INDEN 5010
(1 Credit Hour)

SUBSTITUTES FOR 1,1,1 TRICHLOROETHANE IN DEGREASING OPERATIONS

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ABSTRACT

1,1,1 Trichloroethane (MCF), which was once considered to be a compliance solvent, is soon to be banned. MCF is commonly used in degreasing operations, especially when a high degree of cleaning is required.

This report briefly discusses various degreasing techniques, methods of reducing solvent loss in degreasing, and alternatives to cleaning with MCF.

CHAPTER 1

INTRODUCTION

1.1 Degreasing: Degreasing is a process of removing dirt and oil from the surface of parts. It is an essential step prior to surface finishing or bonding, and is sometimes done to ensure a clean surface prior to packaging.

The principal methods of degreasing are cold cleaning, slightly heated cleaning, and vapor degreasing. Ultrasonic cleaning, which is a more advanced method of degreasing, is based on the principle that agitation improves and speeds cleaning.

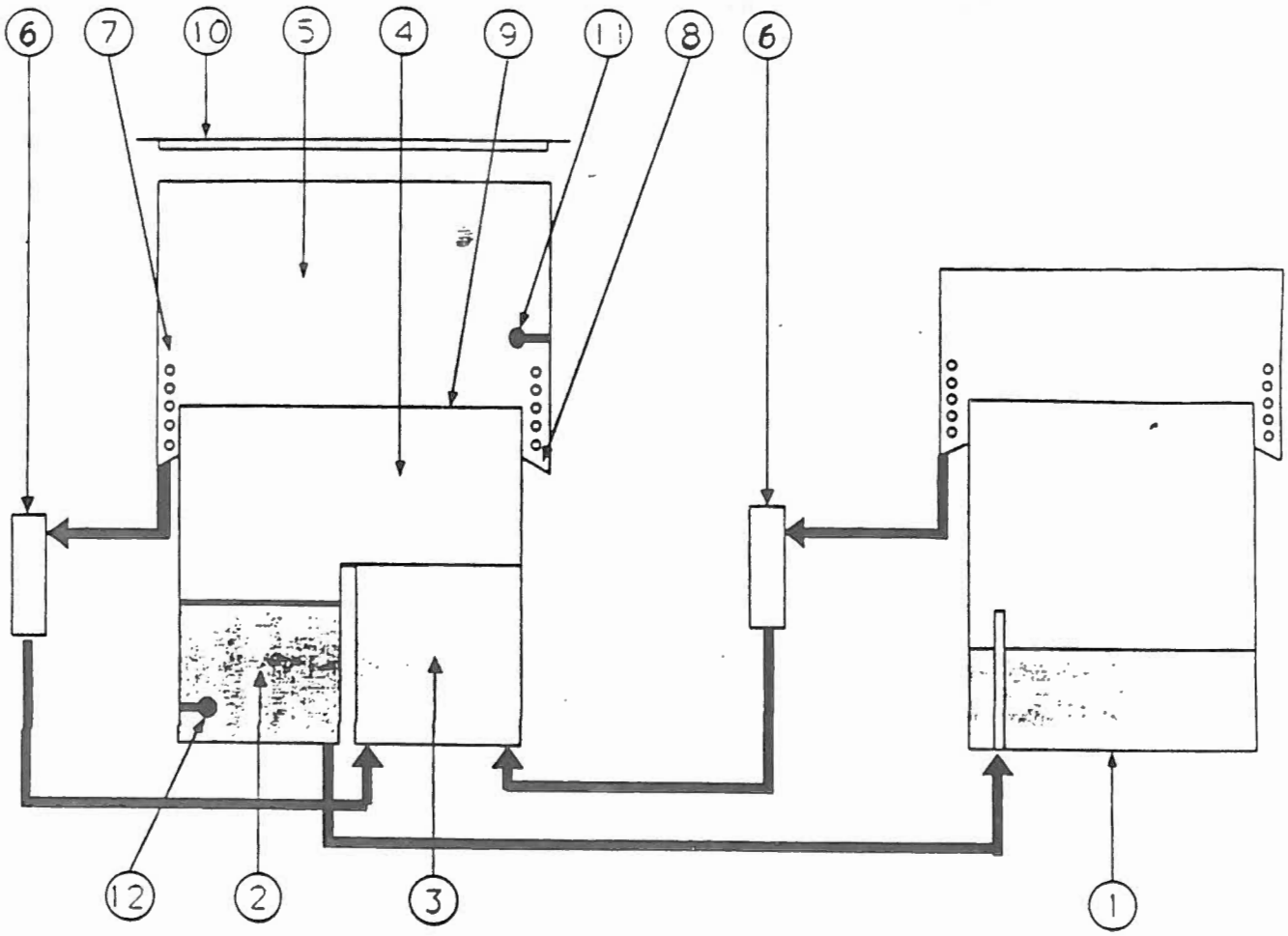
1.2 Cold Cleaning: Cold cleaning is essentially the cleaning of parts with the solvent at room temperature. The parts can be immersed in the solvent bath or sprayed or wiped with the solvent.

Cold cleaning is used for periodic cleaning of small quantities of parts especially in removing cutting oils and coolants, and commonly in maintenance applications like tool cleaning.

1.3 Vapor Degreasing: Vapor Degreasing is a process in which the solvent is heated to a slow boil. The vapors emanating from the solvent are contained within the degreaser using

FIGURE 1

OPEN-TOP VAPOR DEGREASER



1. Solvent Recovery Still
2. Boiling Sump
3. Ultrasonics Sump
4. Vapor Zone
5. Freeboard Area
6. Desiccant Dryer
7. Cooling Coils
8. Condensate Collection Trough
9. Vapor Blanket
10. Removable Cover
11. High-Vapor-Level Sensor
12. High-Solvent-Temperature Sensor

cooling coils, freeboard chiller and freeboard. The parts to be cleaned are then lowered into the vapor zone. The vapors condense into pure solvent when they come into contact with the parts. The condensation stops when the part reaches the temperature of the vapor. Then the part is withdrawn from the vapor zone.

There are some variations to vapor degreasing. In some cases a solvent spray is used in addition to the vapor cycle, to remove insoluble particles like abrasives and metal fines.

A spray can also be used with small parts stacked in baskets, where it helps to break air pockets and reach enclosed areas to ensure proper cleaning.

When degreasers are equipped with provisions for spraying, the parts are first made to pass through the vapor cycle and then sprayed with cool, clean solvent, which helps to flush out soils, and also helps to lower the temperature of the part being cleaned, which results in further vapor condensation.

Another variation on vapor degreasing is the use of both a vapor cycle and a liquid cycle. A two compartment chamber is used for this. One chamber generates the vapor, while the other contains the warm solvent for immersion. In this method the work is first lowered into the vapor zone for

preliminary cleaning, then immersed in the warm solvent and agitated, and raised into the vapor zone for a final rinse before it is removed.

In some cases the parts are first lowered into boiling solvent, where the boiling action helps to agitate the parts. The parts are then rinsed in warm solvent.

These methods are useful when the work has intricate contours and/or a heavy amount of soil, or when cleaning bulk quantities of small parts which are covered with a thin film of soil.

Yet another variation in vapor degreasing is used to clean the interiors of enclosed vessels. Storage tanks, and other enclosed vessels can be cleaned by using a solvent distillate spray, and vapor cleaned using solvent vapor from a vapor generator.

1.4 Ultrasonic Cleaning: Ultrasonic cleaning is a process in which ultrasonic energy is transmitted to a solvent bath, resulting in cavitation. Cavitation which is a process of rapid build-up and collapse of tiny bubbles, produces a scrubbing action on the surface of the parts to be cleaned. This scrubbing action coupled with the action of the solvent provides effective cleaning, to remove oils, fluxes,

insoluble solids and minute contaminants on printed circuit boards.

CHAPTER 2

REDUCING SOLVENT LOSS IN DEGREASING OPERATIONS

2.1 Enhancing Heat Balance

Excess Heat: The solvent should be heated only to maintain a slow boil. Excessive heating results in solvent loss, without improving cleaning.

Cooling coils: Cooling coils should be supplied with sufficient amounts of water at appropriate temperatures, to maintain the vapor zone at the mid point of the coils. Suggested temperatures for water cooled systems are 50 °F for the inlet and 90 °F for the outlet. [7]

Water jackets: Maintaining proper water flow to the water jacket on the outside of the degreaser, keeps the upper surfaces of the degreaser cool and prevents the build up of convection currents, which cause vapor to move up the side walls.

Cold Traps: A cold trap is a set of very cold coils used to cool the air above the vapors. The cold trap generates a dense blanket of cold air that reduces vapor diffusion. As the cold coils are maintained below freezing temperatures, a trough has to be provided to collect water condensing on the coils.

2.2 Eliminating Air Currents

Covers: Making use of a sliding cover, to keep the degreaser closed during idle times can help reduce solvent losses by as much as 55% . Sliding covers are ideal, as they do not cause turbulence when moved, unlike hinged covers.

Air Drafts: Locating an open top degreaser in an area where there is minimal air draft, moved away from fans, air conditioners, windows, doors and general plant air movement, could save about 30% of sovent losses.

Freeboard Height: A 40% saving in solvent use can be obtained with freeboard heights of 75 to 100% the width of the degreaser. [7]

Spray In The Vapor Zone: A 5% reduction in solvent losses can be obtained by spraying below the vapor zone.

Exhaust Velocities: When lip hood vent exhausts are used to control vapor emissions, it is necessary to ensure that the exhaust is not excessively forceful. Minimum exhaust velocities should be used.

Wind Tunnels: Air currents through a machine can be channeled and reinforced when the machine has a semi-enclosed design. Rearranging the air movement in the room or using baffles can help minimize or eliminate this effect.

2.3 Modifying The Procedure

Speed of movement: Moving the work at less than 11 feet per minute helps to prevent the vapor zone from being disrupted. Lower speeds are considered to be better, with three feet per minute being the suggested optimum.

Using the 'stop and go' technique helps prevent solvent vapor from being pushed out by the piston action of the work load. The 'stop and go' technique essentially involves stopping the load at intervals while lowering it into the vapor zone. This technique also allows maximum vapor recovery with shorter cleaning cycles.

Positioning of parts: Solvent carry out can be minimized by positioning the parts properly in the baskets or racks. Rotation or movement of the parts also enables complete drainage.

Temperature of parts: The parts need to reach the temperature of the vapor for the cleaning process to be complete. Removing the parts while the vapors are still condensing will result in increased carry out.

Basket size: Baskets should have an area less than 50% of the opening of the degreaser. Using excessively large baskets results in a piston action which causes increased vapor air mixing.

Materials to avoid: Fabrics and wood when introduced into the degreaser, absorb solvent, which they release later when drying.

Leaks: Routine inspection and maintenance of the degreaser can help prevent leaks. Leaks are difficult to detect as the liquid solvent vaporizes rapidly.

CHAPTER 3

ALTERNATIVES TO CLEANING WITH 1,1,1 TRICHLOROETHANE

Probably the best alternative to cleaning with a hazardous chemical is to not clean at all. This is possible in some cases, as was evidenced by an Irvine company, that offered a lower price for uncleaned parts. In this case the purchasing company was doing it's own cleaning even though the parts were cleaned by the supplier. The lower prices served as an incentive for the purchasing companies to opt for the uncleaned parts, resulting in the elimination of a cleaning phase for the Irvine company and a resultant reduction in the amount of solvent used.

Aqueous cleaners, semi aqueous cleaners and other organic solvents are common replacements for 1,1,1 Trichloroethane. Selection of any one type of cleaner and a corresponding cleaning method would depend on the soils being cleaned, the kind of parts being cleaned and the level of cleaning required. A brief discussion of each of these categories of cleaners, their advantages and disadvantages follows.

3.1 Aqueous Cleaners

Aqueous cleaners are generally water solutions, made of water conditioners, corrosion inhibitors, alkalinity builders and organic surfactants. The builders are alkaline salts, and

are usually a blend of alkali metal orthophosphates, alkali metal hydroxides, silicates, carbonates, bicarbonates and borates. Surfactants are used to provide detergency, emulsification and wetting in an aqueous cleaner.

The aqueous cleaning process involves a wash, rinse and dry stages. In the wash stage, the aqueous cleaner reacts with contaminants like rosin and grease, and through a process of saponification, forms a water soluble soap. The parts are then rinsed by immersing in water or spraying to remove contaminants and residual cleaners. The rinse stage is followed by the drying phase in which air guns, air knives or ovens are used to dry effectively and in a reasonable amount of time. Air drying of parts is generally not a feasible option, due to economic and quality reasons.

Aqueous cleaning has the following advantages:

- The waste streams from an aqueous cleaning process can be recycled or in some cases disposed to a sanitary sewer, unlike in cleaning with Trichloroethane, where the waste stream needs to be disposed as a hazardous waste.
- Aqueous cleaners are less toxic and are not flammable, thereby improving worker safety.
- They are better suited to cleaning particles, films and inorganic soils.
- Aqueous cleaners are better suited to use with ultrasonics

than are organic solvents.

- The chemicals involved are less expensive.

The following are the disadvantages with aqueous cleaning:

- The use of aqueous cleaners results in an increase in waste volumes.
- An energy intensive drying step is almost always required.
- It is difficult to clean and dry parts with blind holes or crevices.
- Better process control is required.
- Rinsing some residues especially non-ionic surfactants is difficult.
- Aqueous cleaning is not suitable for some materials which maybe easily corroded.
- Expensive, high purity water may be required in some instances.

3.2 Semi-Aqueous Cleaners

Semi-aqueous cleaning is sometimes preferred in situations where aqueous cleaning is not suitable due to performance or environmental drawbacks.

Semi-aqueous cleaners are made of terpenes, petroleum hydrocarbons, N-methyl pyrrolidone (NMP), dibasic esters (DBE), vegetable oils and fatty acids. Terpenes and

petroleum hydrocarbons are the most common.

Terpenes are compounds derived from wood and citrus sources. They are typically used for cold cleaning in the metal fabrication industry. Terpenes can be recycled once they have been separated from the cleaning bath.

Hydrocarbons mixed with a surfactant and a rust inhibitor can be used to clean metal working coolants, cutting oils and greases.

N-methyl pyrrolidone is used in the metal fabrication industry, and vegetable oils to remove printing ink soils.

In a semi-aqueous cleaning process organic soils are dissolved in the cleaning solvent, inorganic soils are dissolved or are suspended in the solvent and/or water, and particulate matter is suspended through agitation. Usually the wash phase is followed by a rinse and dry stage.

Semi-aqueous solvents are essentially Terpenes. Terpenes most commonly are isoprene oligmers but may include derivatives such as alcohols, aldehydes and esters. Terpenes can be recycled once they have been separated from the cleaning bath.

Semi-aqueous cleaners have the following advantages:

- Can effectively penetrate into small spaces due to low surface tension.
- Does not require elevated temperatures to be effective.
- Non-corrosive in some applications.
- Can be used to clean polar and non-polar contaminants.
- Recycling is easy, and most of the waste can be disposed through a sewer.

The following are the disadvantages with semi-aqueous cleaning:

- Special equipment may be required, because terpenes are combustible, sometimes have a bad odor and are not compatible will all materials.
- Needs vapor controls, as terpenes are VOCs.
- A water rinse is required, hence water contamination problems cannot be eliminated.
- The toxicity of terpenes has not yet been fully evaluated.

3.3 Other organic solvents

Chlorinated solvents Trichloroethylene (TCE), Perchloroethylene (PERC) and Methylene Chloride (METH) are possible replacements for Trichloroethane. However these chemicals are suspected carcinogens. Further TCE and PERC

contribute to photochemical smog and essentially these solvents are also increasingly regulated.

Flammable solvents like Isopropyl Alcohol (IPA), Acetone, Methyl Ethyl Ketone (MEK) and Petroleum solvents are also possible replacements for Trichloroethane, which are subject to smog regulations. Also, some of these chemicals are yet to be tested for toxicity.

HFCs and FCs are chlorine free substitutes, which do not harm the ozone layer, but at the same time these chemicals contribute to global warming. Further these chemicals are expensive, and need to be combined with other substances like alcohol to make them effective cleaners.

Semi.

CHAPTER 4

ALTERNATIVE SOLVENTS

4.1 PartsPrep Degreaser

* **Manufacturer :** GAF Chemicals Corporation
  1362 Alps Road
  Wayne, NJ 07470.
  PH: (404) 621 8240

* **Chemical components** : Identities of specific chemicals is a trade secret. The hazardous chemical component is **1-Methyl-1-Pyrolidinone.**

* **Flash point :** 193 °F

* **MSDS :** Attached

* **Applications :** Suitable for the metal working industry. Works well on carbon, grease, multipurpose lubricating oils and buffing compounds.

* **Methods of cleaning:**

  1. Immersion cleaning : 'Soak parts in PartsPrep degreaser bath for 1-3 minutes, or as required. PartsPrep can be used from ambient temperatures to 180 °F, with or without ultrasonics. Rinse parts in a two stage bath of deionized water at 200 °F for 1-2 minutes. Dry using forced air.' [1]

  2. Spray Wash : 'Spray metallic parts with PartsPrep Degreaser (ambient to 180 °F) at 20-30 psig. Rinse in two stages with deionized water at 120 °F, 12 psig. Dry using forced hot air.' [1]

Existing equipment can be retrofited. GAF provides equipment retrofit and modification.

* **Materials to avoid :** PVC, Viton, ABS, Buna-N, Kynar, Lexan, Noryl EN-265, PET

* **Cost :** $29.95 /gal (vendor quote)

* **Notes :**

1. Heating improves cleaning performance.

2. Small plastic components which are parts of assemblies could be damaged.

Semi-

4.2 DuSQUEEZE

* **Manufacturer :** DuBois Chemicals, Inc.
  DuBois Tower
  Cincinnati, Ohio 45202-3178.
  PH: 1-800-543-4906

* **Chemical components :** DuSQUEEZE is a blend of **surfactants containing 25% Limonene.** DuSQUEEZE is a **terpene based** cleaner.

  Principal hazardous components are **Dipentene Solvent** and **Nonylphenoxypoly (Ethyleneoxy) Ethanol.**

* **Flash point :** 124 °F

* **MSDS :** Attached

* **Applications :** Designed to remove grease, oil and carbonaceous soils from concrete, metal and other hard surfaces. Particularly effective on asphaltic soils. [2]

* **Methods of cleaning:**

  1. 'DuSqueeze can be used through the DuBois Sureshot Sprayer, Mega Foamer, Foamall 80, Foamall 10, Thermo-Blast units, steam injector wands, mixing manifolds or the DuBois Steamall.' [2]

  2. *Has been* used successfully in a heated ultrasonic bath, with a DI water rinse, and a heat gun for drying. [3]

* **Materials to avoid :** Need to test for safety on plastic and painted surfaces. Safe on ferrous and nonferrous metals.

* **Cost :** $17.58 /gal

* **Notes :**

1. Was tested for degreasing in a plasma spray deposition process. Bonding strengths were actually found to be slightly better for a dilute limonene cleaner. No residual limonene was detected. [3]

2. Dilute Limonene solutions can be disposed by flushing to a sanitary or industrial sewer according to local sewer use permit requirements. [3]

3.3 LPS Precision Clean

* **Manufacturer :** LPS Laboratories, Inc.
  4647 Hugh Howell Road
  Tucker, GA 30085-5052.
  PH: 404-934-7800

* **Chemical components :** LPS Precision Clean is a blended compound. Identities of specific chemicals are not available.

  Principal hazardous components are **Sodium Metasilicate** and **Dipropylene Glycol Methyl Ether.**

* **Flash point :** Non flammable.

* **MSDS :** Attached

* **Applications :** LPS Precision Clean is an all purpose industrial strength cleaner/degreaser. Removes tough, stubborn stains and soils, such as grease, oil, sludge, soot and ink. [8]

* **Methods of cleaning:** Can be used in parts washers, dip tanks, ultrasonic cleaners, steam cleaners, pressure washers and trigger sprayers. Precision clean wipes off and rinses clean from washable surfaces.

* **Materials to avoid :** Safe on all metals.

* **Cost :** $21.99 /gal

* **Notes :**

1. Was tested by an Oklahoma Company in cleaning steel parts soiled with cutting oils and coolant. Did not work as well as 1,1,1 Trichloroethane, but found to be quite satisfactory. [9]

2. Precision clean contains a rust and corrosion inhibitor to help prevent flash rusting of metal surfaces.

3. Precision clean is biodegradable and butyl free.

Semi Aqueous

4.4 LPS PreSolve

* **Manufacturer :** LPS Laboratories, Inc.
  4647 Hugh Howell Road
  Tucker, GA 30085-5052.
  PH: 404-934-7800

* **Chemical components** : LPS PreSolve is a blended compound. Identities of specific chemicals are not available.

  Principal hazardous ingredients are **Solvent Naptha,** and **d-Limonene.** The aerosol contains Carbon dioxide propellant.

* **Flash point :** 105 °F

* **MSDS :** Attached

* **Applications :** LPS PreSolve removes adhesives, oil, grease, wax, tar and dirt. Can be used in situations where rinsing is not desired and where water has to be avoided.

* **Methods of cleaning:** Not clear. Available as an aerosol and also in bulk.

* **Materials to avoid :** Safe on all metals and most plastics.

* **Cost :** $60.48 /gal

* ***Notes :***

Was tested by an Oklahoma Company in cleaning steel parts soiled with cutting oils and coolant. Did not work as well as 1,1,1 Trichloroethane, but found to be quite satisfactory. [9]

CHAPTER 5

CONCLUSION

It is believed that the chief alternative to 1,1,1 Trichloroethane (MCF) solvent degreasing processes may eventually be emissionless surface cleaning with solvents. In this ideal process, it is expected that there will be no solvent loss through emissions, all solvent will be recycled, and solvent residues will either be reused or used as fuel on site. [7]

Currently, new totally enclosed equipment designs are being used in Europe, which eliminate the solvent to air interface. Such systems can reduce emissions beyond 95% compared to open top degreasers. Methods are being developed to trap the remaining 5% of the vapors before they leave the plant.

Virtually emissionless operation is theoretically possible, using properly designed carbon adsorption equipment. However there are problems with carbon adsorption of MCF, and it is expensive. Steam stripping of carbon used with MCF, results in the removal of inhibitors from the MCF resulting in excessive equipment corrosion.

When emissionless processes eventually become available, the emphasis will shift from choosing compliance solvents, to choosing solvents that would be most effective for the cleaning operation.

CASE STUDIES

The following case studies were obtained from a paper titled 'An Analysis of Alternatives to Ozone-Depleting Solvents in Cleaning Applications', by Dr. Katy Wolf, director of the Institute for Research and Technical Assistance (IRTA).

Case Study I (Process Improvement)

A plant was using TCA in cleaning parrafinic oil from aluminium parts. A conveyorised degreaser with a still coupled to it was used to do the degreasing. The solvent had to be replaced with virgin solvent every week, as the acid level was high. By purchasing recycled solvent from a different source, with longer life; changing the RFC temperature from 0 °F to 40 °F, to avoid condensing moisture; adding fresh solvent more frequently; and vacuuming the water separator more frequently to remove aluminium chips that were catalyzing the hydrolysis reaction, the life of the solvent bath was approximately doubled.

Plans to replace TCA at this facility with an aqueous solvent are underway.

Case Study 2 (Solvent and Process Change)

Cold TCA was being used to remove oil from stamped parts at a

plant making aluminium steel and brass parts for an electronic manufacturer. This plant is trying to replace TCA in it's degreasing operations.

IRTA is considering using water spray units in individual work stations. An alkaline cleaner is likely to be used, with the effluent being captured in a container and used to neutralize an acidic waste stream from another part of the plant.

Case Study 3 (Process Improvement)

Another manufacturer was using a TCA based adhesive to attach heat sinks to a backing, prior to stamping. The backing is used both, to prevent damage to the table and to stabilize the sink during stamping.

A vapor degreaser was being used to separate the backing from the sink, and the sink scrubbed with cold TCA to remove residual adhesive.

IRTA suspected, and testing proved that it was the heating that was responsible for separating the two components, resulting in the degreaser being replaced with an oven. Testing is underway to replace the adhesive with a film adhesive which can easily be removed, obviating the need for scrubbing with TCA.

REFERENCES

1. Brochure from **International Speciality Products,** 1361 Alps Road, Wayne, N.J. 07470.

2. MSDS for DuSqueeze, from DuBois Chemicals, Inc.

3. Lisa M. Brown, Johnny Springer, 'Chemical Substitution for 1,1,1 Trichloroethane and Methanol in an industrial cleaning operation', U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio.

4. MSDS for LPS Precision Clean.

5. Product data on PURASOLV, from PURAC Incorporated.

6. J. A. Mertens, 'Metal Cleaning With 1,1,1 Trichloroethane', Metal Finishing, Vol 87, May 1989, Pg 41-44.

7. James A Mertens, 'Reduce Metyl Chloroform Emissions for Environmentally Sound Vapor Degreasing', Metal Finishing, Vol 89, September 1991, Pg 50-52.

8. Brochure from LPS Laboratories, INC.

9. For more information contact Dr. Wayne Turner, Dept. of Ind. Engr., Oklahoma State University, Stillwater.

10. Frederic W. Kaeser, 'Solvent Alternatives Can Help Alleviate Depletion of Ozone', ConnTAP Quarterly, Winter 1991, Vol. 4, No. 1.

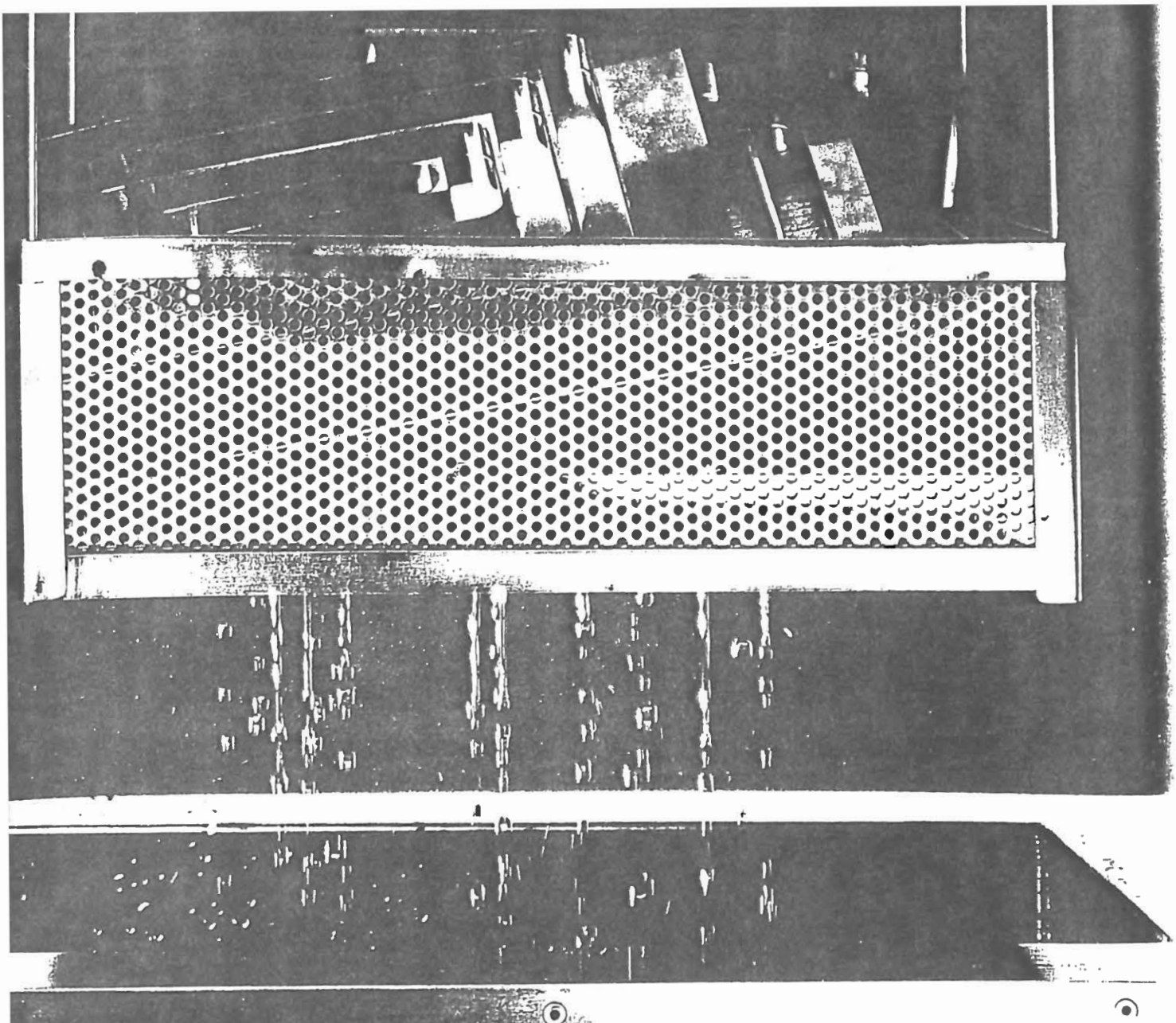
11. 'Semi-Aqueous Cleaning', Newsletter on alternatives to the use of ozone depleting chemicals, Environmental Program Office, City of Irvine.

12. L. M. Thompson, R. F. Simandl, H. L. Richards, 'Chlorinated Solvent Substitution Program At The Oak Ridge Y-12 Plant', report prepared by the Oak Ridge Y-12 Plant, managed by Martin Marietta Energy Systems, Inc., for the U. S. Department of Energy.

13. Richard A. Heckman, 'Alternatives for Hazardous Industrial Solvents and Cleaning Agents', Pollution Prevention Review, Summer 1991, Pg 327-330.

APPENDIX A

Information on the PartsPrep Degreaser



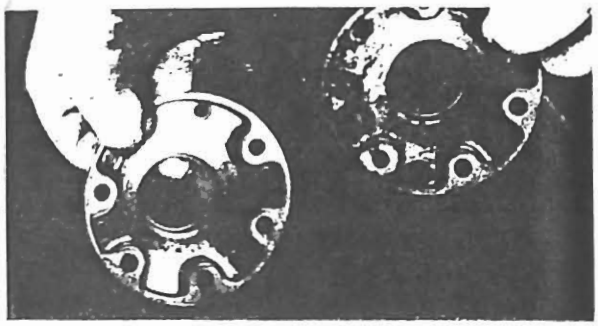
roducing
ep™ Degreaser.
Now replace chlorinated and
fluorinated hydrocarbons.
Without sacrificing
performance.

ISP

Now get high performance cleaning, with lower VOC emissions and improved worker safety.

New PartsPrep™ Degreaser from ISP provides residue-free cleaning for the metalworking industry. PartsPrep™ Degreaser performs as well as 1,1,1,-trichloroethane, CFC-113, and other halogenated solvents. You still get substrate compatibility and aggressive, cleaning. PartsPrep™ Degreaser penetrates, loosens and removes deposits of carbon, smut, grease, multi-purpose lubricating oils and buffing compounds. While it delivers excellent performance, PartsPrep™ also gives you a safer workplace.

And PartsPrep™ is better for the environment. It has low VOC emissions and won't deplete the earth's fragile ozone layer. It's non-flammable, has a low order of toxicity, and it's non-carcinogenic and biodegradable.



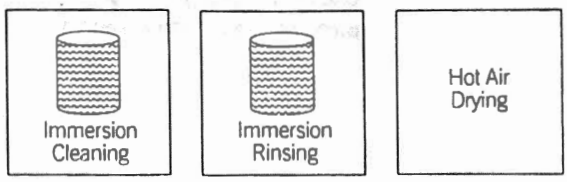
Even cleans aluminum without harming surface.

PartsPrep™ Degreaser Typical Properties

Physical Form	Water thin liquid
Freezing Point	– 12°F (– 24.4°C)
Boiling Point	395°F (202°C)
Flash Point	193°F (90°C) Setaflash/CC
Odor	Slight, amine-like
Miscibility	Completely miscible with water and most organic solvents
Vapor Pressure	0.3 mm Hg
Specific Gravity @ 25°C	1.02
pH (10 wt % aqueous)	8-9

Two Cleaning Techniques, Adaptable To Your Needs.

Use the cleaning method that works best in your operation. PartsPrep™ Degreaser cleans effectively, whether parts are sprayed or immersed as illustrated in these examples:



1. Immersion Cleaning: Soak parts in PartsPrep™ Degreaser bath for 1-3 minutes, or as required. PartsPrep™ can be used from ambient temperatures to 180°F, with or without ultrasonics. Rinse parts in a two-stage bath of deionized water at 200°F for 1-2 minutes. Dry using forced hot air.

2. Spray Wash: Spray metallic parts with PartsPrep™ Degreaser (ambient to 180°F) at 20-30 psig. Rinse in two stages with deionized water at 120°F, 12 psig. Dry using forced hot air.

Although it isn't necessary to heat PartsPrep™ Degreaser, heating will further improve cleaning performance. Small plastic components which are part of assemblies being cleaned may be damaged by this aggressive cleaner. Contact your nearest ISP sales office for detailed technical assistance and to discuss your specific application.

PartsPrep™ Degreaser Handling Procedures.

Materials of construction and storage

Store in 1020 carbon steel, stainless steel 304 and 316, or nickel alloy tanks with dessicant-filled breather pipes. PartsPrep™ is hygroscopic, so store in dry, sheltered areas.

Use proper gasketing materials—Teflon, silicon rubber, Kalrez, polypropylene or mild steel.

Materials to avoid: PVC, Viton,® ABS, Buna-N, Kynar,® Lexan,® Noryl EN-265,® PET.

Safety and handling precautions

Use safety glasses and natural rubber gloves when handling PartsPrep™ Degreaser. Any material which contacts the skin or eyes should be washed off with plenty of water. Although PartsPrep™ has a high flash point, combustibility should be considered in elevated temperature applications.

PartsPrep™ Degreaser contains organic solvents. Avoid breathing vapors or mist. Keep away from excessive heat and open flames. Consult your MSDS before handling.

ISP

INTERNATIONAL SPECIALTY PRODUCTS

MATERIAL SAFETY DATA SHEET PRODUCT : PARTSPREP Part # 0390

SENTRY ECOLINK CHEMICAL CO, 1481 ROCK MTN BLVD, STONE MOUNTAIN, GA 30086
TEL:800/886-8240 OR 404/621-8240 REVISED 3/30/92

THIS MSDS COMPLIES WITH
OSHA'S HAZARD COMMUNICATION
STANDARD, 29 CFR 1910.1200.
STANDARD MUST BE CONSULTED
FOR SPECIFIC REQUIREMENTS

U.S.DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND
HEALTH ADMINISTRATION.
(NON-MANDATORY FORM)
FORM APPROVED BY OMB

SECTION I. PRODUCT IDENTIFICATION

PRODUCT IDENTITY (AS USED ON LABEL & LIST) :

PARTSPREP
DEGREASER

MANUFACTURERS NAME:
GAF Chemicals Corporation
1361 Alps Road
Wayne, NJ 07470

EMERGENCY TELEPHONE NUMBERS:
800/886-8240 or 800/877-3339
404/621-8240 or 404/934-4242

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

HAZARDOUS COMPONENTS: 1-METHYL-2-PYROLIDINONE CAS # 00000872-50-4

Specific chemical identities withheld as trade secret pursuant to
29 CFR 1910.1200(i). Safety and environmental compliance personnel may request detailed tox analysis report.

SECTION III-PHYSICAL DATA

BOILING POINT : 396 °F
VAPOR PRESSURE(mm Hg.) : <0.30 mm Hg
VAPOR DENSITY(AIR = 1) : 3.00

SPECIFIC GRAVITY(H_2O = 1) : 1.02 (AT 25°C)
MELTING/FREEZING POINT : -24.00 ° C
EVAPORATION RATE : < 1 (Butyl Acetate = 1)

SOLUBILITY IN WATER: SOLUBLE
APPEARANCE & ODOR: WATER THIN LIQUID WITH AMINE ODOR

SECTION IV-FIRE AND EXPLOSION HAZARD DATA

FLASH POINT : 193° F
EXPLOSIVE LIMITS : NO DATA FOUND
EXTINGUISHING MEDIA : WATER SPRAY, ALCOHOL RESISTANT OR POLYMER FOAM, CO_2 OR DRY CHEMICALS.
SPECIAL FIRE FIGHTING PROCEDURES: FIGHT AS A HYDROCARBON FIRE. WEAR SELF-CONTAINED, NIOSH APPROVED, BREATHING APPARATUS WITH FULL FACE PIECE. COOL FIRE EXPOSED CONTAINERS WITH WATER SPRAY. DO NOT PUT FIRE OUT UNLESS FLOW FEEDING IT CAN BE SAFELY STOPPED.
UNUSUAL FIRE AND EXPLOSION HAZARDS: AFTER FIRE IS EXTINGUISHED, MATERIAL VAPORS COULD ACCUMULATE AND TRAVEL TO A SOURCE OF IGNITION AND FLASH BACK (DUE TO SOLVENT). NON-TOXIC AND TOXIC FUMES MAY FORM UPON COMBUSTION. STAY UPWIND OF FIRE.

SECTION V - REACTIVITY DATA

STABILITY : STABLE CONDITIONS TO AVOID: HEAT, FIRE, IGNITION SOURCES
INCOMPATIBILITY : STRONG OXIDIZING OR REDUCING AGENTS
HAZARDOUS DECOMPOSITION : CARBON MONOXIDE, CARBON DIOXIDE, OXIDES OF NITROGEN, SMOKE
HAZARDOUS POLYMERIZATION : WILL NOT OCCUR

CONTINUED ON OTHER SIDE

SECTION VI - HEALTH HAZARD DATA

PRIMARY ROUTES OF EXPOSURE : ORAL, INHALATION, AND SKIN

INGESTION : NMP - RAT LD50 4200 MG/KG

INHALATION : NMP - RAT: AT SUPER SATURATED (110° C) CONCENTRATIONS, NO EVIDENCE OF TOXIC EFFECTS.

EYES : MODERATE IRRITANT; NO PERMANENT DAMAGE

SKIN CONTACT : NMP - RABBIT LD50; 8000 MG/KG

SENSITIZER: NMP - HUMAN REPEAT INSULT PATCH TEST; MILD TRANSIENT IRRITATION THROUGH REPEATED CONTACT: MATERIAL WAS FOUND TO BE A FATIGUING AGENT BUT NOT A SENSITIZER.

SUB CHRONIC MISCELLANEOUS TOXICITY : REPRODUCTIVE - RAT (M & F) - 500 MG/KG/DAY FOR 10 WEEKS BEFORE MATING & THROUGHOUT PREGNANCY PRODUCED FETOLETHALITY.

FIRST AID :

INGESTION: INDUCE VOMITING IMMEDIATELY. CALL PHYSICIAN.

INHALATION: REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, GIVE OXYGEN, CALL PHYSICIAN.

EYES: IRRIGATE IMMEDIATELY WITH WATER FOR AT LEAST 15 MINUTES. CALL PHYSICIAN.

SKIN: FLUSH SKIN WITH WATER.

VII-PRECAUTIONS FOR SAFE HANDLING & USE

REMOVE ALL SOURCES OF IGNITION! ABSORB LIQUID ON VERMICULITE ABSORBENT & DISPOSE OF WITH SOLID WASTE ACCORDING TO FEDERAL, STATE AND LOCAL REGULATIONS. FLUSH SPILL AREA WITH WATER.

WASTE DISPOSAL METHOD : THIS MATERIAL SHOULD BE DISPOSED OF IN COMPLIANCE WITH STATE AND FEDERAL REGULATIONS.

PRECAUTIONS TO BE TAKEN IN HANDLING & STORING : TREAT AS A COMBUSTIBLE LIQUID. ALWAYS KEEP CONTAINER CLOSED. READ LABEL BEFORE USE. AVOID EXCESSIVE CONTACT WITH FUMES OR LIQUID.

SECTION VIII-CONTROL MEASURES

RESPIRATORY PROTECTION : NIOSH-APPROVED RESPIRATOR, WHERE TLV OR PEL MAY BE EXCEEDED.
VENTILATION : USE WITH ADEQUATE VENTILATION.
PROTECTIVE GLOVES : IMPERVIOUS GLOVES OF NATURAL LATEX OR NEOPRENE ARE RECOMMENDED.
EYE PROTECTION : CHEMICAL GOGGLES ARE RECOMMENDED

WORK PRACTICES : USE WITH ADEQUATE VENTILATION. WASH HANDS AFTER USE.
PROTECTIVE MEASURES DURING REPAIR/MAINTENANCE OF EQUIPMENT: WASH EQUIPMENT WITH STEAM OR WARM WATER UNTIL CLEAN. CHECK FOR FLAMMABLES WITH AN "EXPLOSION METER" AND ALSO CHECK OXYGEN LEVEL WITH AN OXYGEN METER. IN ALL CASES, FOLLOW GOOD INDUSTRIAL SAFETY PRACTICES BEFORE ENTERING EQUIPMENT.

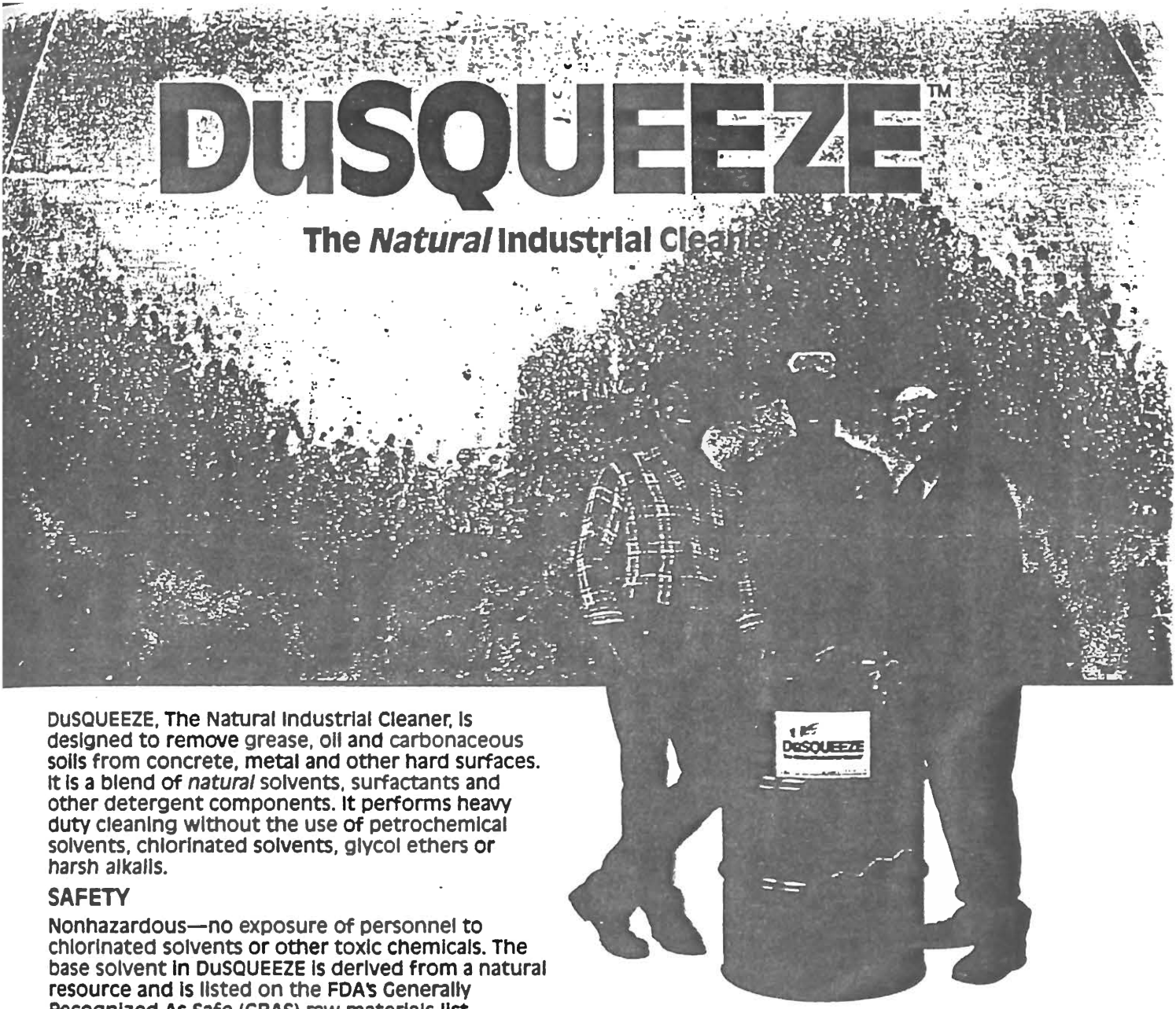
END OF MSDS : PARTSPREP DEGREASER

APPENDIX B

Information on DuSqueeze

DuSQUEEZE™

The *Natural* Industrial Clean



DuSQUEEZE, The Natural Industrial Cleaner, is designed to remove grease, oil and carbonaceous soils from concrete, metal and other hard surfaces. It is a blend of *natural* solvents, surfactants and other detergent components. It performs heavy duty cleaning without the use of petrochemical solvents, chlorinated solvents, glycol ethers or harsh alkalis.

SAFETY

Nonhazardous—no exposure of personnel to chlorinated solvents or other toxic chemicals. The base solvent in DuSQUEEZE is derived from a natural resource and is listed on the FDA's Generally Recognized As Safe (GRAS) raw materials list. Classified by Underwriters Laboratories Inc. as to slip resistance only.

DISPOSABILITY

Because DuSQUEEZE The Natural Industrial Cleaner does not add any toxicity to cleaning operations, and because it is biodegradable, disposal is easier. DuSQUEEZE is recognized as an excellent drain cleaner.

PERFORMANCE

The performance of DuSQUEEZE can be regulated by the degree of dilution. At full concentration to a 1:5 dilution it is a heavy-duty cleaner; at greater dilution with water it becomes a multi-purpose cleaner.

CONVENIENCE/VERSATILITY

The DuSQUEEZE Cleaner performs heavy duty tasks formerly accomplished only by hazardous chlorinated or aliphatic solvents, harsh alkalis and acids or other toxic chemicals. It can be used for hand-wiping cleanup of equipment or house-cleaning. DuSQUEEZE can be foamed for increased dwell time, used in conjunction with steam cleaning equipment; used in pressure washing operations or in heavy duty floor scrubbing. It is particularly effective on most ink and dye stains, as well as the removal of uncured paint spillage or overspray. For milder cleaning chores, it can be further diluted. Unlike most solvent products, DuSQUEEZE provides complete and safe rinsing. Contact your DuBois Representative for other specific cleaning applications.

ECONOMICAL

Because the DuSQUEEZE product can be diluted to accommodate a wide variety of cleaning jobs, it will not be necessary to inventory a multiplicity of products. DuSQUEEZE does it all!

PLEASANT ODOR

The pleasant natural fragrance associated with using DuSQUEEZE is a refreshing change from the odors associated with using harsh or toxic solvents. The fragrance is derived from the citrus base solvent in the formula and is not attributable to perfume.

DuBois Chemicals Facilities Maintenance Division
DuBois Chemicals • DuBois Tower • Cincinnati, Ohio 45202

GENERAL DESCRIPTION:

The DuSQUEEZE product is a blend of natural solvents, surfactants and other detergent components. It is designed to remove grease, oil and carbonaceous soils from concrete, metal and other hard surfaces. DuSQUEEZE is particularly effective on asphaltic and related soils. DuSQUEEZE performs heavy-duty cleaning without the use of petrochemical solvents, chlorinated solvents, glycol ethers, or harsh alkalis.

PROPERTIES:

APPEARANCE	Clear orange liquid
ODOR	Pleasant citrus odor
BIODEGRADABLE	Yes
DENSITY	8.14 lb./gal.
pH	8.5-9.5
FLASH POINT	185° F. Cleveland Open Cup, 124° F. Tag Closed Cup
WETTING ABILITY	Excellent
PHOSPHATES	None
RINSING	Excellent
STABILITY	Stable in hard water
EMULSIFICATION	Rapid
FOAMING ABILITY	Copious foam

PACKAGING:

55-gallon drum (208 liters). Net weight 448 pounds (195.0 kg).

5-gallon plastic pail (19 liters). Net weight 41 pounds (18.0 kg).

USING PROCEDURE:

For hot tank cleaning—the DuSQUEEZE product should be used at 10% to 20% with water. Since it is a liquid, it requires no premixing. When used as a general purpose maintenance cleaner, dilute with water from 1:5 to 1:50. Use area must be ventilated to adequately exhaust solvents.

DISPENSING:

The DuSQUEEZE product can be used through DuBOIS SURE-SHOT SPRAYER, FOAMALL 80, FOAMALL 10, THERMOBLAST units, steam injector wands, mixing manifolds, or the DuBOIS STEAMALL. NOTE: When DuSQUEEZE is used with steam cleaning equipment, a solvent-resistant hose must be used.

TITRATION:

The DuSQUEEZE product is non-titratable.

MATERIAL SAFETY:

Safe on ferrous and nonferrous metals. Test for safety on plastic and painted surfaces.

CAUTION:

PACKAGING: KEEP OUT OF THE REACH OF CHILDREN.

Combustible liquid. Keep away from heat, sparks and fire. Keep container closed when not in use. Effect on skin and eyes; drying to skin, irritating to eyes. For eye contact, flush with water for at least 15 minutes and *GET MEDICAL ATTENTION.* For skin contact, flush promptly and thoroughly with water.

Do not breathe vapors. Use product with adequate ventilation and keep vapors away from sparks or open flame. The U.S. Department of Labor Guide for Safety and Health Standards prescribes that all employees within range of any steam cleaning vapor be protected by a suitable face shield. Conduct steam cleaning with adequate ventilation so that operator does not breathe fumes constantly.

DuBois Chemicals Facilities Maintenance Division
DuBois Chemicals • DuBois Tower • Cincinnati, Ohio 45202

DuBOIS USA

DuSqueeze®

The Natural Industrial Cleaner

Technical Data

GENERAL DESCRIPTION:

DuSQUEEZE® the natural industrial cleaner is a blend of a natural solvent, surfactants and other detergent components. It is designed to remove grease, oil and carbonaceous soils from concrete, metal and other hard surfaces. DuSQUEEZE® is particularly effective on asphaltic soils. DuSQUEEEZE® tends to release these types of soils from the substrate rather than emulsify them. DuSQUEEZE® performs heavy-duty cleaning without the use of petrochemical solvents, chlorinated solvents, glycol ethers, harsh acids, or highly alkaline compounds.

PROPERTIES:

Appearance	Clear orange liquid
Biodegradable	Yes
Density	8.17 lb./gal.
Emulsification	Rapid
Flash Point	185°F Cleveland Open Cup 124°F Tag Closed Cup
Foaming Ability	Copious foam
Odor	Pleasant citrus
pH	9.0
Phosphates	None
Rinsing	Excellent
Stability	Forms a stable emulsion in hard water
Wetting Ability	Excellent

USING PROCEDURES:

Maintenance Cleaning:

EQUIPMENT — dilute 1:5 to 1:20 with water.

FLOORS — dilute 1:20 to 1:50 with water. Heavily-soiled areas should be pre-spotted.

STEAM CLEANING — dilute 1:30 to 1:100.

Hot Tank Cleaning:

Use at 10% to 20% with water from ambient temperature to 160°F. Many greases and oils will float to the surface for easy skimming. If parts flash rust after rinsing, DuBOIS 910 or DuBOIS 200 should be added to *the rinse water* at 0.5% to 3%.

DISPENSING:

DuSQUEEZE® can be used through the DuBois SURE-SHOT SPRAYER, MEGA FOAMER, FOAMALL 80, FOAMALL 10, THERMO-BLAST units, steam injector wands, mixing manifolds or the DuBois STEAMALL. Note: When DuSQUEEZE® is used with steam cleaning equipment, a solvent-resistant hose must be used.

TITRATION:

DuSQUEEZE® is non-titratable.

MATERIAL SAFETY:

Safe on ferrous and nonferrous metals. Test for safety on plastic and painted surfaces.

STORAGE INSTRUCTIONS:

If frozen, thaw and mix to make usable.

PRECAUTIONS:

KEEP OUT OF THE REACH OF CHILDREN.

WARNING: Contains dipentene solvent. Combustible liquid. Keep away from heat, sparks and fire. Keep container closed when not in use. Effect on skin and eyes: drying to skin, irritating to eyes. For eye contact, flush with water for at least 15 minutes and GET MEDICAL ATTENTION IMMEDIATELY. For skin contact, flush promptly and thoroughly with water.

Do not breathe vapors. Use product with adequate ventilation and keep vapors away from sparks or open flame. The U.S. Department of Labor Guide for Safety and Health Standards prescribes that all employees within range of any steam cleaning vapor be protected by a suitable face shield. Conduct steam cleaning with adequate ventilation so that operator does not breathe fumes constantly.

ACCEPTABILITY:

Authorized by the USDA for use in federally inspected meat and poultry plants.

All ingredients in DuSQUEEZE® cleaner comply with FDA regulations for use in the manufacturing of paper intended for contact with food or listed as Generally Recognized As Safe (GRAS).

Kosher certified.

Conforms to AMS1526 as a cleaner for aircraft exterior surfaces when diluted 1:6 with water.

Meets or exceeds metal safety guidelines of SAE ARP1755A, Effect of Cleaning Agents on Aircraft Engine Materials.

Disposal of spent solutions — For information on spent solutions contact Process (Wastewater) Treatment Technical Service @ (513) 554-4314 or Health, Safety & Environmental Affairs Department @ (513) 554-4296.

A Material Safety Data Sheet is available on request.

DuBOIS

...WHEN THE ACCENT IS ON QUALITY

DuBois Chemicals, Inc. • DuBois Tower • Cincinnati, Ohio 45202-3178

DuCARE CUSTOMER SERVICE: 1-800-543-4906 (In Continental U.S.A. 8 a.m. - 5 p.m. EST, Monday - Friday)

TO CONTACT YOUR REPRESENTATIVE, CALL OUR 24-HOUR MESSAGE CENTER: 1-800-4DuBOIS (In Continental U.S.A.)

APPEARANCE & ODOR: CLEAR ORANGE LIQUID; PLEASANT CITRUS ODOR

FLASH POINT: TCC 124 °F — FLAME EXTENSION: N/A in. — FLAMMABLE LIMITS IN AIR BY VOLUME: LOWER NONE UPPER NONE — AUTO IGNITION TEMPERATURE: N/A °F

EXTINGUISHER MEDIA: CO2, FOAM, DRY CHEMICALS

FIREFIGHTING SPECIAL PROCEDURES: NONE

UNUSUAL FIRE AND EXPLOSION HAZARDS: COMBUSTIBLE LIQUID; AVOID OPEN FLAMES.

STABILITY: STABLE — POLYMERIZATION: NONE

INCOMPATIBLE WITH: STRONG OXIDIZERS; STRONG ACIDS WILL EFFECT QUALITY.

DECOMPOSITION PRODUCTS: OXIDES OF CARBON, HYDROGEN, NITROGEN

PRIMARY ROUTES OF ENTRY — INHALATION: YES — SKIN: NO — INGESTION: YES

1. ACUTE SIGNS AND SYMPTOMS OF OVEREXPOSURE: DEFATS SKIN; MAY IRRITATE EYES.

2. CHRONIC: SAME AS ACUTE

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: SENSITIVE SKIN

LISTED CARCINOGEN: NONE — NTP: NO — IARC: NO — OSHA: NO

EMERGENCY AND FIRST AID PROCEDURES

1. INHALATION: REMOVE TO FRESH AIR.

2. EYES: FLUSH THOROUGHLY WITH FRESH WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION.

3. SKIN: FLUSH WITH FRESH WATER. WASH WITH SOAP AND WATER
REMOVE CONTAMINATED CLOTHES AND SHOES

4. INGESTION: GIVE MILK OR WATER. DO NOT INDUCE VOMITING. GET MEDICAL ATTENTION.

RESPIRATORY PROTECTION: NOT NORMALLY REQUIRED.

VENTILATION MECHANICAL: NORMAL AIR DILUTION — VENTILATION LOCAL: YES — SPECIAL: NONE

PROTECTIVE GLOVES: SOLVENT RESISTANT

EYE PROTECTION: SAFETY GLASSES

OTHER PROTECTIVE CLOTHING/EQUIPMENT: PROVIDE ADEQUATE VENTILATION AND FACE SHIELD WHEN STEAM CLEANING.

HANDLING AND STORAGE PRECAUTIONS: DO NOT PRESSURE CONTAINER TO EMPTY. KEEP CONTAINER CLOSED.
IF FROZEN, THAW AND MIX TO MAKE USABLE.

OTHER PRECAUTIONS: DOT CLASS: NOT REGULATED IN QUANTITIES LESS THAN 110 GAL.;
OTHERWISE, D.O.T. CLASS: COMBUSTIBLE NA 1993.

IF MATERIAL IS RELEASED/SPILLED: FLUSH SMALL AMOUNTS TO DRAIN; COLLECT AND RETURN LARGE AMOUNTS TO CONTAINER.

WASTE DISPOSAL METHODS: USE UNTIL LESS THAN 1 INCH REMAINS IN CONTAINER, EMPTY CONTAINER
TRIPLE RINSE WITH WATER, ADD TO OPERATION
REMOVE OR DEFACE LABEL BEFORE SELLING CONTAINER OR DISPOSAL

CONTAINS NO PHOSPHATES. EMULSION BREAKING AND SEPARATION OF INSOLUBLES. DISPOSE OF MATERIALS BY INCENERATION, LANDFILL OR NPDES PERMIT COMPLYING WITH FEDERAL, STATE AND LOCAL REGULATIONS.

HMIS RATING — HEALTH: 1 — FLAMMABILITY: 2 — REACTIVITY: 0 — PERSONAL PROTECTION: B

NONE

N/A

ERIAL SAFETY DATA SHEET

QUICK IDENTIFIER DUSQUEEZE 6

8:00-5:00 EST-MON-FRI 1-800-543-4916 MEDICAL(COLLECT) 303-592-1024
CHEMTREC 1-800-424-9300

MANUFACTURER'S NAME
DIVERSEY CORP.
12025 TECH CENTER DRIVE
LIVONIA, MICHIGAN 48150
PREPARED BY: M. ANTOSIAK
ON 12/31/90

EMERGENCY PHONE NO.
313-458-5000

REFERENCE SEQ # 42467

ABBREVIATIONS ---C-CEILING---MP-MAXIMUM PEAK---N/A-NOT APPLICABLE---N/K-NOT KNOWN---P-POTENTIAL---PEL-PERMISSIBLE EXPOSURE LIMIT ---PM-PENSKY MARTENS---S-SKIN---ST-SHORT TERM---TLV-THRESHOLD LIMIT VALUE---TWA-TIME WEIGHT AVERAGE---

COMMON NAME USED ON LABEL DUSQUEEZE CODE 01866

CHEMICAL FAMILY EMULSIFIED SOLVENT CLEANER

PRINCIPAL HAZARDOUS COMPONENT(S) CHEMICAL & COMMON NAME	%	EXPOSURE LIMITS (TWA 8 HOURS UNLESS OTHERWISE SPECIFIED)	UNITS
DIPENTENE SOLVENT (#CAS138-86-3)	<30	NONE ESTABLISHED FLASH POINT 115F TCC	
NONYLPHENOXYPOLY(ETHYLENEOXY) ETHANOL (9016-45-9)	<10	NONE ESTABLISHED	

FLASH POINT 22 F (METHOD USED TCC) SPECIFIC GRAVITY 0.978 VAPOR PRESSURE 17.5 mmHg@ 20 °C VOLATILE BY VOLUME <70 %

APPEARANCE & ODOR CLEAR ORANGE LIQUID; PLEASANT CITRUS ODOR

N/A EVAPORATION RATE (BUTYL ACETATE=1) >1 SOLUBILITY IN WATER <75 % BIODEGRADABILITY / VOC EPA REGULATION NONE

CHEMICAL SUBSTITUTION FOR 1,1,1-TRICHLOROETHANE AND METHANOL IN MANUFACTURING OPERATIONS

by: Lisa M. Brown
Johnny Springer
U.S. Environmental Protection Agency
Risk Reduction Engineering Laboratory
Cincinnati, Ohio

Matthew Bower
APS Materials, Inc.
Dayton, Ohio

ABSTRACT

Hazardous wastes are generated from cold solvent degreasing operations used in many industrial processes. The spent solvents are managed under Subtitle C of the Resource Conservation and Recovery Act (RCRA). With the land ban of spent solvents, disposal has become increasingly difficult. As a result, industries began investigating ways to avoid using RCRA listed cleaning solvents. EPA's Pollution Prevention Research Branch along with APS Materials, Inc., a small metal finishing company, participated in a joint research project to evaluate the substitution of a dilute, terpene-based cleaner for 1,1,1-trichloroethane (TCA) and methanol, hazardous wastes F001 and F003 respectively, in their degreasing operations.

This paper presents the results of a study evaluating the waste reduction/pollution prevention that can be achieved by substituting dilute limonene solutions for TCA and methanol in the cleaning of orthopedic implants (e.g. metal knee and hip replacements). This paper describes the original cleaning process, the modifications made to the process in using the dilute limonene solution, and the sampling plan used in evaluating the effectiveness of the solution. The paper presents qualitative results of the sampling tests and an economic evaluation of plant modifications.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication. Mention of trade names of commercial products does not constitute endorsement or recommendation for use.

INTRODUCTION

Passage of the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) of 1976 has redirected the U.S. environmental policy towards waste minimization to improve the quality of the environment. In its efforts to pursue the objectives set forth by Congress in the HSWAs to RCRA, the USEPA has established a national comprehensive pollution prevention program that includes information gathering, research and development, demonstration, support of state and local government pollution prevention programs, training and education, technology transfer activities, pollution prevention assessments, and extensive communications with universities and the general public. Implementation of programs to achieve several of these objectives is accomplished through research conducted by the Pollution Prevention Research Branch of the Risk Reduction Engineering Laboratory. This research addresses the intent of the Amendments to reduce the release and transport of hazardous, toxic, and nonhazardous materials through the air, water and solid media. The research is of significant benefit to the USEPA, states, waste generators, and the general public since results of this research will assist in reducing the generation of pollutants that threaten both public health and the environment. The principal goal of the Pollution Prevention Research Branch is to encourage the identification, development, and demonstration of processes and techniques that result in less waste being generated in order to promote a more rapid introduction of effective pollution prevention techniques into broad commercial practice.

1,1,1-trichloroethane (TCA) is used as a cold solvent degreasing agent in many industrial degreasing processes. In 1986, (TCA) was identified as a hazardous waste that must be managed under Subtitle C of the Resource Conservation and Recovery Act. As a result of this action, industries began looking for ways to avoid the use of TCA cleaning solvents. The EPA decided to target the metal finishing industry for participation in a joint research project to examine the possibility of substituting a terpene-based cleaner for TCA in degreasing operations. APS Materials, Inc., a facility in Dayton, Ohio participated in the research project. APS Materials, Inc. is a metal parts finishing company which generates TCA and methanol waste from cold solvent degreasing operations associated with their plasma spray deposition process.

PLASMA SPRAY DEPOSITION PROCESS

The plasma spray deposition process has emerged as a major means to apply a wide range of materials on diverse substrates. The deposition process is accomplished with the use of a plasma gun. In the plasma gun, an electric arc is formed between positive and negative electrodes via an electric discharge initiated by direct current. The discharge gives rise to a breakdown of the dielectric nature of the gas, making it conductive. The net result is a gaseous collection of energetic electrons and ionized molecules known as a plasma. The plasma exits as a high velocity flame through the nozzle of the gun. A powdered feedstock is injected into the flame via a carrier gas (usually argon). The injected powder accelerates, melts, and is carried at sonic velocities to the substrate on which the particles impact and solidify rapidly, at rates about one million degrees per second, building a well adhered protective coating.(1)

While APS Materials, Inc. employs the fundamental plasma spray deposition process, a few changes were made to better accommodate the plasma spray work performed by their company. First, APS Materials performs its plasma spraying in an inert atmosphere chamber. This is done for cooling and to prevent the titanium powder used in many of its coating applications from becoming oxidized thus forming brittle coatings. APS Materials also uses helium in the spray gun as a mix gas and to adjust the heat level and arc length.

Typically, the plasma spray deposition process requires only a small amount of substrate preparation. However, because APS Materials is involved in plasma spraying parts that must perform in such hostile environments as aircraft engines (aircraft parts) and the human body (orthopedic implants), they must be assured that the plasma sprayed coating is securely adhered to the substrate. For this reason, parts that arrive at APS for coating undergo a thorough cleaning process prior to the application of the plasma spray coat.

PROCESS DESCRIPTION

ORIGINAL PROCESS

In the APS biomedical parts division, the company primarily coats cobalt/molybdenum parts and titanium parts with a porous titanium alloy. By using plasma spray technology, the porosity of the coating is controlled so that growing bone will attach to the metal surface. In order to achieve a strong and adhesive coating, the parts were cleaned with TCA or methanol (TCA for cobalt/molybdenum and methanol for titanium). TCA is more economical than methanol but weakens titanium over time. The cleaning process consists of several steps. Initially, the parts

received undergo a visual inspection for any gross defects. The parts are then partially masked with tape, exposing only the surfaces that will receive spray coating. Next, they are grit blasted to roughen the surface of the part for the application of the spray coat. After the grit blast has been completed, the masking tape is removed. The part is then immersed in a small pail containing TCA or methanol. The pail is placed in an ultrasonic bath containing warm water for 15 minutes. Solids from grit blasting, oil and grease from the manufacturing and handling of the parts, and any adhesive residuals from the masking tape are removed in this cleaning process. After the ultrasonic bath, a graphite masking suspension is applied to the part on surfaces where the plasma spray coating is not wanted. The part is then plasma sprayed and cleaned again to remove excess titanium and the graphite mask.

As a check system, APS runs small one inch diameter disks of the same composition as the part to be coated - called "test buttons" - through the same cleaning and coating process. The test buttons are placed on a tensile strength testing machine which measures the tension required to separate the coating from the substrate as a quality control measure.

Many wastes are generated during the preparation of the part for spray coating, with TCA and methanol being the wastes of primary concern. Waste TCA and methanol were being generated at the rate of 1/2 barrel per month each. Disposal of these solvents was becoming more and more difficult.

DESCRIPTION OF INITIAL BENCH SCALE EXPERIMENTS

DuSqueeze, a product of DuBois Chemicals, was selected as a possible substitute for TCA and methanol because of its disposal qualities. Disposal of dilute solutions of DuSqueeze could be accomplished by flushing it to a sanitary or industrial sewer according to local sewer use permit requirements. The feasibility of substituting a dilute, terpene-based cleaner (DuSqueeze) for TCA and methanol was determined by assessing the tensile strength of the plasma coating bonds made after cleaning with DuSqueeze. Five tests were performed, four on plasma coated test buttons to assess the tensile strength of bonds made after cleaning with Dusqueeze as compared to the tensile strength of bonds made after cleaning with methanol and TCA, and one test to determine if any limonene remained on the buttons after being cleaned. In the first test, four titanium test buttons were placed in a stainless steel beaker containing a 20:1 dilute solution of DuSqueeze and water. The solution was agitated for 20 seconds. The test buttons were then placed in a stainless steel beaker containing deionized (DI) water which was agitated for 20 seconds. The test buttons were then blow-dried and plasma sprayed. The tensile strength of the bond between the plasma arc coating and the substrate was measured using a Tinius Olsen tensile tester.

In the second test, four titanium buttons were placed in an ultrasound bath containing a 50:1 dilute solution of DuSqueeze for 10 minutes. Next the buttons were placed in a stainless steel beaker containing DI water for thirty seconds. The titanium buttons were blow dried for sixty seconds and then plasma sprayed. The tensile strength of the bonds were then tested in the same manner as the first test. The third test followed the same procedure as test two, using a 100:1 dilute solution of DuSqueeze. In the fourth test the buttons were cleaned by the same process as the third test, but the buttons were analyzed for residual limonene and were not plasma sprayed and tensile tested. In the fifth test, cobalt/molybdenum buttons were used instead of the titanium buttons with the test protocol identical to the third test.

MODIFICATIONS TO EXISTING SYSTEM

APS purchased a heated ultrasound bath with a timer for the conversion. However, when this ultrasound bath malfunctioned, a heater was added to the old ultrasound bath. The TCA/methanol cleaning system did not require a DI water rinse, so a DI water system was purchased along with a stainless steel bath and immersion heater. With the new cleaning system, the parts take longer to dry, so a heat gun was purchased to speed-up the drying process.

SAMPLING AND ANALYSIS

The overall purpose of the sampling and analysis project at APS Materials was to support a purely qualitative judgement of the cleaning capabilities of the substitute cleaning solution (i.e., DuSqueeze). The sampling and analysis protocol for this project was set up in three parts; sampling spent solutions of methanol and TCA, sampling the terpene-based cleaning solution after modifications were made to the cleaning system, and developing data for a comparative analysis of plasma coating bond strengths between the coatings of test buttons that were cleaned with methanol/TCA prior to coating and the coatings of test buttons that were cleaned with the terpene-based solution prior to coating.

PRE-MODIFICATION SAMPLING

The first part of the sampling process was performed prior to any modifications. This sampling was performed in order to determine the type and amounts of contaminants found in the cleaning solvents. Samples of the methanol and TCA cleaning solutions were taken and analyzed for oil and grease, dissolved solids, suspended solids, titanium metal and cobalt metal. This sampling also established the baseline performance for methanol and TCA. The samples were taken by mixing the material in a plastic bucket and then pouring a sample from the bucket through

a glass funnel into a glass bottle. The data derived from this sampling served as a bench mark for the ensuing DuSqueeze sampling.

POST-MODIFICATION SAMPLING

The second part of the sampling scheme was performed after the modifications were made to the system in order to determine the effectiveness of the terpene-based solvent (DuSqueeze) in cleaning the parts. Sampling of the cleaning solution was performed throughout a typical operating cycle. Samples were recovered at the beginning of a bath cycle (i.e., when the tank contents were completely replaced with fresh cleaning solution) to establish baseline concentrations. A second sample was taken midway through the effective life of the cleaning solution. A final sample was recovered prior to removing the spent solution from the dip tank.

One liquid sample was collected during each sampling episode and split into two aliquots. One aliquot was placed in a 1000-ml linear polyethylene bottle with a screw-cap lid. This sample was used to analyze for dissolved/suspended solids and the two specific metals. The second aliquot was used to test for oil and grease and was placed in a 1000-ml glass bottle with screw-cap lid. Before use, the sample containers were soap-and-water washed, rinsed thoroughly, and then soaked in acid (nitric acid for plastic, sulfuric acid for glass) for several hours. The bottles were then rinsed thoroughly with tap water, distilled water, and deionized distilled water respectively. They were air-dried and stored with their caps in place.

Preservation procedures were performed on the liquid samples immediately after sample collection. The pH of each liquid sample was measured using pH indicator paper. Acid was added to each sample until the pH was reduced to 2.0. The samples that were analyzed for dissolved/suspended solids and metals were pH-adjusted using nitric acid. Sulfuric acid was used for preserving the oil and grease samples.

In addition to taking samples of the cleaning solution, wipe samples were taken of the cleaned parts. Wipe samples were taken to evaluate the cleaning efficiency of the solution over time by analyzing for residual contaminants (oil and grease) on the parts. One wipe sample was taken from the cleaned metal parts during each sampling interval to determine if there was a residual of oil and grease. The wipe sample was performed using sterile, uncontaminated cloth. Sterile gloves were worn to prevent contamination of the cloth with oil and grease. The wiping procedure was consistent for each sample. A glass container of sufficient volume was used to hold the cloth after sampling. Three wipe samples were taken over the life of the DuSqueeze cleaning solution, to coincide with the three liquid samples described above.

Analysis for metals was performed using inductively-coupled plasma atomic emission spectroscopy (ICP). Oil, grease and dissolved/suspended solids were analyzed using gravimetric analytical techniques. Spikes and replicate analyses were also done to check for accuracy and precision and to identify the presence of any matrix effects associated with sample preparation or measurement. Data were then combined and statistically evaluated.

The analysis of plasma coating bond strength compared current data collected by APS Materials regarding the strength of coatings applied after parts were cleaned with DuSqueeze and historical data of bond strength resulting from parts cleaning with TCA and methanol. Data generated two months prior and two months following the conversion to DuSqueeze was used for this comparison.

RESULTS AND DISCUSSION

BENCH SCALE EXPERIMENTS

The before and after tensile strength results were comparable. Overall, the bonding strengths were actually slightly better for the dilute limonene cleaner (see Table 1). No residual limonene was detected (detection limit 1 ppm) for cleaner at 100:1 dilution.

TABLE 1. TENSILE STRENGTH TEST RESULTS FOR BENCH SCALE EXPERIMENTS

Test Buttons	Cleaning Agent	Tensile Strength (psi)
titanium	methanol	6300+/-1260
titanium	DuSqueeze*	7000+/-570
cobalt/molybdenum	TCA	5150+/-1990
cobalt/molybdenum	DuSqueeze*	5400+/-1290

* Tensile strengths measured for test button cleaned with various dilutions of DuSqueeze showed no trends or statistical differences, so values shown include all measurements.

ANALYSES FOR IN-PLANT OPERATIONS

The initial tests for contaminants in methanol and TCA used for cleaning yielded the results shown in Table 2. The samples for these analyses were taken when the baths were considered spent, just prior to being dumped.

TABLE 2. RESULTS OF ANALYSES OF SOLVENT SAMPLES FOR CONTAMINANTS

Test	Methanol (mg/l)	TCA (mg/l)
Dissolved solids	1	29
Suspended solids	33	9
Oil and Grease	911	141
Metals		
Cobalt	-	ND
Titanium	0.021	-

* Method detection limit is 0.01

The amounts of oil and grease found in the wipe samples, shown in Table 3, were very low at about 1 mg or less. The increase in oil and grease from the bath dump as compared to the fresh bath was very small for one sample and was less than the fresh bath in the second bath dump sample. This latter result could have resulted from the wiping technique. In any case, the parts seem to be cleaned just as well at the time the bath is dumped as when the bath is fresh.

TABLE 3. RESULTS OF ANALYSES FOR OIL & GREASE ON PARTS CLEANED WITH 100:1 DILUTE SOLUTION DUSQUEEZE

Test	Oil and Grease Total Mg
Wipe Sample, Fresh Bath	1.0
Wipe Sample, Mid-life Bath	0.4
Wipe Sample, End-life Bath	1.2
BLANK	ND*

* Method detection limit is 0.3

Table 4 shows results from analyses for residual limonene on the parts. Limonene was not detected in the rinse samples, thus indicating that all of the limonene was removed during dragout and subsequent drying of the parts.

TABLE 4. RESULTS OF ANALYSES FOR RESIDUAL LIMONENE ON PARTS CLEANED WITH 100:1 DILUTE SOLUTION DUSQUEEZE

Test	limonene concentration Total Ug/sample
Rinse Sample, Fresh Bath	ND(<0.3)
Rinse Sample, Mid-life Bath	ND(<0.65)
Rinse Sample, End-life Bath	ND(<0.3)
BLANK	ND(<0.2)

In comparing the results in Table 5, it is noted that dissolved solids and oil and grease were much higher in the fresh bath and the bath used to clean parts only prior to plasma spraying (Dump#1), than in the bath used also for cleaning after plasma spraying (Dump#2), while the reverse was true for the suspended solids. The graphite in the bath may affect the DuSqueeze cleaning solution to create these differences.

TABLE 5. RESULTS OF ANALYSES OF 100:1 DULUTE DUSQUEEZE SOLUTION FOR CONTAMINANTS

Test	Fresh Bath	Dump#1	Dump#2
Dissolved solids	3650	3010	887
Suspended solids	ND*	ND*	19
Oil and Grease	37.0	30.8	15.1
Metals			
Cobalt	0.019	0.18	0.081
Titanium	ND#	ND#	1.65

* Method detection limit is 2
\# Method detection limit is 0.047

In comparing the DuSqueeze cleaning solution with the previous methanol and TCA samples, it is noted that the oil and grease levels in the DuSqueeze are much lower than the other cleaning solvents. Suspended solids for the DuSqueeze are lower than the previous solvents except for the sample containing graphite which is roughly equivalent. Dissolved solids for DuSqueeze are much higher than the other solvents.

The higher dissolved solids may reflect the fact that the DuSqueeze is an emulsifying agent which converts the oil and grease to dissolved solids. This would explain the lower oil and grease levels for DuSqueeze.

TABLE 6. TENSILE STRENGTH TEST RESULTS FOR IN-PLANT OPERATIONS

Coating/Substrate	Cleaning Agent	Tensile Strength
titanium / titanium	methanol	5560+/-600
titanium / titanium	DuSqueeze	7180+/-610
titanium / cobalt-moly	TCA	5820+/-370
titanium / cobalt-moly	DuSqueeze	5330+/-1560

Although the data generated by the sampling and analysis program, shown in Table 6, indicates that the terpene-based cleaner adequately cleaned the parts for this process, since wipe samples were not taken for the original process, a statement of comparison between the former and present cleaning techniques is not feasible.

ECONOMIC ANALYSIS

Although the old ultrasound bath was in use at the time of the test, economic analysis is shown for the system that APS is now operating.

- Capital Cost:
  - Ultrasound with heater $1425
  - 5 gallon stainless rinse vessel $38
  - Immersion heater $105
  - Heat Gun $75
  - DI water system installation $150
  - TOTAL - $1793
- Annual operating costs:
  - 7.8-11.8 gal DuSqueeze $150
  - 1825-2920 gal DI water $700
- Cost savings from avoided purchases:
  - 330 gal TCA $1650
  - 120 gal methanol $1000
- Cost savings from avoided disposal: 6 barrels $3000
- Net Cost savings: $4800 a year
- Payback $1793/$4800 = 0.37 year, 4.5 months

CONCLUSIONS

In summary, it has been determined that a terpene-based cleaner can adequately clean metal parts without adversely affecting the performance of the plasma-arc coating application. The use of a terpene-based cleaner in place of methanol and TCA has proven to be an environmental and economic success. Elimination of the disposal problems associated with methanol and TCA coupled with the maintenance of plasma-arc coating quality makes the use of terpene-based cleaners attractive to other plasma spray coating processes as well as other metal cleaning/coating operations. The annual cost savings as well as the short payback period also make the cleaner attractive from an economic standpoint.

REFERENCES

1. Herman, Herbert, "Plasma Spray Deposition Processes", MRS Bulletin, p. 60 - 68, December 1988.

2. Test Methods for Evaluating Solid Waste. SW-846, Third Edition, U. S. Environmental Protection Agency, November 1986.

3. Environmental Monitoring and Support Laboratory. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-29-020, U.S. Environmental Protection Agency, Cincinnati, Ohio, March 1983.

APPENDIX C

Information on LPS Precision Clean

LPS LABORATORIES, INC.

MATERIAL SAFETY DATA SHEET

Section 1 • Product Identification and Use

Manufacturer's Name:
LPS Laboratories, Inc.

Address (Number Street)
4647 Hugh Howell Road

Address (City, State, Zip)
Tucker, GA 30085-5052

Telephone Number: 404-934-7800
Emergency Telephone Number:
1-800-424-9300 Chemtrec
Outside U.S. (202) 887-1255

Trade Name:
LPS Precision Clean™

Chemical Family:
Blended Compound

Part Numbers:
02704, 02728, 02701, 02705, 02755

Hazardous Materials Description and proper shipping name (49 CFR 172.101):
Compound, Boiler, Preserving Liquid NMFC 50093 SUB 2 BRL/BXS CL55

TSCA Inventory:
All of the ingredients are listed on the TSCA inventory.

HMIS Labeling:
Health: 1
Flammability: 0
Reactivity: 0

Section 2 • Hazardous Ingredients / Identity Information

Ingredients	CAS Numbers	%WW	OSHA PEL	ALGIH TLV	OTHER LIMITS
Sodium Metasilicate	6834-92-0	<4	N.E.	N.E.	None
Dipropylene Glycol Methyl Ether	34590-94-8	<6	100 ppm	100 ppm	150 ppm STEL

Section 3 • Physical / Chemical Characteristics

Boiling point: (F°): Approx. 212°F
Vapor pressure (mmHg) @ 100°F : N.A.
Vapor density (Air = 1) N.A.
Solubility in water: Complete.
Appearance and odor: Clear, turquoise liquid with citrus odor.

Specific gravity (H_20 = 1): 1.07 Concentrate
1.017 Ready-to-use
Percent volatile by volume (%): 88 Concentrate
97 Ready-to-use
Evaporation rate (Water = 1): 1.0

Section 4 • Fire and Explosion Hazard

Flash point (method used): None T.C.C.

Flammable limits (by volume 25° C): **LEL** N.A. **UEL** N.A.

Extinguishing media: None

Special fire fighting procedures: None

Unusual fire and explosive hazards: None

N.E. = Not established
N.A. = Not applicable

Section 5 • Health Hazard Data

Threshold limit value: See section 2.
Primary route(s) of entry: Inhalation, eyes, skin.
Health hazard/effects of over exposure:

Inhalation:	Headache, dizziness.
Eyes:	Liquid will cause temporary irritation.
Skin:	Repeated or prolonged contact may cause drying and defatting of skin.

Medical conditions aggravated by exposure: None known at this time.
Chemicals listed as potential carcinogen: **NTP:** No **IARC:** No **OSHA:** No
Emergency and first aid procedures:

Inhalation:	Move to fresh air.
Eyes:	Flush eyes with plenty of water,lifting upper and lower lids occasionally. Contact a physician.
Skin:	Wash with soap and water; apply medicated skin cream.
Ingestion:	Unlikely route of entry. However, if ingested, drink large amounts of water, followed by milk and contact physician immediately.

Section 6 • Reactivity Data

Stability: Stable **Conditions to avoid:** None

Incompatibility (Materials to avoid): Strong oxidizing agents.
Hazardous decomposition products: None known at this time.
Hazardous polymerization: Will not occur.

Section 7 • Precautions for Safe Handling and Use

Steps to be taken in case material is released or spilled: Remove leaking container and contain spill. Soak up or mop up with absorbent material, such as sand or clay. Do not flush to sewer.
Waste disposal methods: Dispose of in accordance with local, state and federal regulations.
CERCLA Reportable Quantity: N.A.
SARA TITLE III Chemicals: None
Precautions to be taken in handling and storage: Product should be stored above 20°F and below 120°F. Keep containers closed when not in use.

Section 8 • Control Measures

Respiratory Protection: None required if good ventilation is maintained.
Ventilation: Local exhaust should be sufficient to maintain a comfortable work environment.
Protective gloves: Use rubber gloves.
Eye protection: Use safety glasses or goggles.
Other protective equipment: Eye washes and safety showers.
Work/hygienic practices: Wash hands with soap and water after use and/or before breaks, lunch and at the end of work periods. Remove contaminated clothing and launder before reuse.

Cleaners / Degreasers

LPS® Precision Clean™ All Purpose Cleaner/Degreaser

LPS Precision Clean is an all purpose super industrial strength cleaner/degreaser precisely formulated to be environmentally safer. All purpose Precision Clean removes tough, stubborn stains and soils, such as grease, oil, sludge, soot, ink, coffee, and more. Precision Clean is biodegradable. The special water-based T1 formula delivers maximum cleaning power without harmful butyl, chlorinated or petroleum solvents. LPS Precision Clean wipes off and rinses clean from virtually any washable surface. Precision Clean contains a rust and corrosion inhibitor to help prevent flash rusting of metal surfaces. Precision Clean is available in two convenient formulations: Concentrate and ready-to-use. Precision Clean may be diluted with water for economical performance in various cleaning applications replacing potentially harmful solvents. Precision Clean is authorized by the USDA for use in federally inspected meat and poultry plants.

Advantages

- Super industrial strength removes tough stains and soils
- Biodegradable and butyl free
- Water-based T1 formula
- Contains no harmful butyl, chlorinated or petroleum solvents, bleach, ammonia or abrasives
- Universal in application
- Safe on all metals
- Rinses clean
- Two formulations: Ready-to-use and concentrate
- Nonflammable

Applications

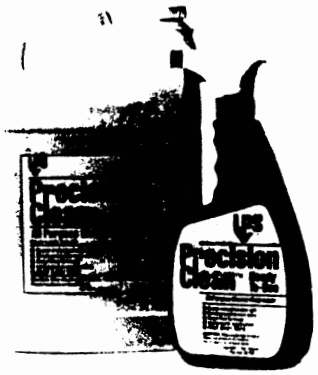
Precision Clean can be diluted with water up to 1:100 giving a single product for multiple cleaning needs in a variety of industries, equipment and applications. Typical equipment where LPS Precision Clean can be used include parts washers, dip tanks, ultrasonic cleaners, steam cleaners, pressure washers and trigger sprayers. Use LPS Precision Clean to clean all types of equipment an surfaces including machinery, forklifts, tools, bilges, concrete, driveways, sidewalks, carbon blocks, grease traps, tanks, engines, drill presses, printing presses, exhaust hoods, hoists, compressors, varnish, ovens and floors and walls.

Meets or exceeds these specifications:

Authorized by USDA for use in federally inspected meat and poultry plants. Aircraft cleaning specs for McDonnell-Douglas CSD#1, Boeing D6-17487 Rev. H, and Aerospace Material Spec. AMS 1526 A

Physical Properties:

Flash Point: None
Rinsability: Excellent
Biodegradable: Yes
Viscosity at 77° F: 4 cps
pH Ready-to-Use: 12.5
Odor: Citrus
Foaming Property: Moderate
Concentrate Weight per Gallon: 8.9 lbs.
Color: Turquoise



02704 4 oz. spray
02728 28 oz. trigger spray
02701 1 gal. bottle
02705 1 gal. pail
02755 55 gal. drum

LPS® Instant Super Cleaner/Degreaser

LPS Instant Super Cleaner Degreaser is a fast acting heavy-duty industrial safety solvent that cleans and flushes in a single operation. LPS Instant Super Cleaner/Degreaser's quick penetrating action instantly removes oil, grease, wax, dirt, moisture, tar, brake fluid and other contaminants leaving no residue and requiring no rinsing. LPS Instant Super Cleaner/Degreaser is nonconductive and contains no petroleum solvents. LPS Instant Super Cleaner/Degreaser is nonflammable and can be applied while equipment is in operation avoiding costly downtime.

Advantages

- Fast acting, heavy-duty safety solvent for cleaning and degreasing parts and equipment
- Penetrating action instantly removes oil, grease, wax, dirt, moisture, tar, brake fluid, and other contaminants
- Leaves no residue, no rinsing needed
- Works while equipment is in operation, minimizing downtime
- Nonflammable, non-staining
- Safe to use on fabrics
- Non-conductive
- Contains no petroleum solvents

Applications

Cleans and degreases chains and cables, pulleys, bearings, gears and gear drives, forklifts, hand trucks, conveyors, air compressors and other heavy equipment, electric motors, starters, clutches and generators, electric and pneumatic hand tools, welding equipment, air conditioning compressors and equipment, coils, contacts, controls. cables and other electrical components. Prepares metal surfaces for paint and adhesive bonding and metals for painting and lubrication. Removes grease and oil spots from carpet, fabric and upholstery, road tar, semi-conductive particles from end of high voltage cable when making splices and connections, excess wire pulling compounds and silicone lubricants, and oil and grease from concrete floors, driveways and work areas.

Meets or exceeds these specifications:

O-T-620C
MIL-T-81533A

Physical Properties

Flash Point: None
Specific Gravity: 1.36
KB Value: 120
% Non-volatiles: 10 ppm maximum
Dielectric Strength and Breakdown Voltage (ASTM D877): 28kv
Contains no carbon tetrachloride, perchlorethylene, methylene chloride or petroleum solvents
Propellant: Carbon Dioxide

00720 20 oz. aerosol
07128 1 gal. bottle
00705 5 gal. pail
00755 55 gal. drum

Technical Data

General Information

LPS Precision Clean cleans surfaces effectively without harmful butyl, chlorinated or petroleum solvents, bleach, ammonia or abrasives. It rinses clean and can simplify disposal problems. LPS Precision Clean contains a rust and corrosion inhibitor to help prevent flash rusting of metal surfaces.

LPS Precision Clean is a water-based, non-butyl cleaner. The special T1 formula penetrates built-up deposits and then disperses them by surrounding minute particles with a strong anionic (positive) charge. Particles repel one another and resist recombination. Once the particles are separated, water wets them to form a free flowing mixture that rinses cleanly away.

Material Safety Data Sheets are available upon request.

Properties

Flash point:
None

Viscosity at 77°F:
4 cps

Color:
Turquoise

Odor:
Citrus

Foaming property:
Moderate

pH Ready-to-use:
12.5

Rinsability:
Excellent

When should LPS Precision Clean be used? When should LPS PreSolve be used?

LPS Precision Clean works best on dirt, grime, soot and stains. LPS PreSolve works best on grease, oil and tar. LPS Precision Clean cleans by emulsifying and suspending grime. LPS PreSolve dissolves soils. LPS PreSolve is best where rinsing is not desired and where water cannot be tolerated. LPS Precision Clean is best to use in cleaning equipment, and is a very economical alternative to chlorinated solvents.

TACT

When cleaning parts and equipment, the size, shape, surface, type of soil, and cleaning time involved must all be considered to ensure the desired end results. Use this *TACT*-ful formula when selecting the proper cleaning method for your next job.

*T*IME
*A*GITATION
*C*ONCENTRATE
x *T*EMPERATURE

= *TACT*
FOR
MAXIMUM CLEANING EFFICIENCY

Dilution Chart

LPS Precision Clean: Water		Equipment	Applications
1 :	5 - 20	Pressure washer (Spray cleaning)	Clean and degrease lathes, stamping mil sheers,motors, air compressors, engines, heavy equipment, trailers,driveways, concrete floors, aircraft, boats and other equipment
1 :	5	Dip tanks	Tools, lifts, hoists, compressors, food process equipment machine parts and stampings
1 :	4 - 10	Parts washers	Tools, small parts, pulleys, machined parts and other oily and greasy parts
1 :	7	Tumblers	Oily parts, machined parts, pulleys, etc.
1 :	10	Ultrasonic cleaners	Cleaning electrical parts (Deionized water rinse/dry)
1 :	20	Floor scrubbers	Concrete, marble, brick and ceramic floors
1 :	4 - 20	Steam cleaner	Engines, heavy equipment, compressors, concrete floors
1 :	4 - 60	Trigger sprayer	Bulk cleaning of walls, floors, tile, leather, fabrics, plastic, exhaust hoods and appliances
1 :	40 - 80	Pressure washer (Spray cleaning)	Cleaning trucks, floors, loading ramps/docks, and other greasy, grimy equipment
1 :	100	Trigger sprayer	General cleaning of glass, walls, formica, stainless steel and appliances

Dilution Rates

Cleaner	Water	Cleaner	Water
1 to	4 parts =	32 fl. oz.	to 1 gallon
1 to	5 parts =	26 fl. oz.	to 1 gallon
1 to	10 parts =	13 fl. oz.	to 1 gallon
1 to	20 parts =	6.5 fl. oz.	to 1 gallon
1 to	40 parts =	3 fl. oz.	to 1 gallon
1 to	80 parts =	1.5 fl. oz.	to 1 gallon
1 to	100 parts =	1.3 fl. oz.	to 1 gallon
1 to	128 parts =	1 fl. oz.	to 1 gallon

LPS Laboratories, Inc.
4647 Hugh Howell Road
Tucker, GA 30085-5052
800-241-8334
Fax 404-493-9206
From Canada, Fax 800-543-1563

Printed in U.S.A.
Form# 2052

Morgan

APPENDIX D

Information on LPS PreSolve

LPS LABORATORIES, INC.

MATERIAL SAFETY DATA SHEET

Section 1 • Product Identification and Use

Manufacturer's Name:
LPS Laboratories, Inc.

Address (Number Street)
4647 Hugh Howell Road

Address (City, State, Zip)
Tucker, GA 30085-5052

Telephone Number: 404-934-7800
Emergency Telephone Number:
1-800-424-9300 Chemtrec
Outside U.S. (202) 887-1255

Trade Name:
LPS PreSolve

Chemical Family:
Blended Compound

Part Numbers:
001420

Manufacturer's D-U-N-S No.:
04-221-6549

Hazardous Materials Description and proper shipping name (49 CFR 172.101):
Compound, Boiler, Preserving Liquid NMFC 50093 SUB 2 BRL/BXS CL55
CONSUMER COMMODITY ORM-D

TSCA Inventory:
All of the ingredients are listed on the TSCA inventory.

HMIS Labeling:

Health:	1
Flammability:	2
Reactivity:	0

Section 2 • Hazardous Ingredients / Identity Information

Ingredients	Cas Numbers	%WW	OSHA PEL	ALGIH TLV	OTHER LIMITS
Solvent Naphtha (Petroleum) Medium Aliphatic	64742-88-7	30-50	500 ppm	100 ppm	200 ppm STEL
d-Limonene	5989-27-5	50-70	N.E.	N.E.	None
Carbon dioxide propellant (aerosol only)	124-38-0	2-3	5,000 ppm	5,000 ppm	30,000 ppm STEL

Section 3 • Physical / Chemical Characteristics

Boiling point: (F°): Approx. 315°F
Vapor pressure (mmHg) @ 100°F : <5
Vapor density (Air = 1) 4.8-5.3
Solubility in water: Slight
Specific gravity (H_2O = 1): .808
Percent volatile by volume (%): 100
Evaporation rate (n-Butyl Acetate= 1): 0.15
Appearance and odor: Clear, colorless liquid with mild citrus odor.

Section 4 • Fire and Explosion Hazard

Flash point (method used): 105°F TCC **Flammable limits** (by volume 25° C):

LEL	UEL
0.7%	6.0%

Extinguishing media: Foam, dry chemical, or carbon dioxide. Do not use a direct stream of water.

Special fire fighting procedures: Self-contained breathing apparatus should be provided to fire fighters. Water fog may be used to cool closed containers.

Unusual fire and explosive hazards: Intensive heat created by fire will cause aerosols to burst.

N.E. = Not established

Primary route(s) of entry: Inhalation, eyes, skin

Health hazard/effects of over exposure:

Inhalation:	Headache, dizziness, nausea and anesthetic effects.
Eyes:	Irritation.
Skin:	Repeated or prolonged contact may cause drying and defatting of skin.
Ingestion:	Low order of oral toxicity; however, minute amount aspirated into lungs during ingestion may cause severe pulmonary injury.

Medical conditions aggravated by exposure: Pre-existing eye, skin and respiratory disorders may be aggravated.

Chemicals listed as potential carcinogen: **NTP:** No **IARC:** No **OSHA:** No

Emergency and first aid procedures:

Inhalation:	Move to fresh air and contact physician. Administer oxygen if breathing is difficult.
Eyes:	Flush eyes with plenty of water, contact a physician.
Skin:	Wash with soap and water; apply medicated skin cream.
Ingestion:	Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into lungs. Get medical attention.

Section 6 • Reactivity Data

Stability: Stable

Conditions to avoid: Avoid sparks or open flames. See handling and storage precautions.

Incompatibility (Materials to avoid): Strong oxidizing agents.

Hazardous decomposition products: Thermal decomposition may yield carbon monoxide.

Hazardous polymerization: Will not occur.

Section 7 • Precautions for Safe Handling and Use

Steps to be taken in case material is released or spilled: Ventilate area by opening doors and windows. Remove ignition sources. Remove leaking container and transfer remaining product to another vessel. Prevent product from going into sewers and water courses by diking or impounding. Using appropriate safety equipment, mop up or soak up with absorbent material, such as sand or clay.

Waste disposal methods: Dispose of in accordance with local, state and federal regulations for petroleum distillates.

RCRA Hazardous Waste No.: This material has the RCRA characteristic of ignitability and if discarded in its purchased form would have the hazardous waste number D001.

CERCLA Reportable Quantity: N.A.

SARA TITLE III Chemicals: None

Precautions to be taken in handling and storage: Store aerosols below 120°F and above 32°F. Store away from ignition sources and avoid breathing vapors.

Section 8 • Control Measures

Respiratory Protection: None required if good ventilation is maintained. For enclosed areas, use NIOSH approved organic vapor cartridge respirator or self-contained breathing apparatus.

Ventilation: Local exhaust is usually adequate. However, mechanical ventilation should be used when spraying in enclosed areas. Vapor concentration should be minimized as much as possible.

Protective gloves: Use solvent resistant gloves for liquid handling.

Eye protection: For spraying or splashing of solvent, use face shield or goggles.

Other protective equipment: As necessary to prevent prolonged or repeated skin contact.

Work/hygienic practices: Wash hands with soap and water after use and/or before breaks, lunch and at the end of work periods. Remove contaminated clothing and launder before reuse.

LPS® Electro Contact Cleaner

LPS Electro Contact Cleaner is a fast, evaporating cleaner that penetrates, cleans and degreases, leaving no residue. LPS Electro Contact Cleaner is specially suited for cleaning electrical and electronic parts as well as other types of delicate mechanisms. LPS Electro Contact Cleaner contains no 1,1,1 Trichloroethane or methylene chloride making it safe to use on rubber, paint, plastic, metal, fabric and glass surfaces. Because of its superior wetting action, LPS Electro Contact Cleaner penetrates into minute spaces for thorough and effective cleaning. LPS Electro Contact Cleaner's special formulation reduces temperatures to subfreezing levels while it cleans, helping pinpoint thermally defective capacitors, resistors and coils. It can even locate cracks on PC boards. LPS Electro Contact Cleaner is also nonflammable and non-conductive so it can be used on equipment during operation eliminating costly downtime.

Advantages

- Cleans electrical/electronic components and delicate mechanisms
- Penetrates and removes light greases, oils, dirt and organic soils
- Safe on rubber, paint, plastic, metal, fabric and glass surfaces
- Leaves no residue, evaporates completely
- Non-conductive
- Superior wetting action
- Minimizes downtime

Applications

Cleans printed circuits, relays, switches, electric motor connectors, terminals, communications equipment, electronic ignitions, alternators, generators, magnetos, switches and relays, digital equipment, navigation equipment, computers, calculators, radios, radars, teletypes, stereos, and CB equipment.

Meets or exceeds these specifications:

MIL-C-81302D Type II
NASA MSFC 237
NASA MSFC-237a
FED.BB-C 00310
Authorized by the USDA for use in federally inspected meat and poultry plants.

Physical Properties

Flash Point: None
% Non-volatiles: 2 ppm maximum
Specific Gravity: 1.57
KB Value: 31
Boiling Point: 118° F
Dielectric Strength and Breakdown Voltage (ASTM D877): 32kv
Surface Tension: 19 dynes/cm
Propellant: HCFC 22

00047 7 oz. aerosol*
00416 16 oz. aerosol
04128 1 gal. bottle
00405 5 gal. pail
00455 55 gal. drum

LPS® PreSolve™ Cleaner/Degreaser

LPS PreSolve is designed to solve the toughest cleaning problems without harming the ozone layer. LPS PreSolve is a high performance cleaner/degreaser that effectively removes adhesives, oil, grease, wax, tar, dirt and other contaminants in seconds. It evaporates without leaving any residue. LPS PreSolve does not contain any upper ozone depleting CFC's or 1,1,1 Trichloroethane. It has a high dielectric strength and is excellent for cleaning electrical equipment. LPS PreSolve is safe to use on all metal parts and equipment.

Advantages

- Natural based solvent
- Industrial performance
- No rinsing, no residue
- Cleans and degreases on contact
- Non conductive
- Fast acting
- Safe on all metals
- Safe on most plastics
- Nonflammable propellant
- Controlled evaporation for deep cleaning penetration
- Environmental formula
- All organic
- Contains no CFC's or chlorinated solvents such as 1,1,1 Trichloroethane
- Ready-to-use, convenient aerosol

Applications

Cleans and degreases air compressors, alternators, bearings, chains and cable connections, cranes, diesel engines, electric motors, forklifts, gasoline engines, gears, generators, high voltage cables, power and air tools, printing presses, pulleys, terminals and switches. Removes, adhesives, coatings, cosmoline, grease, gummy residues, inks, oils, oil (oxidized), paint (uncured), rust preventatives, sealants, tar, varnishes and waxes.

Meets or exceeds these specifications:

Authorized by USDA for use in federally inspected meat and poultry plants.

Physical Properties

Specific gravity: 808
Flash point: 104°F T.C.C.
% Non-volatiles: < 100 ppm
Dielectric Strength and Breakdown Voltage (ASTM D877) 32kv min.
Propellant: Carbon Dioxide

01420 15 oz. aerosol

* Not available in Canada