqueous	2

Cleaning Varies From Case To Case



- ▣ Process specific and pilot testing on potential replacement cleaning chemicals is recommended
- ▣ If more information is needed on a particular product, please contact the lab
- ▣ If you are interested in assistance with your cleaning process, let us know:
 - Phone: (978)934-3133
 - Email: sclab@cleanersolutions.org