Advanced Waste Characterization Workshop

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Product Substitution Stories & Tips

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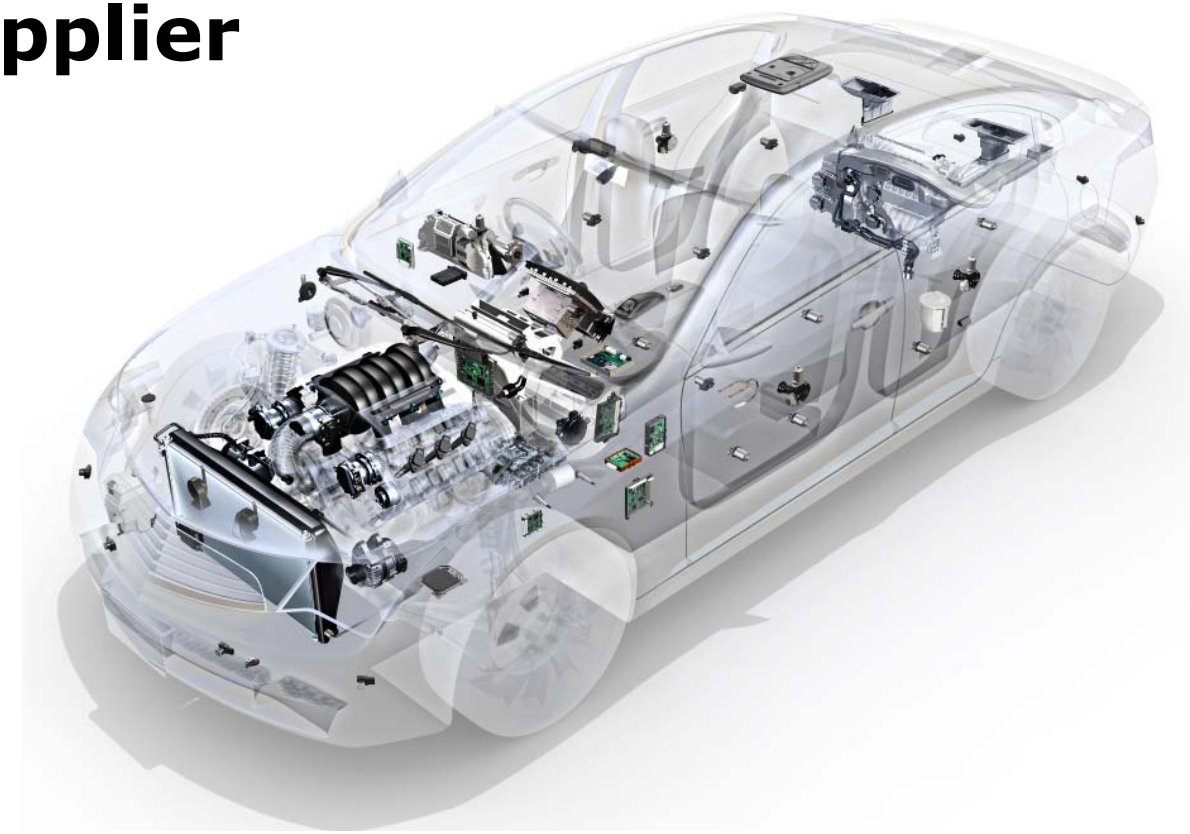
Agenda

- **DENSO Overview**
- **Common Process**
  - **8 Step Problem Solving Method**
- **Case Studies**

DENSO Overview

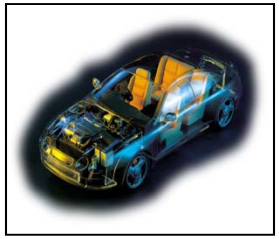
DENSO is an automotive OEM component supplier

- A/C Compressors
- Radiators
- GPS Navigation
- Spark Plugs
- Fuel Pumps
- Starters
- Alternators
- Filters
- Electric Motors
- And many more. . .



DENSO Overview

DENSO



- **#2 Automotive Parts Supplier in the World**
- **2013 Sales $39.8 Billion (US $)**
- **140,000 employees - Globally**
- **17,000 employees - North America**
- **28 Manufacturing locations in NA**

Our Facility - DMMI

- **About 100 acres in Battle Creek, MI**
- **Campus: 5 buildings (including WWTP)**
  Roughly 1.4 million ft²
- **Sales: $1.38 B (FY 2013)**
- **Associates: 2,400 employees + ≈ 500 temps**

Our Products

- DMMI is the manufacturer of high quality automotive heat exchangers
- Radiators, heaters, air conditioning components, and their final assemblies
- Our customers include Toyota, Chrysler, Honda, GM, Ford, and others
- In FY 2013, produced 18.3 M cores produced (radiator, heater, condenser, and evaporator)

Fun Facts (2013)

- Our average electric bill: 8,9000,000 kW-hr/ month
- **Recycling rate: 89%** *12.1 M pounds in 2013*
- **Landfill waste: ⇩ 99.8%** (from 1999)
- **Trash volume: ⇩ 78%** (from 2001)
- **CO2 emissions: ⇩ 50% *n*** (from 2001) (Nat. gas + electricity)
- **VOC emissions: ⇩ 36% *n*** (2000)
- **Water use: ⇩ 42% *n*** (2000)

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8 Step Problem Solving Method

PDCA Stage	Plan				Do	Check	Act	
Problem Solving Stage	1 Organize Team	2 Select Theme	3 Define Situation	4 Analyze Situation	5 Take Action	6 Check Results	7 Prevent Recurrence	8 Prepare Summary
Typical Activities	•Select Leader & members •Determine roles, skills •Set norms	•Identify the problem •Determine its priority	•Observe the problem •Define its nature •Collect data on it	•Find potential causes •Investigate potential causes •Use facts & data •Find root causes •Brainstorm solutions •Base goals on facts •Develop project schedule •Get plan approval	•Implement improvements •Modify jigs & fixtures •Modify existing equipment •Test countermeasures	•Check your results •Use same quality tools •Compare before & after •Goal assessment •Check side effects	•Standardize improvements •Revise old manuals •Make new manuals •Take across line actions •Increase associate awareness •Develop standard checks	•Summarize remaining problems •Make future improvement plans •Reflect on your successes •Reflect on your short comings •Review lessons learned •Prepare final presentation
Purpose	Establish the roles of members, meeting plan & assure the skills needed for the project are available	To focus the team's energy on one type of problem, match team abilities & interests to an area requiring improvement, find company/dept. goals that match their own	To quantify the problem & show its magnitude, establish its priority, create a baseline condition for before & after results	To look beyond the symptoms & find the causes of the problem. To involve the team in creative thinking activities, encourage the team to set their own goals, promote time-mgmt. skills	To implement solutions Short-term – attack the symptoms to contain the problem Long term – attack the causes to permanently fix the problem. Actions must be based on careful analysis of the facts & data.	To determine the results of your actions and evaluate their effectiveness (goal assessment). To check for good & bad side effects To determine next steps in the improvement process	To remove the root cause of the problem permanently. To standardize your countermeasures & communicate the new standard to everyone	To summarize remaining problems, reflect on successes & road blocks, plan future improvements in your problem solving process

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Organize Team

The most important step, involve:

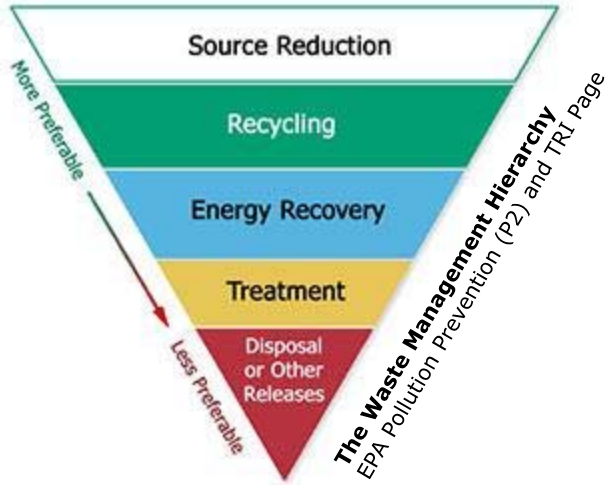
- **Users/Operators/Employees**
- **Machine Techs/Maintenance**
- **Engineers**
- **Vendors**
- **Trail areas**

Define the Situation

1. **Processes: Every step is important**
   - **Reactions, conditions, etc.**
2. **Chemicals:**
   - **SDS/MSDS**
   - **Production or Sub-material**
3. **Equipment:**
   - **Materials of construction, function, etc.**

Think about the life cycle

1. Materials Extraction
2. Manufacturing
3. Distribution
4. **Usage**
   - **Prevention/Alternatives**
5. **End of Life Management – Triangle above**



Case Studies

- **Flux Wastes – Two Parts**
  - **Virgin Vs. Brazed (Where Gen. Know. fails)**
  - **Carrier Change**
- **Powder Paint vs. Solvent**
- **Antifreeze Substitution**
- **Part Washers – Two Parts**
  - **Virgin vs. Reused**
  - **Solvent vs. Bioremediation**
- **Aerosol Cans (Maybe, if we have time)**

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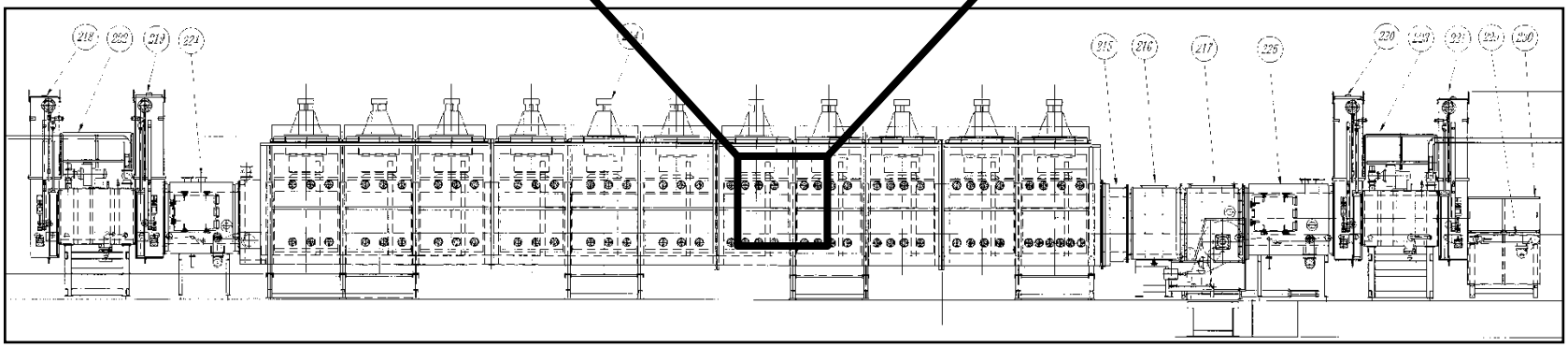
Flux Waste: Virgin vs. Brazed

Example of where Gen. Know. fails:

- **DENSO uses several types of flux**
  - **Dry**
  - **Paste**
  - **Spray (VOC and Water Based)**
- **Flux is a chemical cleaning, flowing and purifying agent. It improves the brazing process.**

Flux Waste: Virgin vs. Brazed



Flux Waste: Virgin vs. Brazed

R 299.9302 (b) For the purposes of complying with the provisions of 40 C.F.R. part 268 *(LDR)*, or if the waste is not listed as a hazardous waste, the generator shall determine if the waste meets 1 of the characteristics of hazardous waste pursuant to the provisions of R 299.9212 by doing either of the following:

- **(i) Testing the waste according to the methods set forth in the provisions of R 299.9212 or according to an equivalent method approved by the director pursuant to the provisions of R 299.9215.**
- **(ii) Applying knowledge of the hazardous characteristics of the waste in light of the materials or processes used.**

Flux Waste: Virgin vs. Brazed

Applying Knowledge (Generator)

Process/Equipment

Brazing = Not listed (F, K)

&

Chemicals (SDSs)/ Materials

Flux on an Aluminum Core = Not Char. D

Test

What Happened? "Change"

Test	Result	Units of Measure	Method
Cadmium, total	*33.1*	*mg/kg*	*EPA 200.7*
Calcium, total	*<300*	*mg/kg*	*EPA 200.7*
Chromium, total	*6220*	*mg/kg*	*EPA 200.7*

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Flux Waste: Virgin vs. Brazed

Brazed Flux = Hazardous

- **TCLP for Cadmium & Chromium**
  - **Total by ICP / 20 (worst case)**

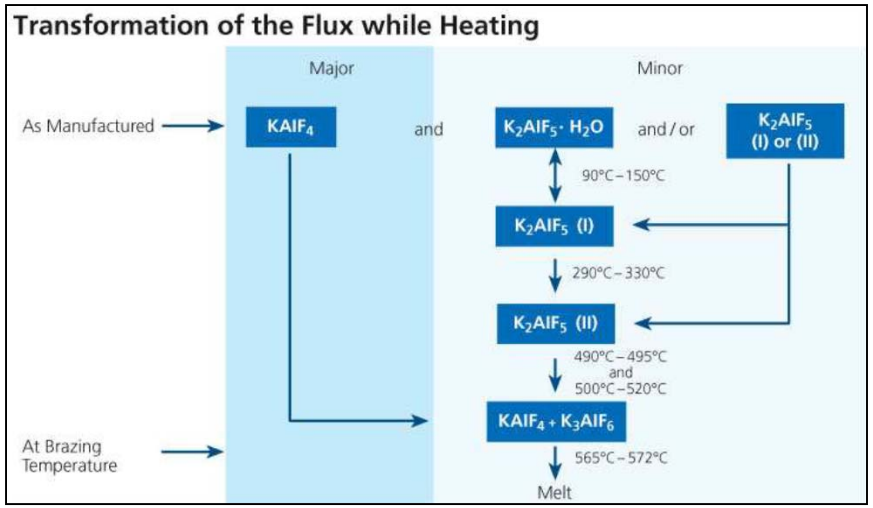
Virgin Material = Non-hazardous using generator knowledge & TCLP

- **No Cadmium or Chromium**

Flux Waste: Virgin vs. Brazed

Follow the process: What happens to flux in the electric arc furnaces?

- **Conditions:**
  - **Nitrogen purged**
  - **1100°F**
  - **Low dew point**
- **Flux transforms,**
- **Melts, and**
- **Brazes parts**



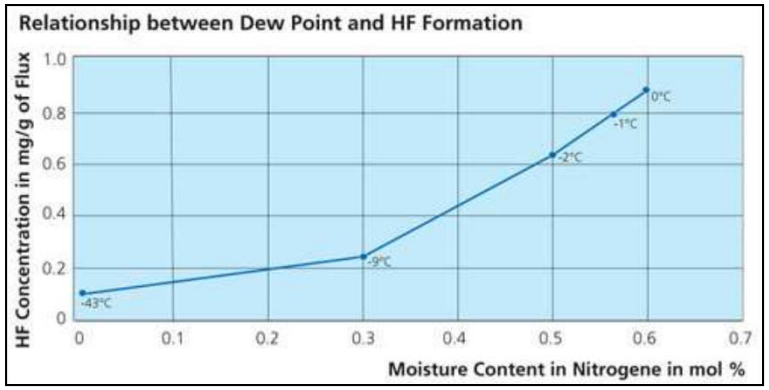
http://www.aluminium-brazing.com/

Flux Waste: Virgin vs. Brazed

What else happens? Side Reactions

- **Flux mixes with water and makes HF**

$$3KAlF_4 + 3H_2O \rightarrow Al_2O_3 + K_3AlF_6 + 6HF$$

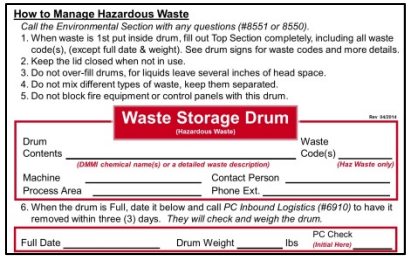


http://www.aluminium-brazing.com/

- **The HF reacts with the furnace and pulls out heavy metals.**

Flux Waste: Virgin vs. Brazed

- **Can't change the chemistry, but… we can manage the process for less accumulation**
- **Guidance for employees:**
  - **Control the fluxing process**
  - **Don't mix waste**
    - **Disposal is 5x cost of Virgin**
  - **When naming, ask yourself ?s**



How to Manage Hazardous Waste

Call the Environmental Section with any questions (#8551 or 8550).

1. When waste is 1st put inside drum, fill out Top Section completely, including all waste code(s), (except full date & weight). See drum signs for waste codes and more details.
2. Keep the lid closed when not in use.
3. Do not over-fill drums, for liquids leave several inches of head space.
4. Do not mix different types of waste, keep them separated.
5. Do not block fire equipment or control panels with this drum.

Rev. 04/2014

Waste Storage Drum
(Hazardous Waste)

Drum Contents _____ Waste Code(s) _____
(DMM chemical name(s) or a detailed waste description) *(Haz Waste only)*

Machine _____ Contact Person _____
Process Area _____ Phone Ext. _____

6. When the drum is Full, date it below and call *PC Inbound Logistics (#6910)* to have it removed within three (3) days. *They will check and weigh the drum.*

Full Date _____ Drum Weight _____ lbs PC Check *(Initial Here)* _____

Flux Waste Carrier Change

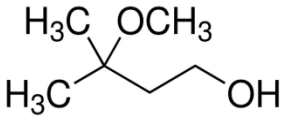
Background:

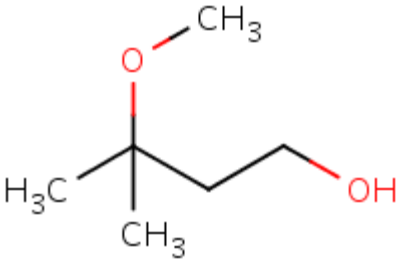
- **DENSO has had a goal to reduce VOCs since 2000.**
- **Title V Air Permit**
- **About 25% of the plants VOCs were from fluxes**
- **Most of that was from one area**

Flux Waste Carrier Change

Background:

- **Used a flux with**
  - **46% VOC = 3-Methoxy-3-methylbutan-1-ol (3-MMB)**
  - **Flash Point: 160°F**
  - **Waste: Easy to handle**





Flux Waste Carrier Change

- **After some testing, we found a low VOC flux (0.7%) that worked**
  - **Brazed well**
  - **No residue or black marks**
  - **No quality issues**
- **Designed a machine**
  - **Centrifuge to pull out solids**
  - **Reuse water (flush and clean)**

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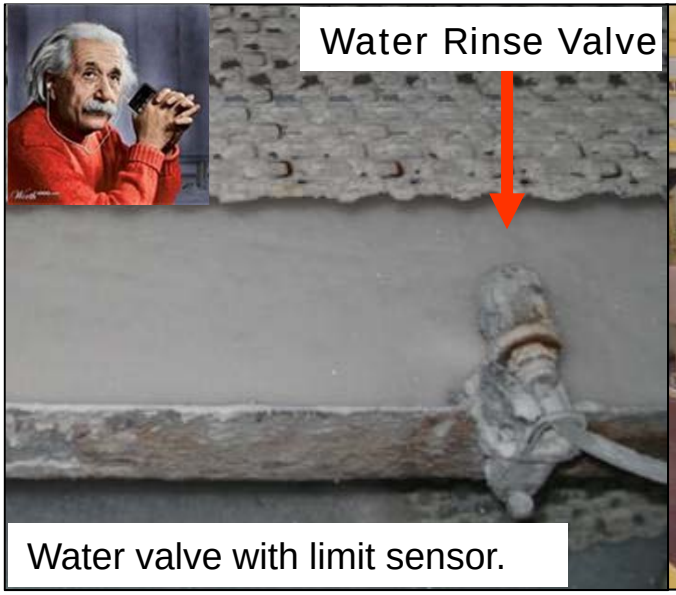
Flux Waste Carrier Change

- **Issue: After a year and a half of messing with the process, the system failed**
- **Pulled out**
- **Redesigned**
  - **Catch Tray**
  - **Flushing**
  - **Settling tanks**

Flux Waste Carrier Change

Worked with engineering, a kaizen team, and the operator.



Flux Waste Carrier Change

Reduction of flux waste

- **200,000 lbs/year**

Water Recycled

- **21,000 gallons/year**

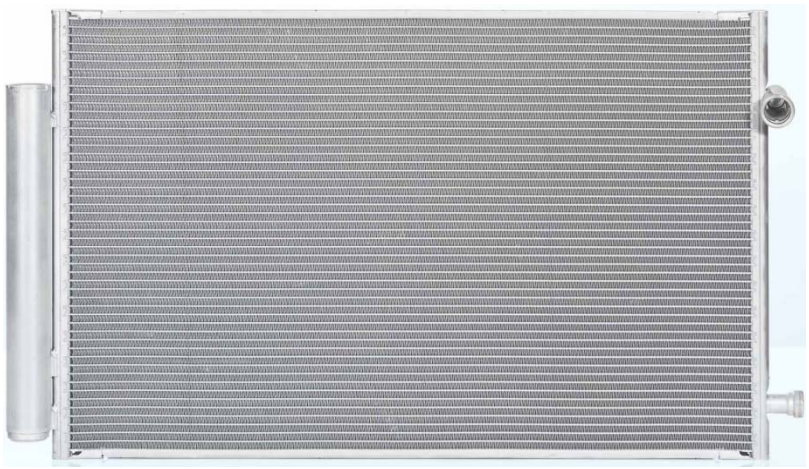
Total Net Savings

- **$35,979**

Solvent vs. Powder Paint

Background:

- **Customers requirement: Paint product black (visual reasons)**



Solvent vs. Powder Paint

Challenge: Solvent Paint Impacts

- Air Emissions – VOCs, HAPs
- Overspray waterfall maintenance
- Incinerator cost & maintenance
- Paint sludge & other wastes
  - F003, D001, etc.
- Potential fire hazard

Solvent vs. Powder Paint

Change Over: Powder Paint

- **A "classical" opportunity**
  - **Metal (conductive) substrate**
  - **One color of Paint (Black)**

- **Changed in 1997**
  - **Annual savings $280,000**
  - **Waste reduction 154,000 lbs**

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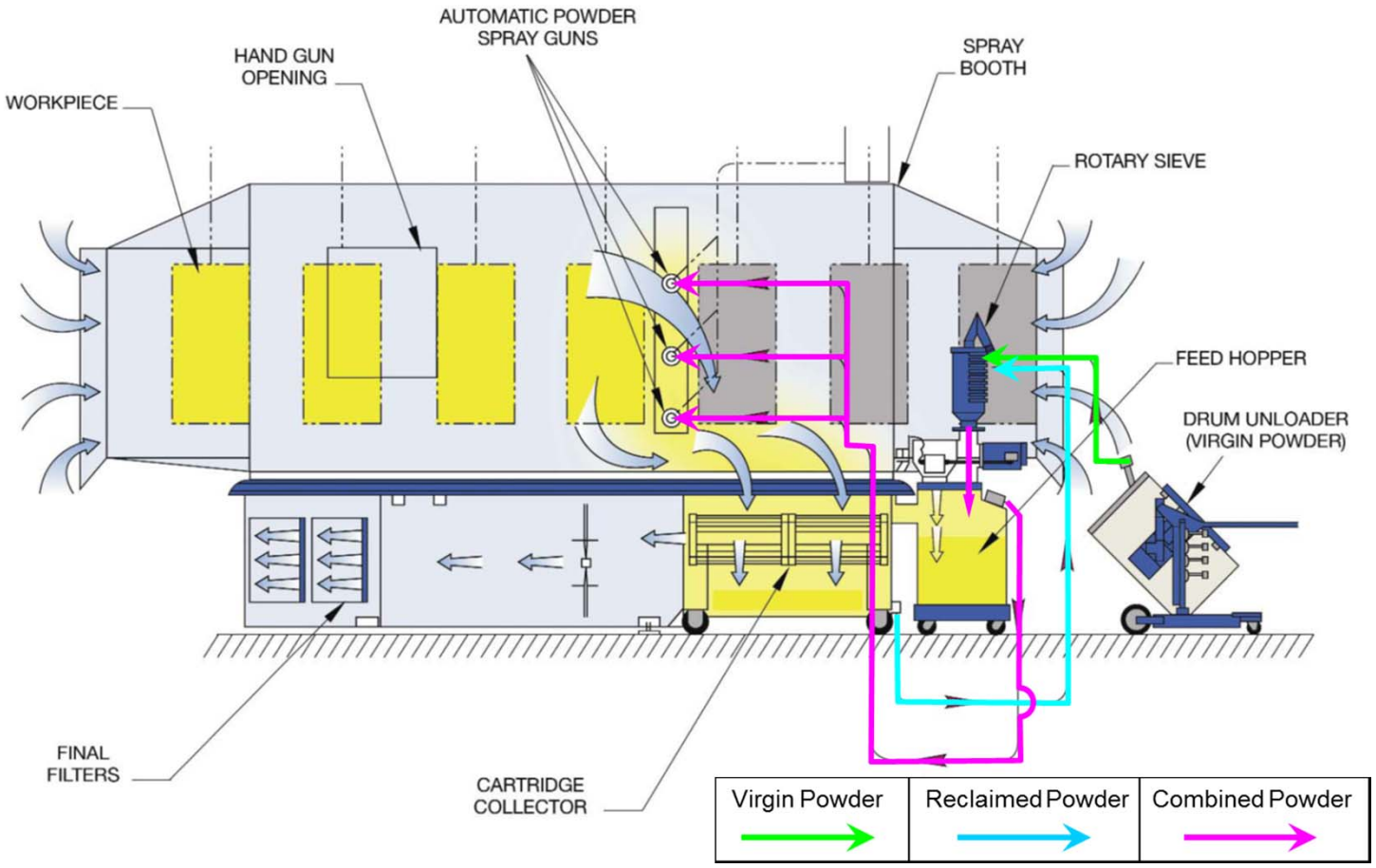
Solvent vs. Powder Paint



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Solvent vs. Powder Paint

Powder Paints Dirty Little Secret

- **Frequent color changes cause tons of waste**
- **Solutions:**
  - **Re-use on non-visual parts**
  - **Melt down for plastic parts**
  - **Additive to Cement**
  - **Adhesive replacement**

Sustainable Manufacturer Network
sustainablemfr.com

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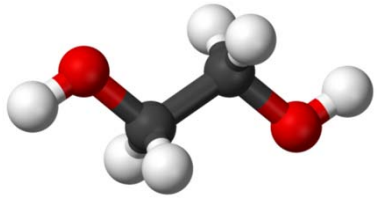
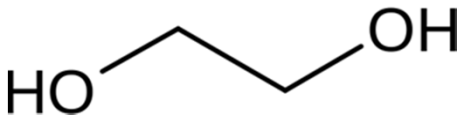
Antifreeze Substitution

Background:

- **DENSO has had a goal to reduce toxic chemicals since 2000.**
- **In 2008, we started looking at Ethylene Glycol**
- **Major users: Quality Lab and Molding**





Antifreeze Substitution

Ethylene Glycol

- **Hazardous chemical subject to reporting under 40 CFR 372 (SARA Title III, Sec. 313 aka Form R Rules).**

Antifreeze Substitution

Failure one: DI Water with additive

- **Gummed up the molds**
- **Overheated, Etc.**

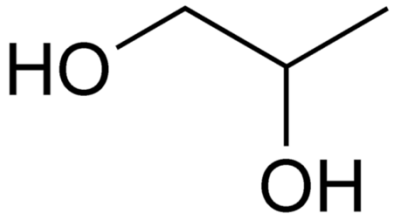
Back to the drawing board:

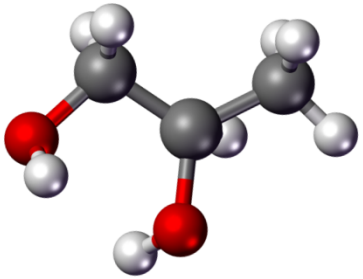
- **Met with several vendors**
- **Suggested propylene glycol product**

Antifreeze Substitution

Propylene Glycol

- **Considerably less toxic**
- **Recycled the same way**
  - **Glycol Recovery**
- **Not a hazardous chemical subject to Form R reporting**





Antifreeze Substitution

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Antifreeze Substitution: Ethylene Vs. Propylene Glycol

Results: Worked better

- **Started with a 50% conc.**
- **Now use a 30% conc.**
- **2013: used 70 drums**
  - **Cost savings of almost $100/drum over EG**
- **Did not report EG on our next Form R**

Parts Washers: Part One Recycled Vs. Virgin

Background:

- **Rented standard parts washers with a low flash solvent (D001)**
- **Switched solvents**
  - **Recycled**
  - **Money saving effort**
  - **More sustainable**

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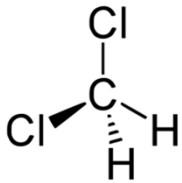
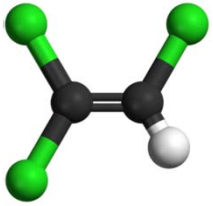
Parts Washers: Part One Recycled Vs. Virgin

Issue:

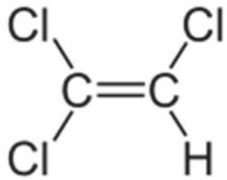
- **Key issue: Waste contained chlorinated solvents.**





Where did they come from?

- **Chemicals: We did not use chlorinated solvents**



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Parts Washers: Part One
Virgin vs. Recycled

When all else failed, lots of testing

- **Every parts washers waste**
- **Virgin parts washer solvent**
  - **Contaminated before we used it**

Contamination was a benefit

- **Switched to a higher flash <u>virgin material</u> = no hazardous waste**

Parts Washers: Part Two
Solvent vs. Bioremediation

Employees liked it, but…

- **It smelled (petroleum based)**
- **Serviced every 4 to 12 weeks ($)**
- **Lots of non-hazardous waste**

Can we do Better?

- **Enter a rebuild employee**

Parts Washers: Part Two
Solvent vs. Bioremediation

New style parts washer:

- **Natural microorganisms biodegrade greases and oils into CO_2 and H_2O**

- **Cleaner continuously renews itself**

Parts Washers: Part Two
Solvent vs. Bioremediation

New style parts washer:

- **Solvent-free parts cleaning/degreasing**
- **Safe to use, hassle-free**
- **Non-flammable, non-toxic, free of VOC's**
- **No waste disposal problem***

Parts Washers: Part Two
Solvent vs. Bioremediation

Results:

- **Annual cost savings $14K**
  - **7 solvent to 6 bioremediation**
- **Associates loved them**
- **Optional cleaning service**
  - **Filters fluid**
  - **Machine Maintenance**
- **However…**

Parts Washers: Part Two
Solvent vs. Bioremediation

Downsides:

- **Dispose of tank contents ~1/year**
  - **Don't handle synthetic grease**
- **Heated to 106°F**
- **Everyone's definition of a VOC is not the same**

Aerosol Cans

Hard to get rid of:

- **Operators love them**
- **Easy to use**

There is no easy answer

- **Puncture and drain systems***

They are more than likely going to be a hazardous waste

Aerosol Cans

Depending on who you talk to, waste aerosol cans could be:

- **Flammable (D001)**
- **Reactive (D003)**
- **Filled with solvents (F001-F005)**
- **Etc.**

Aerosol Cans

Create a spec sheet of your needs

- **Know your process**
- **Involve operators**
- **Get buy-in**

Recently, we did just this.

Aerosol Cans

Our organization has not had that much luck

- **Banned HMIS flammability 3+ and several ingredients**

We have tried 100s of alternatives

- **Hand spray bottles**
- **Compressed air charged bottles**
- **Manual applications**

Michigan Department of Environmental Quality

www.michigan.gov/deq

1-800-662-9278