TECHSPRAY®

TECHLAB REPORT

QUALIFICATION TESTING OF PWR-4™ SOLVENT CLEANERS

by Pierce Pillon, Techspray Chemist

Toxicity concerns, changes in the regulatory environment, and increased liability have been driving many in the industry away from common industrial solvents like n-propyl bromide (nPB), trichloroethylene (TCE), perchloroethylene (Perc) and methylene chloride (MeCl). Unfortunately many substitute solvents do not match the performance and cost effectiveness of what they replace, making the search for viable alternatives challenging.

Techspray has engineered the PWR-4™ cleaning solvents to be safer replacements for these toxic products. PWR-4™ is formulated with trans 1,2-dichloroethylene (trans-DCE) and does not contain nPB, TCE, Perc, MeCl, or any other hazardous air pollutants (HAP). Studies performed by the National Toxicology Program (NTP) and others have verified the low toxicity profile of trans-DCE (See white paper "Reducing Exposure to Toxic Cleaners with Replacement Solvents" for details. Available at www.techspray.com.), while this study indicates that its performance is superior. This paper details Techspray's qualification and comparative testing for PWR-4™.

VAPOR-DEGREASING CLEANER EVALUATON

Vapor-degreasing is a cleaning method commonly used in critical applications like aerospace and medical electronics, because it is effective and can drastically reduce the potential for cross-contamination. Specialized cleaning equipment is used to clean or rinse in the vapor-phase of a boiling solvent, which is constantly going through a distillation process. The solvent boils, vaporizes, and is condensed again for hundreds of cycles a day. This process also requires specialized solvents that maintain their properties (e.g. non-flammability) through days and weeks of cycling, and stabilized to prevent corrosiveness as moisture is absorbed from ambient air.

Techspray PWR-4™ solvents are designed to be stable in the vapor-degreasing process. Soils tested were Alox 165L (corrosion inhibitor), Royco 782 (hydraulic fluid), silicone fluid (TBF9350), 80W-140 motor oil, Unilube All Purpose Grease, CRC Food Grade Chain Lube, and two different fluxes. They were applied to stainless steel coupons. The fluxed coupons were sent through a reflow oven at a profile that peaked at 446°F (230°C) to fully activate. To clean the coupons, they were exposed for three minutes in the hot vapor phase using a Branson B250R vapor degreaser. No further agitation was used, and the coupons were not wiped after the cleaning process.

The method of evaluation was based on a military test standard, MIL-PRF-29608A (AS). The weight of the clean coupon was recorded (W1). After the grease was applied, the coupon was weighed and recorded (W2). The soiled coupon was run through the cleaning process and allowed to dry completely before the weight was recorded again (W3). Cleaning efficiency was then determined by the following calculation:
*% Cleaning Efficiency (CE) = ((W2-W3) / ((W2-W1))*100*

Results demonstrate that PWR-4™ is effective on a wide range of soils in the vapor degreasing process (fig 1).

FIG. 1: PWR-4™ CLEANING EFFICIENCY IN VAPOR DEGREASING PROCESS

SOIL	AVE. CLEANING
Alox 165L	100.0
Royco 782	100.0
Silicone Fluid	99.6
APG 80W-140	100.0

SOIL	AVE. CLEANING
Unilube	65.4
Chain Lube	99.9
Kester 186	100.0
AIM NC277	97.5

PRINT CIRCUIT BOARD (PCB) DEFLUXING EVALUATION

An additional study with solder paste and liquid fluxes was performed, with an attempt to duplicate the soldering process as closely as possible. Activated flux residues on a printed circuit board poses additional challenges beyond standard degreasing, because of the tenaciousness of the soil and the extreme temperatures in the soldering processes.

Liquid fluxes were applied only to the test vehicle pads and put into a Plato SP-600T solder pot, filled with Kester K-100 solder at 550°F (288°C), to simulate wave conditions and activate the flux. Pastes were reflowed on the test PCB with components with a Novastar DDM reflow oven according to the paste profiles. After soldering, the PCBs sat for 4-hours to approximate a typical work flow.

To clean, the soiled and baked PCB were suspended in the vapor-degreaser (Branson B250R) vapor zone for 5 mins, then submerged into the boil sump for 3 mins. Performance evaluation was done by a subjective review of cleaned PCBs magnified at 120X (see fig 3-6 for examples). Each sample was ranked according to visual cleanliness (fig 2).

FIG. 2: PCB CLEANLINESS TESTING OF PWR-4™ FLUX REMOVER IN VAPOR DEGREASER

KEY:
++ = complete removal + = slight flux residue/white residue - = partial removal 0 = non-removal

PASTE OR FLUX	RANK
AIM M8	++
AIM NC259	+
AIM 257-2	-
AIM NC258	+
Aim NC512	+
Alpha OM-338	+
Alpha OM-338PT	-
Alpha OM-338T	-
Alpha OM-340	-
Alpha OM-5000	+
Alpha OM-5100	-

PASTE OR FLUX	RANK
Alpha R-100 liq flux	++
Alpha 615-25 liq flux	++
Indium NC-SMQ92H	+
Indium NC-SMQ92J	+
Indium NC-SMQ230	+
Indium RMA-SMQ51AC	++
Indium 5.1	++
Indium 5.1AT	+
Indium 5.8LS	+
Indium 8.9	+
Indium 8.9E	-

PASTE OR FLUX	RANK
Indium 8.9HF1	+
Indium 8.9HFA	-
Indium 9.0	-
Indium 10.1	-
Indium 10.5HF	+
Kester 186 liq flux	++
Kester EP256	++
Kester 256HA	+
Kester NP 505HR	++
Loctite HF212	+
Loctite MP218	-

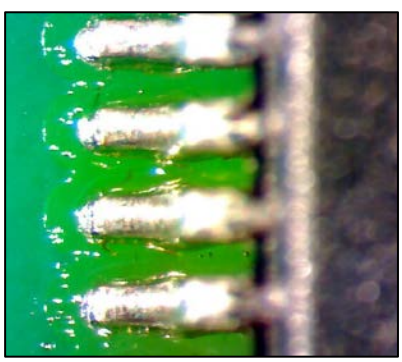


FIG. 3: INDIUM SMQ 51AC QFP80 PRECLEAN

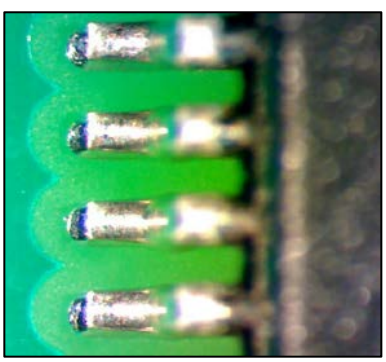


FIG. 4: INDIUM SMQ 51 AC QFP80 POST CLEAN

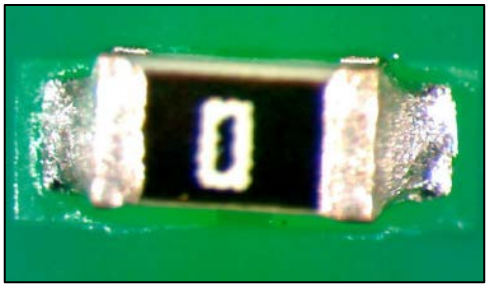


FIG. 5: KESTER NP505 HR CAP PRECLEAN

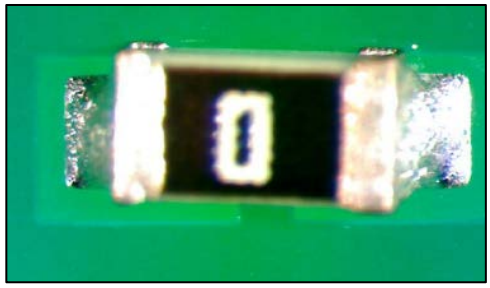


FIG. 6: KESTER NP505 HR CAP POST CLEAN

AEROSOL CLEANER EVALUATION

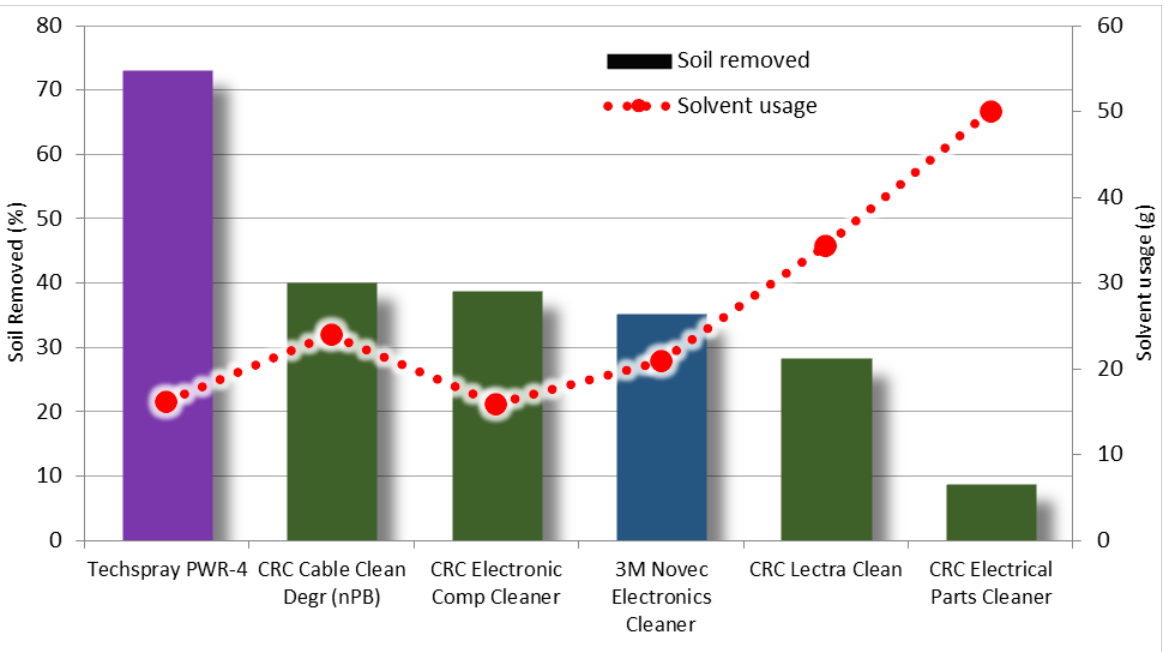
Aerosol cleaners in the study included products from CRC and 3M. Heavy-duty Unilube All Purpose Grease was applied on clean stainless steel coupons in triplicate. The method of evaluation was the same as described in the vapor-degreaser evaluation. Solvent usage was assessed by weighing the aerosol can before and after the test, the difference being the solvent usage. Dividing by the spray time (3 seconds) provided the delivery rate (DRT).

The test data (fig 7) demonstrates that PWR-4™ outperformed the other solvents cleaners, both those containing nPB and Perc and trans-DCE based alternatives (fig 8). In a side by side comparison, PWR-4™ also had greater efficiency. In addition, the delivery rate of PWR-4™ was far less compared to the products whose outputs were higher, but did not have the same cleaning efficiency (fig 8). While many industrial cleaners have a satisfying blast, giving the perception of cleaning effectiveness, using PWR-4™ requires less solvent to achieve the cleaning performance.

FIG. 7: CLEANING EFFICIENCY AND SOLVENT USAGE DATA

PRODUCT	BASE CHEMISTRY	% CE	DRT (g/sec)	TOTAL SOLVENT (g)
Techspray PWR-4™	Trans-DCE	73	5	16
CRC Cable Clean Degreaser	nPB	40	8	24
CRC Electronic Comp Cleaner	Trans-DCE	39	5	16
3M Novec Electronics Cleaner	Trans-DCE	35	7	21
CRC Lectra Clean	Perc	28	12	34
CRC Electrical Parts Cleaner	Perc	9	17	50

FIG. 8: CLEANING EFFICIENCY AND SOLVENT USAGE COMPARISON



Techspray has engineered the PWR-4™ high performance cleaning solvents to be a safer replacement for n-propyl bromide and other toxic solvents. These studies demonstrate that regardless of the cleaning process, facilities can change to PWR-4™ without hurting their operating cost, efficiency, and product reliability.

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Techspray®, a division of Illinois Tool Works (ITW), is a leading manufacturer of chemical products and soldering tools for the electronics industry. Techspray formulates, blends, and packages a wide variety of chemicals and assorted support products for the electronics industry, heavy industry, and plant and equipment maintenance including degreasers, contact cleaners, flux removers, dusters, conformal coating, solder mask, water-based cleaners, desoldering wick, soldering tips, and the popular Plato shear cutters. More information can be found at www.techspray.com.