



Research Results for Safer Sealant Removal Alternatives

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Background

Polysulfide and polythioether based sealants are widely used in the aerospace/defense industry to seal and protect components of aircraft, missiles, and other products.

Maintenance, repair, and overhaul (MRO) operations require the removal of sealant from coated surfaces, mostly with the aid of sealant removal chemicals.

In the aerospace/defense industry, commonly used sealant removers include hazardous chemicals such as toluene, methylene chloride, and N-propyl bromide.

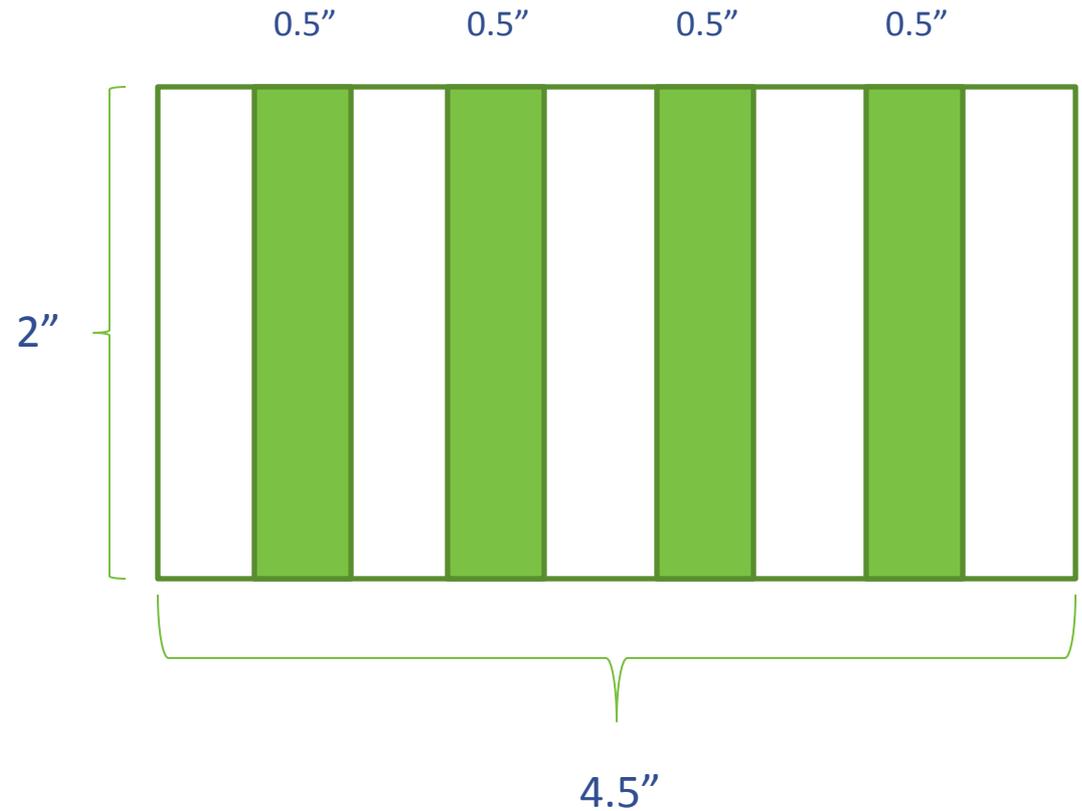


Research Project Approach

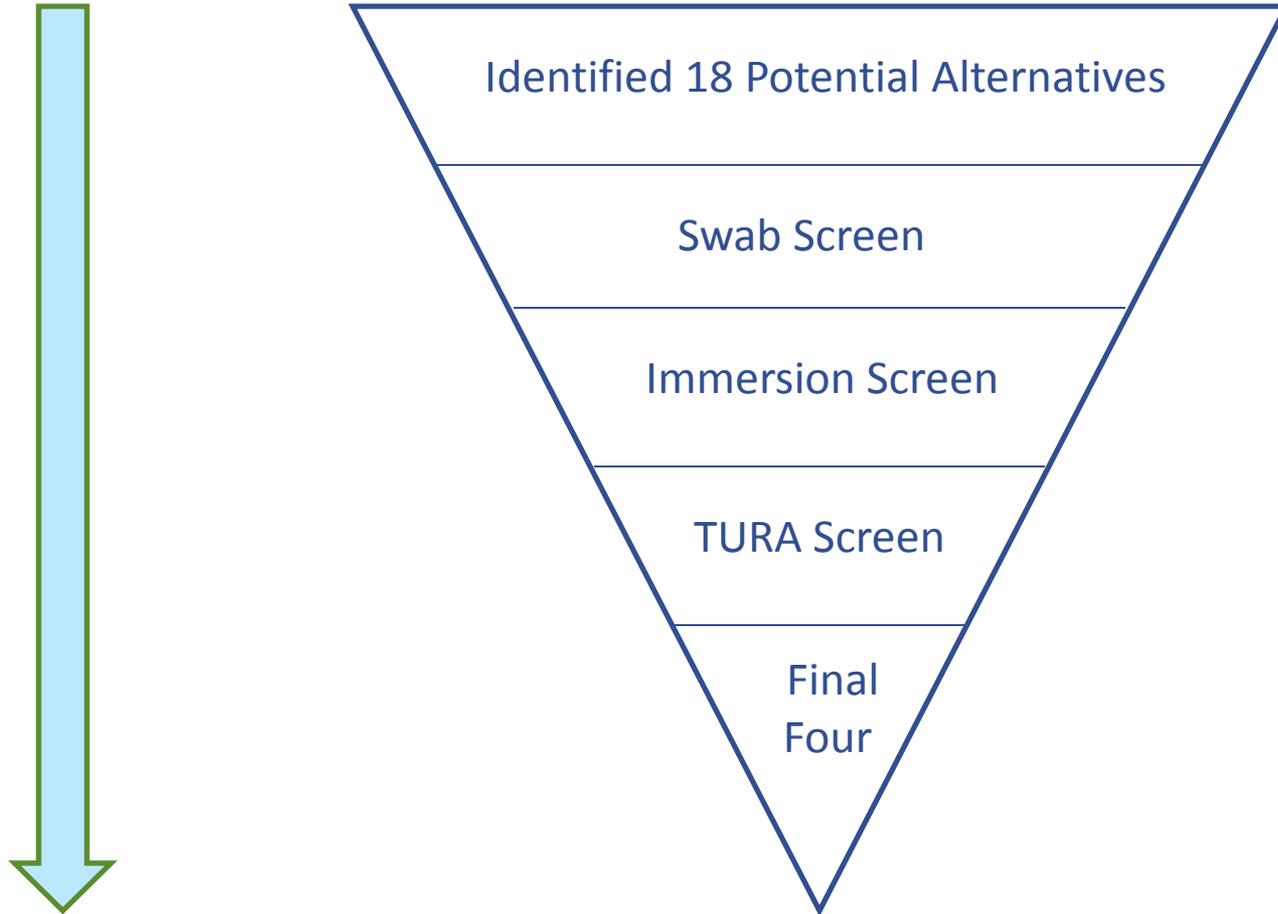
- This assessment identifies and evaluates potentially safer alternatives for sealant removal applications.
- The sealant removal performance of the alternatives was evaluated using a designed experiment.
- The environmental, health, and safety impacts of the alternative removal products were evaluated using the Pharos Chemical and Material Library chemical hazard assessment tool and the Toxics Use Reduction Institute's Pollution Prevention Options Assessment System (P2OASys).

Test Vehicle

- Aluminum plates
- Sealant applied to plate surface
- Sealant is 1" square area,
- Sealant is 0.005" thick.
- Six types of sealants applied



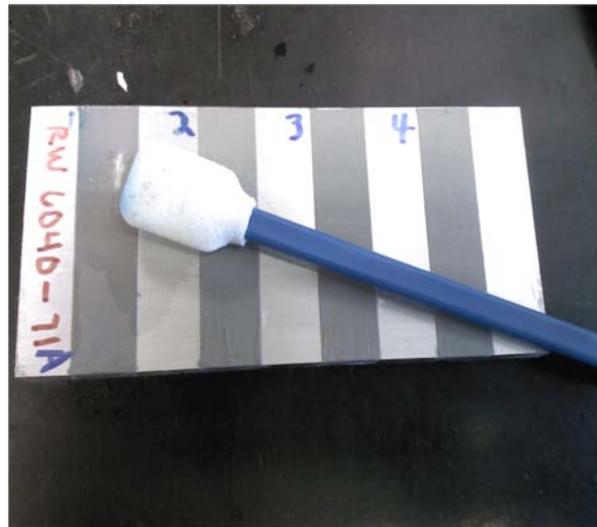
Screening Process



Swab Screen

The first screening method was to apply three drops of sealant remover to a sealant strip for a duration of two minutes, after which the strips were rubbed for one minute using foam swabs to determine if any sealant material was removed.

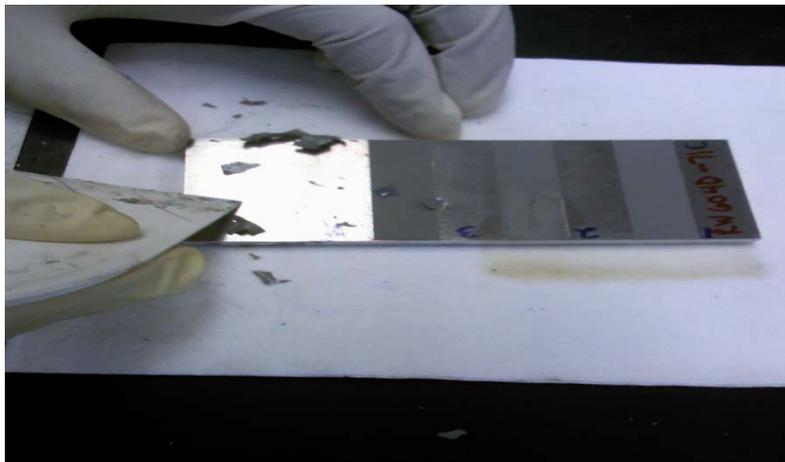
Sealant removers that generated removal of some sealant material during the swab test were considered to pass this screen.



Immersion Screen

The aluminum plates were immersed in glass beakers containing approximately 100 ml of liquid sealant remover for a dwell time of thirty minutes.

Then the aluminum plate was removed from the glass beaker, dried off with a paper towel, and scraped using a plastic scraper. If the sealant strip was completely removed before the end of the three minute scraping process, then the sealant remover passed the screen.



TURA Screen

The Massachusetts Toxics Use Reduction Act (TURA) maintains a list of toxic chemicals. Each chemical ingredient used for the sealant removal products was checked with the TURA list. If the chemical ingredient was on the list then it failed this screen.



Toxics Release Inventory (TRI)

CERCLA (Superfund)

Miscellaneous TURA additions

Screening Results

	Vendor	Product	Screen #1 Swab	Screen #2 Immersion	Screen #3 TURA
★	Barco Products	Soysafe Graffiti Rem.	Pass	Pass	Pass
	Bio Chem Systems	Solsafe 245	Pass	Fail	N/A
	Bio Chem Systems	Bio T Max	Fail	N/A	N/A
	Dupont	DBE6	Pass	Fail	N/A
★	Eastman (Solutia)	SkyKleen 1000	Pass	Pass	Pass
	Finger Lakes Chemical	Resin Eater	Pass	Pass	Fail
	Finger Lakes Chemical	Graffiti Remover	Pass	Pass	Fail
	Gemtek Products	EZ Solv	Pass	Fail	N/A
	Gemtek Products	Maxisolv	Fail	N/A	N/A
	Kreussler	SolvonK4	Fail	N/A	N/A
★	RPM Technology	PolyGone 310 AG	Pass	Pass	Pass
	Socomore	DS-108	Pass	Fail	N/A
★	Socomore	Diestone DLS	Pass	Pass	Pass
	Spartan Chemical Co.	Graffiti Remover SAC	Pass	Fail	N/A
	Spartan Chemical Co.	Green Solutions Floor Stripper	Pass	Fail	N/A
	United Laboratories Int.	Smart Solve 605	Pass	Fail	N/A
	Vertec Biosolvents	Biogold	Pass	Fail	N/A
	Westford Chem. Corp.	BioSolve	Pass	Fail	N/A

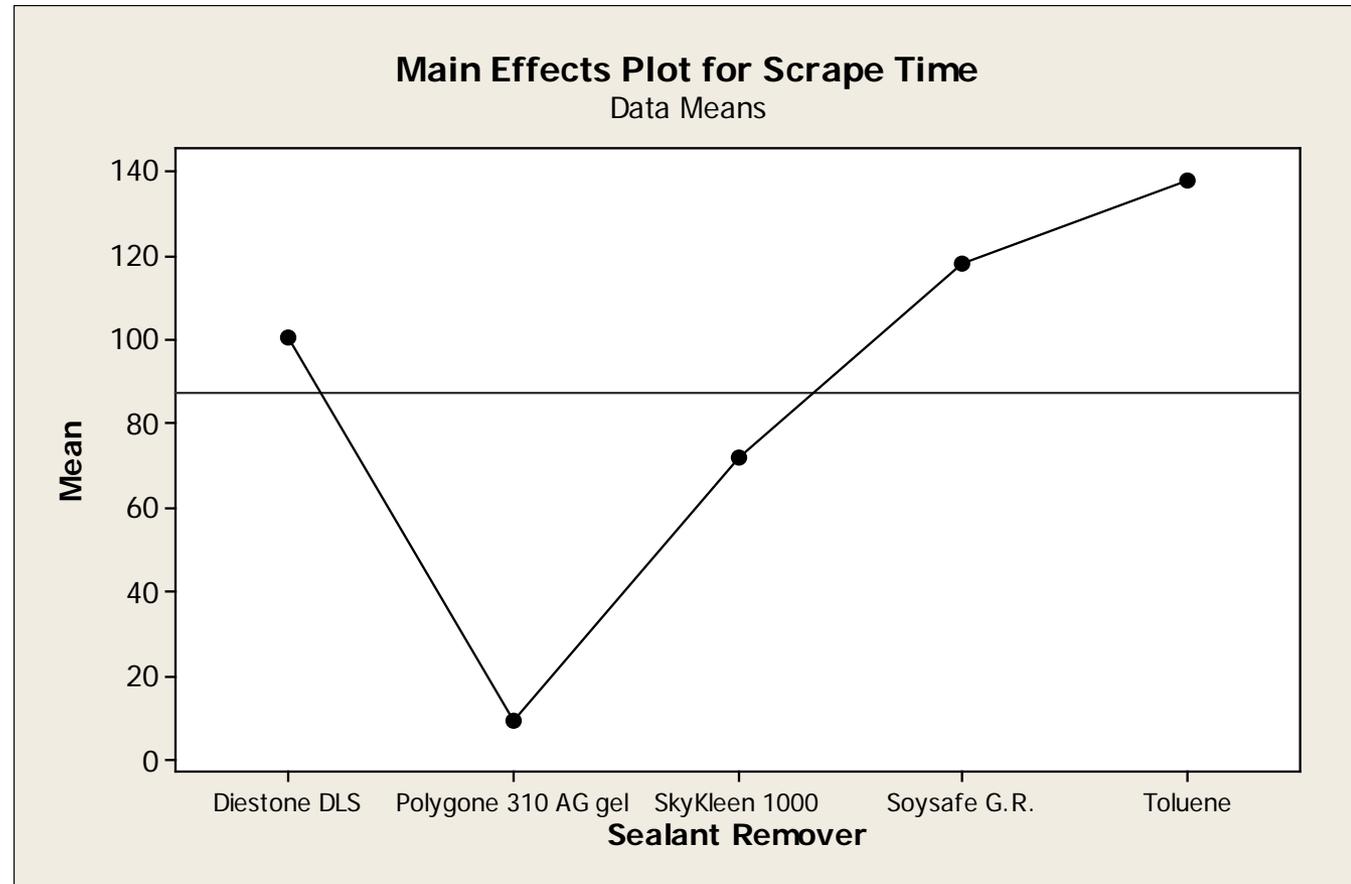
Performance Testing

Category	Description
Process	Immersion for 30 minutes Scrape until complete removal
Sealant removers	<ol style="list-style-type: none">1. Diestone DLS2. Polygone 310 AG3. SkyKleen 10004. SoySafe Grafitti Remover5. Toluene
Sealant products	<ol style="list-style-type: none">1. PPG Aerospace PR-1440 (polysulfide)2. 3M AC-735 (polysulfide)3. PPG Aerospace P/S 870 (polysulfide)4. PPG Aerospace PR- 1775 (polysulfide)5. Flame Master CS-5500 (polysulfide)6. PPG Aerospace PR-2870 (polythioether)
Aluminum plates	6061, 7075
Number of tests	30

Performance Testing Results

- There was no statistically significant difference (P value = 0.147) identified between the scraping time results for the different sealant products.
- There was no statistically significant difference (P value = 0.596) identified between the scraping time results for the different aluminum alloys used for the aluminum plates.
- There was no statistically significant difference (P value = 0.384) identified between the scraping time results for the sealant types (polysulfide and polythioether).
- There was a statistically significant difference (P value = 0.012) identified between the scraping time results of the different sealant removal products.

Sealant Remover Performance Results



<u>Sealant Remover</u>	<u>Mean</u>	<u>Group</u>
Toluene	137.7	A
Soysafe G.R.	117.8	A
Diestone DLS	100.7	A
SkyKleen 1000	72.2	A B
Polygone 310 AG	9.3	B

Ultrasonic Cleaning

Used the Branson 1510 Ultrasonic Cleaner to evaluate the effects of agitation on the sealant removal process. was used for this testing. Transmits ultrasonic sound (frequency of 40 kHz) for enhanced cleaning of materials and parts.

Used the indirect method: placed the aluminum plates within the beaker, and then placed the beaker into the water filled tank.



Ultrasonic Cleaning Results

Sealant Removal Product	Sealant	Scrape Time without Ultrasonic Bath (sec)	Scrape Time with Ultrasonic Bath (sec)	% Reduction in Scrape Time
Gemtek SafeCare EZ Solv	CS5500	12	5	58%
SkyKleen 1000	AC-735	120	90	25%
SkyKleen 1000	PR-1775	50	15	70%
SoySafe Graffiti Remover	PR-1775	90	8	91%

There were not enough samples (4) included in this test to achieve statistically significant results. However, it appears that the use of the ultrasonic cleaner may reduce the scrape time necessary to remove the sealant material.

Environmental, Health, & Safety Evaluation

- Pharos Chemical and Material Library (CML)
- Pollution Prevention Options Assessment System (P2OASys) developed by the Massachusetts Toxics Use Reduction Institute

P2OASys Hazard Areas

Hazard Area	Characteristic
Acute human effects	Inhalation LC50, PEL/TLV, PEL/TLV (dusts/particles), IDLH, respiratory irritation, oral LD50, dermal irritation, skin absorption, dermal LD50, ocular irritation
Chronic human effects	Reference dose (RfD), carcinogen, mutagen, reproductive effects, neurotoxicity, developmental effects, respiratory sensitivity/disease, other chronic organ effects
Physical hazards	Heat, noise generation, vibration, ergonomic hazard, psychosocial hazard
Aquatic hazards	Water quality criteria, aquatic LC50, fish NOAEC, plant EC50, observed ecological effects
Persistence/bioaccumulation	Persistence, BOD half life, hydrolysis half-life, bioconcentration, bioconcentration factor (BCF)
Atmospheric hazard	Greenhouse gas, ozone depletor, acid rain formation, NESHAP
Disposal hazard	Landfill, EPCRA reportable quantity, incineration, recycling
Chemical hazard	Vapor pressure, solubility in water, specific gravity, flammability, flash point, reactivity, pH, corrosivity, high pressure system, high temperature system, mixture/reaction potential, odor threshold, volatile organic compound
Energy and resource use	Non-renewable resource, water use, energy use
Product hazard	Upstream effects, consumer hazard, disposal hazard
Exposure potential	Exposure potential

P2OASys Scoring

Score	Interpretation
10	High hazard
8	Medium/high hazard
6	Medium hazard
4	Low/medium hazard
2	Low hazard

P2OASys Results

Hazard Area	Toluene	nPB	Methylene Chloride
Acute human effects	9	8	8
Chronic human effects	10	8	8
Physical hazards	6	6	6
Aquatic hazard	7	5	3
Persistence/bioaccum.	4	5	5
Atmospheric hazard	6	10	6
Disposal hazard	6	6	6
Chemical hazard	10	6	8
Energy/resource use	6	8	8
Product hazard	8	6	6
Exposure potential	6	6	6
Weighted Final Score	7.1	6.7	6.4

P2OASys Results

Hazard Area	SkyKleen 1000	Polygone 310 AG	Diestone DLS
Acute human effects	8	9	5
Chronic human effects	4	7	4
Physical hazards	3	4	3
Aquatic hazard	6	2	2
Persistence/bioaccum.	3	4	4
Atmospheric hazard	2	2	2
Disposal hazard	4	4	4
Chemical hazard	5	6	9
Energy/resource use	3	6	6
Product hazard	2	2	2
Exposure potential	6	6	6
Weighted Final Score	4.2	4.7	4.3

Conclusions

- For the technical performance of the sealant removers, the Polygone 310 AG product had the best results for all the sealant removers evaluated. The Diestone DLS, SkyKleen 1000, and Soy Safe Graffiti Remover products exhibited sealant removal performance comparable to that of toluene.
- For environmental, health, and safety considerations, the SkyKleen 1000, Polygone 310 AG, and Diestone DLS products had safer chemical profiles than toluene, nPB, and methylene chloride. The Soy Safe Graffiti Remover could not be fully evaluated because of limited information on the MSDS and the non-disclosure of the actual ingredients of the product.

Acknowledgements

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Publication of Research Results

The complete results for the safer sealant removal evaluation will be documented in a white paper and published (on-line) by Products Finishing in October 2014.

