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Wiltech Component Cleaning & Refurbishment Facility CFC Elimination Plan at NASA Kennedy Space Center

Steve Williamson, Bob Aman, Andrew Aurigema
Wiltech
Kennedy Space Center, FL 32899

Orlando Melendez
NASA/Materials Science Division, LO-G3-C
Kennedy Space Center, FL 32899

The Wiltech Component Cleaning & Refurbishment Facility (WT- CCRF) at NASA Kennedy Space Center performs precision cleaning on approximately 200,000 metallic and non metallic components every year. WT-CCRF has developed a CFC elimination plan consisting of aqueous cleaning and verification and an economical dual solvent strategy for alternative solvent solution.

Aqueous Verification Methodologies were implemented two years ago on a variety of Ground Support Equipment (GSE) components and sampling equipment. Today, 50% of the current workload is verified using aqueous methods and 90% of the total workload is degreased aqueously using, Zonyl and Brulin surfactants in ultrasonic baths. An additional estimated 20% solvent savings could be achieved if the proposed expanded use of aqueous methods are approved. Aqueous cleaning has shown to be effective, environmentally friendly and economical (i.e.. cost of materials, equipment, facilities and labor).

Cleaning Facilities

Cleaning Facilities are divided into Pre-Clean and Precision Cleaning. Various forms of aqueous processes have been used in the Pre-cleaning area since the beginning of the program. Traditional pre-cleaning processes started with a solvent degrease followed by exposure to a variety of aqueous based solutions that were dependent upon the material being cleaned and its configuration. At Wiltech we have replaced the traditional solvent degreasing step with a purely aqueous one so that the entire pre-cleaning process is solvent free. The pre-clean degreasing facilities consists of the following systems. System A is a 260 gallon, 27 kHz ultrasonic tank filled with a 3% by vol.) solution of Brulin 815 GD and De-Ionized (DI) water heated to 140-180 °F. The ultrasonic generators are rated at approximately 9600 watts. The tank has a separate agitation and filtration system and is used for gross degreasing. System C consists of two separate systems: a surfactant tank and a DI water rinse tank. The DI water rinse tank is a 120 gallon, 40 kHz ultrasonic tank filled with DI water.

A Hydro-Air Gun is used to remove large deposits of surface contamination in the initial stages of pre-cleaning. The Hydro-Air Gun is a hand held pressure washer type spray gun used for spraying all the parts with high velocity heated (~ 140° F) DI water. The Hydro-4000 Gross Parts Washer is a polycarbonate glove box with a hand held pressure washer type spray gun used for degreasing parts with a high velocity solution of 1.5%-3% Brulin 1990 GD and DI water.

Precision cleaning at Wiltech consists of the Cascade DI Water Rinsing system and the Recycle DI water system. The Cascade DI Water Rinsing consists of 3 adjacent 30 gallon 40/25 kHz ultrasonic tanks filled with DI water at ambient temperature or heated to140° F. The supply water is filtered with a 10 micron filter prior to entering the system. The Recycle DI water system consists of 3 adjacent 30 gallon 40/25 kHz ultrasonic tanks filled with DI water at ambient temperature or heated to 140°F. Each tank has its own adjustable flow recirculation and filtration system for high volume low pressure flow. The recirculation system contains 5 micron filters.

New Aqueous Processes

Aqueous processes have also been developed to replace the CFC-113 Dip-cleaning , CFC-113 Flush cleaning and CFC-113 Filter cleaning methods. Vigorous Manual Agitation using Zonyl and water for Particulate Sampling is being used to replace the CFC-113 dip method. Parts are manually agitated in a solution of Zonyl and water at 140° F for 3 seconds. Parts cleaned by this method include piece parts such as fitting components and small valve parts of simple and complex geometries. A comparison test using more than 900 individual items showed that the method compares favorably with the CFC-113 dip cleaning method.

A Low Pressure Impingement Sampling Method using De-mineralized (DM) water was developed to replaced the CFC-113 flush method. The method applies to exposed metal surfaces of hard metals such as stainless steel. An Aqueous Filter Cleaning and Verification method has been developed at WT-CRCA to replace the CFC-113 Flush cleaning method. Wire mesh-stainless steel filter elements were precision cleaned and validated using a combination of degreasers, high pressure sprays and ultrasonic cleaning baths. Repeated cleaning and validation showed no significant degradation to the structural integrity of the filter elements. The new method employs nylon and Aclar bags in place of canisters. In the process, new aqueous filter cleaning and validation methods exceed performance expectations and have been implemented on GSE filters with only minor difficulties. A 25% - 35% solvent savings can be achieved if this method is approved by the program.

Dual Solvent Approach

Wiltech is proposing a dual solvent strategy using Vertrel MCA and HFE-7100 to eliminate CFC-113 usage. Only AK-225, Vertrel MCA and HFE-7100 are being added to SE-S-0073 as CFC-113 alternatives on a compatibility level, figure 1. Figure 2 is a comparison of the effectiveness of material removal for AK-225, Vertrel MCA and HFE-7100. AK-225 is not being considered for use in our CFC elimination plan at this time because of time and cost constraints imposed by facility modifications, strong toxicity concerns and currently mandated phase out of AK-225.

PROPERTY	*CFC-113*	*AK-225 **	*VERTREL MCA*	*HFE-7100*
Boiling Point - °C	48	54	39	60
Surface Tension - Dynes/cm	17.3	16.2	15.2	13.6
Vapor Pressure mmHg@20°C	331	290	375	210
Liquid Density	1.56	1.55	1.41	1.52
Solubility of H2O (ppm by wt)	110	420	490	95
Solubility in H2O (ppm by wt)	170	210	140	10
8 HR Exposure Limit (ppm)	1000	50	200	600
Category	CFC	HCFC	HFC	HFE
Ozone Depleting Potential (Max=1.0)	0.8	0.03	0.0	0.0
Global Warming Potential	High	Lo	Lo	Lo
Flammable	No	No	No	No
Auto-Ignition Temperature Issue	No	No	Yes	No

** Scheduled for phase out in 2015; may be accelerated. Exposure limits may be lowered due to recent exposure incidents involving HCFC's..*

	Contaminant, Percent Removed					
FLUID	**DC-33**	**Braycote 601**	**Mil-H-83282**	**Mil-H-5606**	**Houghto-Draw**	**Titanlube**
None	3	0	0	78	0	1
CFC-113	80	91	100	100	100	100
AK-225	85	87	100	100	100	16
Vertrel MCA	60	12	100	92	100	51
HFE-7100	16	85	34	86	1	4
Dual Solvent Strategy ***(Vertrel MCA & HFE-7100)***	60	85	100	92	100	51

- Table reflects data extracted from BNA Laboratory Test Report, LTR 6887-4097, with the exception of the Dual Solvent Strategy data which is a combination of the solvency data of both the Vertrel MCA and the HFE-7100.

The Dual Solvent Strategy consists of using Vertrel MCA outside of the clean room where facility costs and exposure concerns can be minimized. Non Volatile Residue (NVR) verification can be performed with Vertrel MCA outside the clean room relieving medium to heavy hydrocarbon contamination concerns. HFE-7100 will be used for the verification fluid in the clean room for both particulate and NVR (Light Hydrocarbon Contamination). Aqueous

cleaning and verification techniques will continue to be employed whenever possible. Items being certified to an "A" Level NVR will be tested as follows: items solvent degreased and solvent verified will be NVR tested twice, once with Vertrel MCA in preclean and again with HFE-7100 in the clean room. Items aqueously degreased and solvent verified will be NVR tested once with HFE-7100 in the clean room. Suitable items may be completely processed aqueously and tested for NVR using the Total Organic Carbon (TOC) method.

The proof of concept will consist of defining Manpower and Equipment Requirements, selecting and testing the hardware, building a Test Plan and performing the Tests. The hardware will consist of complex parts with internal passages including dead-end bourdon tube gages Teflon lined flexhoses
convoluted flexhoses, Valve Assemblies, Quick Disconnects complex parts with no internal passages such as Omni Seals and Swivel fittings and simple parts with all surfaces exposed simple fittings softgoods.
The Test Plan consists of the following: Test solvent flush, flow and dip methods against appropriate test hardware start with a certified clean test specimen, contaminate the test specimen, clean the test specimen with the dual solvent process to level 100A, perform a rinse analysis with CFC-113 and compare the results to level 100A
test Both the Solvent-Solvent and the Aqueous-Solvent Plan