evapco®

Cleaning Solutions and Sanitizers Keep Pace with Evaporator Coil Materials

A Comprehensive Laboratory Test to Analyze the Compatability of Leading Cleaners and Sanitizers on Today's Industrial Refrigeration Evaporator Coils.

Stainless Steel Tube-Aluminum Fin

Aluminum Tube-Aluminum Fin

Copper Tube-Aluminum Fin

Hot Dipped-Galvanized Steel

Superior Products from Superior Technology

U.S. Green Building Council Member

Member of iiar International Institute of Ammonia Refrigeration www.iiar.org

IARW International Association of Refrigerated Warehouses

Research & Development

The EVAPCO Research & Development Center features the industry's largest low temperature, insulated environmental test chamber. The conditions in the test chamber are controlled by a fully functional ammonia refrigeration system designed to operate at suction temperatures as low as -60° F.

EVAPCO is committed to providing the most innovative products to meet today's stringent application needs and has dedicated the necessary resources to provide that technology to the Industrial Refrigeration Industry.

EVAPCO evaporators have long been known for their innovative heat exchanger coil design. In addition, R&D resources have been used to address key issues in evaporator product design to improve the durability of materials, address maintenance features and improve the hygienic design of the coils. These research programs often include corrosion and stress analysis of construction materials in order to simulate actual field operating conditions and improve the service life of EVAPCO products.

EVAPCO technician inspects material samples

Addressing Industry Needs

The Food Processing Industry has experienced increasing pressure from both the federal government and the public to provide a cleaner and safer environment in its production facilities. These increasing demands to provide a contaminant free hygienic environment in food preparation and packaging areas continues to have an impact on refrigeration equipment, system design and maintenance practices. End-Users are continually asked to review their maintenance procedures and to consider which cleaning and sanitizing solutions are compatible with the various types of equipment materials that are installed in their facilities.

Many End-Users and their sub-contractors have relied on outdated information and poorly documented records to determine which cleaning solutions are compatible with evaporator materials of construction. This has often led to incorrect assumptions when selecting evaporator materials for specific applications, as well as, reduced equipment service life due to improper selection and application of cleaning solutions and sanitizer chemicals.

EVAPCO has addressed this important issue with a comprehensive laboratory test which was designed to review the effects of the leading cleaners and sanitizers on common materials used in the manufacture of evaporator coils applied in today's industrial refrigeration systems. The test results are intended to provide End-Users with numerous options in coil cleaning and sanitizer compounds and demonstrate their compatibility with all types of coil materials including:

- **Stainless Steel Tube - Aluminum Fin Coils**
- **Aluminum Tube - Aluminum Fin Coils**
- **Copper Tube - Aluminum Fin Coils**
- **Hot Dipped Galvanized Steel Coils**

World Headquarters & Research/Development Center, Taneytown, MD

Testing Program-Cleaning Solutions and Sanitizers

Scope of Research Project:

- Identify some of the more common cleaning solutions and sanitizers which are used by the leading food processing companies to maintain evaporator coils in their industrial refrigeration systems.
- Determine the primary components in these compounds and the dilution ratios recommended by their manufacturers.
- Evaluate the corrosion rate on various materials of construction for evaporator coils and determine the suitability of each cleaning solution and sanitizer for use with EVAPCO's evaporator product lines.

The cleaning solutions and sanitizers which were evaluated as part of these tests are summarized in the following Tables I & II. The tables include the product trade names, manufacturers, primary components, dilution ratio as recommended by the manufacturer, the pH value and conductivity of each solution.

Table I:
Cleaning Solutions Evaluated

Trade Name	Mfg.	Components*1	Dilution Ratio*2	pH*(3)	Cond.*3 (µS)
CL-122	Nalco	Diethanolamine (1-5%) Triethanolamine (5-10%) Dipropylene Glycol Monomethyl Ether (5-10%) Sodium Hydroxide (0.1-1%)	1:20	11.4	1330
CL-127	Nalco	Dipropylene Glycol Monomethyl Ether (5-10%)	1:20	9.4	2200
LMC-44	LW Chemical	Dipropylene Glycol Methylether (<5%)	1:64	10.3	983
SoilSolv	DuChem	Ethylene Glycol Monobutyl Ether (<5%)	1:20	10.1	840
E+	Refrigeration Technologies	Enzyme Based	Straight	8.9	12600
FS Process Cleaner	Zep	Potassium Hydroxide Sodium Metasilicate	1:32	12.1	6940

Table II
Sanitizers Evaluated

Trade Name	Mfg.	Components*1	Dilution Ratio*2	pH*(3)	Cond.*3 (µS)
CoilClear	Nalco	2-Bromo-2-Nitropropane-1, 3-Diol (Powder & Liquid Mix)	1:45	8.0	370
DQS	DuChem	N,N Dialkyl-N,N-Dimethylammonium Chloride (4.5%) N-Alkyl-N,N-Dimethly-N-Benxylammonium Chloride (3%)	1:512	8.0	430
Amine A	Zep	Alkyl Dimethylbenzyl Ammonium Chlorides (10% combined) Alkyl Dimethyl Ethylbenzyl Ammonium Chlorides Ethanol	1:512	7.9	430
Amine Z	Zep	Octyl Decyl Dimethyl Ammonium Chloride (5-15% Comb.) Dodecyl Dimethyl Ammonium Chloride Dioctyl Dimethyl Ammonium Chloride Alkyl Dimethyl Benzyl Ammonium Chloride	1:512	7.9	430
UltraKleen (4)	Sterilex	Hydrogen Peroxide (Concentration not specified) Calcium Sequestrant (Concentration not specified)	1:1:12.8	10.9	14700

Notes: 1) Components listed on material safety data sheets.
2) Dilution ratio shown as Cleaner/Sanitizer mixed with parts of water.
3) pH and Conductivity shown as tested.
4) UltraKleen requires two part solution mixed with designated parts of water.

Immersion Test:

The primary test designed for this study utilized each of the cleaning solutions listed in Table I and each of the sanitizers listed in table II. The selected cleaning solutions and sanitizers were evaluated for each material of construction through a series of immersion tests conducted with corrosion coupons. Exhibit "A" shows the typical immersion test apparatus used in the study.

Exhibit "A" Immersion Test Apparatus

Immersion Test Procedure:

1. Pre-weighed corrosion coupons (1/2" wide x 3" long) were purchased from Metal Samples (Alabama Specialty Products Inc). The corrosion coupons where selected representing the materials of construction used in Evapco evaporators as follows:
   - Aluminum AL 1100
   - Hot Dipped Galvanized Steel
   - Copper CDA 122
   - Stainless Steel 304L
2. Each coupon was exposed to the test environment for the duration of the testing program.
3. Each material of construction was tested independent from the others.
4. Duplicate corrosion coupons were exposed and analyzed for each data point collected in the study.
5. Solutions were aerated for the entire duration of the test.
6. The coupons were then removed from the solution and dried in a vacuum desiccator.
7. All test coupons were returned to Metal Samples for analysis where corrosion products are removed and the corrosion rate is determined by weight loss.

Immersion Test Exposure Schedule:

In order to analyze the corrosion effects of the samples at various stages throughout the test, a procedure was developed to collect five data points for each material and solution test series. These five data points allow for the characterization of changes in solution corrosiveness and metal corrodibility as the system ages.

As corrosion products are formed, the corrosion properties of the solution and the metal are subject to change. The data collected in the test allowed for the comparison of corrosion rates of both "fresh" metal and "aged" metal. For example, it was noted that fresh metal immersed in a fresh solution experienced a corrosion rate higher than a fresh metal sample immersed in an aged solution. With another test sample, aged metal immersed in a fresh solution demonstrated a lower corrosion rate as compared to the fresh metal immersed in the fresh solution. Since the evaporator cleaning process is repetitive in nature, the aged metal immersed in the fresh solution sample is considered to best represent an actual field condition corrosion rate.

Evaluation Process

Material Compatibility:

For the purpose of this study, compatibility was determined by material loss predicted for 10 years of service administering 365 coil cleanings per year. The chemical exposure is estimated not to exceed 30 minutes for each cleaning at temperatures less than 70°F. Compatibility criteria for each material presented is as follows:

Aluminum AL1100,
Copper CD122,
Stainless Steel 304L . . . . . Less Than 3.5 mils loss in ten years.

Hot Dipped Galvanized Steel . . . . Less Than 1.5 mils in ten years.

The corrosion rate of each material sample was determined by independent laboratory analysis of the actual material loss on each sample following the cycle exposure tests. The analysis first considered material loss by weight and then calculated the **Ten Year Corrosion Rate** based on one cleaning cycle per day.

The compatibility criteria established for this study assumes the corrosion loss of no more than one-half of the Aluminum fin thickness and one-half of the zinc coating thickness on hot dipped galvanized fin stock over a ten year period of cleaning cycles. Based on the compatibility criteria, the following Table III and Table IV present the recommendations for the cleaning solutions and sanitizers as applied to the materials of construction used in this study.

Table III:
Cleaning Solution / Material of Construction Compatibility

STAINLESS STEEL / ALUMINUM COILS*	
Trade Name	**Manufacturer**
CL-122	NALCO
CL-127	NALCO
LMC-44	LW Chemical
SoilSolv	DuChem
FS Process Cleaner	Zep
Formula 940	Zep

ALUMINUM / ALUMINUM COILS	
Trade Name	**Manufacturer**
CL-122	NALCO
CL-127	NALCO
LMC-44	LW Chemical
SoilSolv	DuChem
FS Process Cleaner	Zep
Formula 940	Zep

HOT DIPPED GALVANIZED COILS	
Trade Name	**Manufacturer**
CL-127	NALCO
E+	Refrigeration Technologies
FS Process Cleaner	Zep
Formula 940	Zep

COPPER ALUMINUM COILS	
Trade Name	**Manufacturer**
CL-122	NALCO
CL-127	NALCO
LMC-44	LW Chemical
SoilSolv	DuChem
FS Process Cleaner	Zep
Formula 940	Zep

Table IV:
Sanitizer / Material of Construction Compatibility

STAINLESS STEEL / ALUMINUM COILS*	
Trade Name	**Manufacturer**
CoilClear	NALCO
DQS	DuChem
Amine A	Zep
Amine Z	Zep

ALUMINUM / ALUMINUM COILS	
Trade Name	**Manufacturer**
CoilClear	NALCO
DQS	DuChem
Amine A	Zep
Amine Z	Zep

HOT DIPPED GALVANIZED COILS	
Trade Name	**Manufacturer**
DQS	DuChem
Amine A	Zep
Amine Z	Zep

COPPER ALUMINUM COILS	
Trade Name	**Manufacturer**
CoilClear	NALCO
DQS	DuChem
Amine A	Zep
Amine Z	Zep

Note: The results of the laboratory test contained in this report pertain to material compatibility when exposed to readily available cleaning and sanitizer solutions. EVAPCO does not intend to promote a specific manufacturer's products or the ultimate effectiveness of their cleaning and sanitizing chemicals.

* Applies to Stainless Steel Tube Coils with Aluminum or Stainless Steel Fins.

Trim off 5/8"

Application Considerations
Cleaning Solutions and Sanitizers

Field Recommendations:

The laboratory tests presented in this study utilize many of the cleaning and sanitizer chemicals currently used by food processors to meet government regulations for hygienic standards in refrigeration equipment and to maintain a clean environment in their plants. The test results confirm that these commonly used cleaning and sanitizer solutions are compatible with Stainless Steel, Aluminum and Copper Tube Coils with Aluminum Fins as well as the traditional Hot Dipped Galvanized Coils selected for Industrial Refrigeration applications.

The cleaning and sanitation chemical compatibility recommendations for evaporator materials of construction which were developed from this study are considered to be guidelines for the safe application of these products. The study did confirm that many factors may influence the corrosion rate of these chemical solutions. Some of these include:

- Temperature During Application
- Cleaner & Sanitizer Concentration
- Water Chemistry and Hardness
- Quantity of Chemical Applied
- Rate of Application

Operations and maintenance personnel should consider these variables for each location and consult with their chemical provider to confirm material compatibility and application procedures prior to implementing their cleaning and sanitation system.

Selecting the best coil material for your application:

Many End-Users and Contractors have often assumed that galvanized steel coils were the only option available when selecting evaporators for food processing areas which demand frequent chemical cleaning. These assumptions are based on "field experience from the good ole' days" when industrial evaporators were almost always constructed of galvanized steel and the availability of cleaning solutions and sanitizers was limited. Today, there are more coil material options and new cleaning solutions and sanitizer systems available. However, there has been little, if any, research done by equipment manufacturers to confirm the corrosion effects of the new cleaning and sanitizing solutions on evaporator coil materials of construction used today.

The study presented in this bulletin provides a comprehensive laboratory test performed by EVAPCO which was designed to analyze the effects of the leading cleaners and sanitizers on common materials used in the manufacture of evaporator coils applied in today's industrial refrigeration systems.

SSTMC - Cooler & Freezer Units

STW - Work Room Units

Laboratory tests confirm that many of the cleaning solutions and sanitizer compounds which are commonly used in the industrial refrigeration industry are compatible with Stainless Steel - Aluminum Fin coils as well as other traditional coil materials. The assumption that only Hot-Dip Galvanize coils are compatible with cleaning and sanitizer solutions has been proven to be OLD and FALSE!

When a contaminant free Hygienic environment is required in food preparation and packaging areas, Stainless Steel/Aluminum Coil construction is compatible with today's highly effective cleaning/sanitizing systems.

Trim off 5/8"

EVAPCO - YOUR ONE SOURCE FOR QUALITY REFRIGERATION SYSTEM COMPONENTS

Evaporative Condensers


ATC-E


eco-ATC


WDC


*c*ATC

Induced Draft Models

Evaporative Condensers


PMC-E


LSC-E/LRC

Forced Draft Models

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Evaporators — Stainless Steel • Aluminum • Galvanized Steel • Copper


SSTMC Unit Coolers


STL Product Coolers


STW Workroom Units


STD Low Profile Coolers

Custom Freezing Capabilities


Draw Through Coils with Inlet Air Filters


Spiral Blast Freezer Evaporator


Stacked Blast Freezer Evaporator

Liquid Recirculator Packages & ASME Pressure Vessels


MVI Intercooler Package


MPS Chiller Package


MPC Plate Chiller Package


MRP Recirculator Systems

World Headquarters & Research / Development Center

EVAPCO, Inc. ▪ 5151 Allendale Lane ▪ Taneytown, MD 21787 USA
PHONE: 410-756-2600 ▪ FAX: 410-756-6450 ▪ E-MAIL: marketing@evapco.com

Visit EVAPCO's Website at: **http://www.evapco.com**

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