Solvent Cleaning in Today's Environment

Joe McChesney, Farr Mfg. & Eng., Bowling Green, KY.

With the ever-tightening rules and regulations imposed on solvent cleaning by Federal, State, and other regional governing bodies, today's cleaning systems must be safe, efficient, effective, environmentally compliant, and provide the required throughput to meet the end user's needs.

As existing solvents are regulated and new solvents emerge, it is important for the user public to understand the guidelines for using these governmental approved solvents in conjunction with available cleaning systems on the market today.

One would think these statements would not indicate growth in the solvent cleaning market. But there is! Replacement modern equipment and new processes yield a limited upward trend in solvent applications.

This seminar will provide a current comprehensive look at:

- State-of-the-art equipment and their operational processes
- Available / EPA approved solvents review
- Current EPA / OSHA / NESHAP solvent regulations review
- Market trends for solvent cleaning
- Gazing into the crystal ball…"What is the future of solvent cleaning from today's view?"

For More Information Contact:
Joe McChesney
National Sales Manager
FARR Manufacturing & Engineering
401 Emmett Avenue
Bowling Green, KY 42101
Phone: (207) 782-2411 ext.299
Fax: (207) 781-3425
E-mail: sales@farrmfg.com

Body of the Paper

To understand today's use of solvent cleaning systems, one must first take a retrospective look at how our current environmental rules and regulations were developed. This brief glance backwards will establish the criteria that ushered in the current regulations for solvent systems. It will also help you understand how today's companies (that use solvent cleaning systems, that manufacture and provide the equipment, and those that manufacture and provide the solvents) all have common goals of meeting the environmental parameters established by governing bodies worldwide. Goals consisting of achieving even lower limits of solvent usage to better our environment, preserving a process that is currently required for specific applications, and providing a cost effective process with a safe working environment.

<u>Retrospect</u>

For several decades, solvent degreasing was the preferred cleaning method for most manufacturers. This method had replaced the aqueous processes in most factories as a more simple, one step process, that required less floor space, less maintenance, greater compatibility for numerous soils/substrates, and generally less costly to operate. It provided a cleaning system that generally:

- Accepted any type of metal substrate.
- Removed most lubricants or contaminants in a single tank or process step.
- Cleaned any size/shape parts providing maximum solvent penetration into the smallest tolerance achievable.
- Parts were dry upon removal or if any residual solvent remained, it soon **evaporated into the atmosphere** leaving minimal residue.
- Consolidated waste into one area for recycling/disposal.
- Easy to operate / easy to maintain.

Pre-Montreal Protocol

As scientists studied the earth's environment, one such area of interest in the 1980's was the ozone layer. It was soon a topic of great interest and concern. The scientific community theorized that the use of these solvents for degreasing, carrier fluids, and other applications was harmful to the ozone layer around the earth. **One of the features that contributed to the success of solvent usage soon became the focal point of action.** Public awareness increased, world government bodies formed investigative committees, chemical manufacturers performed tests, and environmental organizations made models of the atmosphere to analyze these theories. The results of these actions were the driving factors to create a worldwide pact to decrease and eliminate the use of certain solvents, first as aerosol carrier fluids and later as degreasing fluids as well as other applications. Based on the world opinion of environmental stewardship, a group of nations formed and sanctioned the rules and regulations concerning these solvents. This meeting and joint agreement became known as the "Montreal Protocol".

Post Montreal Protocol

After the initial regulations were established and the final review and approval by each member nation was obtained, the following new environmental regulations were enacted:

- Prohibit the use of some of these solvents.
- Regulate the amount of others that could be used.
- Establish future replacement / phase-out dates for some.
- Enact new regulations for the equipment that used these solvents.
- Require "warning label notices" to be applied to products cleaned in certain solvents during the phase-out period.
- Set and enforce limits for air emissions concerning equipment operator exposure, actual equipment emissions to the atmosphere, and the amount of solvent that a company could use within a defined time frame.

Effects in the 90's

- NESHAP developed (degreasers regulated by this Federal guideline).
- Approximately 50% of degreasers nationwide retrofitted to meet these rules.
- SNAP issued (certain solvents prohibited, some limited by this Federal guideline).
- Some solvent users change to different SNAP approved solvent.
- Many companies switch to alternative processes based on misinformation or fear of any future solvent regulations.
- Many companies switch based on environmental outlook / corporate direction.
- Many companies switch based on Federal/State/Local record keeping requirements.
- Switch sometimes "Too Quick"
    1. Wrong equipment
    2. Wrong chemistry
    3. Wrong application
    4. Wrong process

Results

- Learning period going to aqueous from solvent.
- Success for some companies – some partial success (still using limited solvent cleaning).
- Failure to others – leading to converting back to solvent or replacing the wrong equipment with correct application type.
- Some companies are still using solvent but not in compliance with the law.
    1. Awareness???
    2. Cost of compliance???
    3. Avoidance???
    4. Waiting for the future to bring an inexpensive universal environmental accepted drop-in solvent!

Today's State-of-the-Art Equipment and their Operational Procedures

Today's regulations change quickly regarding environmental concerns for solvent degreasers. Research by the major solvent equipment manufacturers and the solvent suppliers evolves at the same expediency to match the regulatory changes. New solvent choices are constantly being developed and offered, sometimes within the regulations time frame and sometimes ahead of them. The degreasers of today meet and typically exceed all Federal guidelines concerning design criteria, operator exposure, and atmospheric emissions. Just as today's automobiles are more reliable with greater fuel economy, today's degreasers clean better with less solvent consumption. The equipment manufacturers have been able to incorporate new designs and technology that solves cleaning problems quicker with less operator involvement/exposure to the actual cleaning process. New solvents on the market have also contributed to this equation by reacting with certain lubricants quickly and effectively. The new solvents are designed for environmental compliance regarding VOC content, vapor pressure, lower air emissions, stability, and other chemical concerns. When combined with current generation degreasing systems, the user realizes the full effect of solvent conservation and improved cleaning that yields a higher quality product at less cost than in the previous years. Operator exposure is minimum, if any, and the solvent emissions from the actual equipment are the lowest in years.

Equipment

Basic degreasers can be generally classified in three categories:

1. Traditional Open-Tops
2. Totally Enclosed-Low Emission-Maximum Efficiency Type
3. Sealed Chamber Degreasers (Airless or Vacuum Type)

Regardless of whether the cleaning process involves vapor only, immersion, spray-in-air, ultrasonics, spray-under-immersion, etc…the actual equipment generally falls within the three above stated categories. I will briefly describe these systems and how the current designs are configured to insure environmental compliance and maximize production while minimizing solvent consumption and/or drag-out.

Traditional Open-Top Degreasers

Attributes:

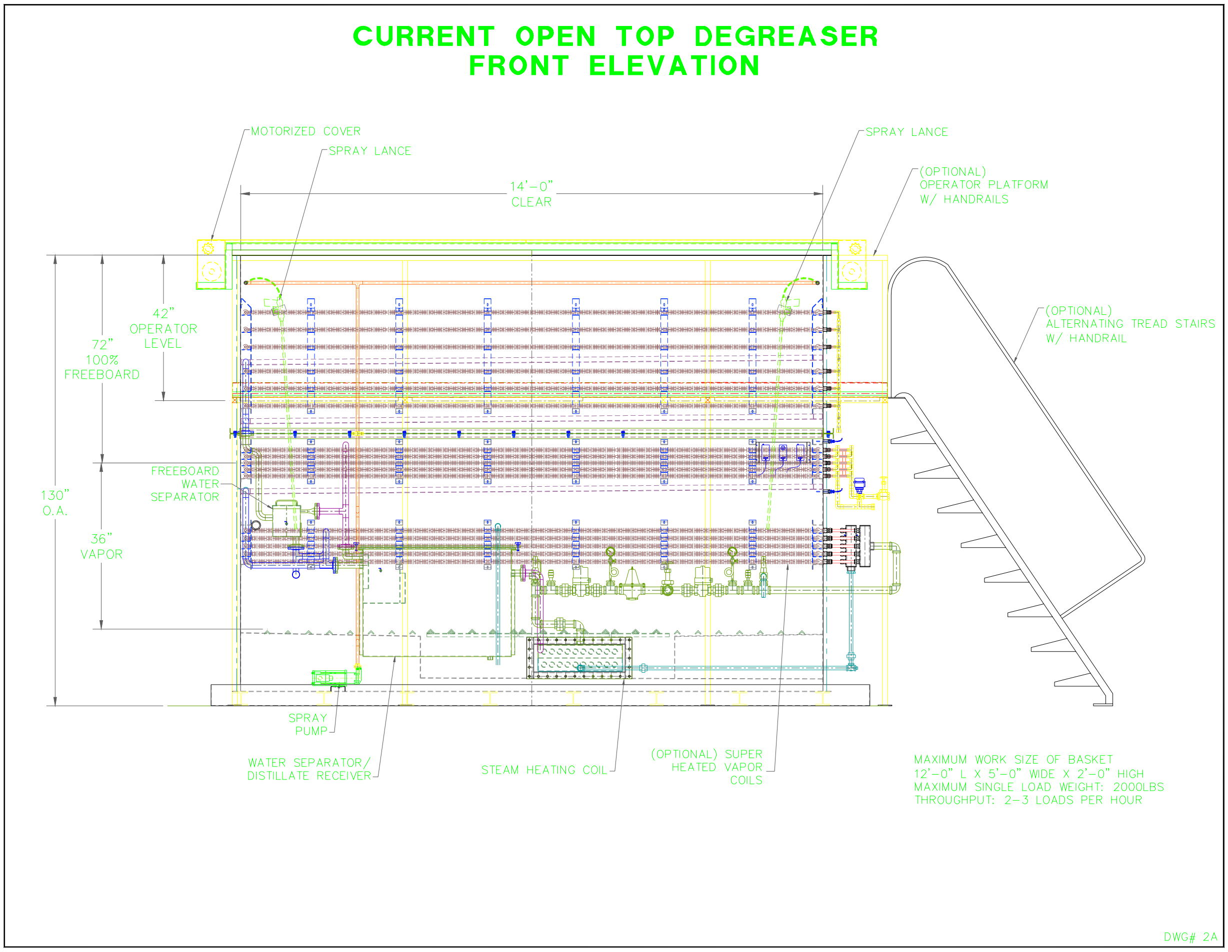
- **See Drawing No. 1.**
- Various shapes/sizes designed upon products to be processed parameters (weight/size/throughput).
- Basic design lends itself to be loaded through tank top opening either manually or with conveyance device.
- Throughput is generally higher than other type units based on loads per hour and size of these loads.
- Simple design equates to standard equipment offering minus complex material handling and cleaning processes, thus generally lower equipment cost.

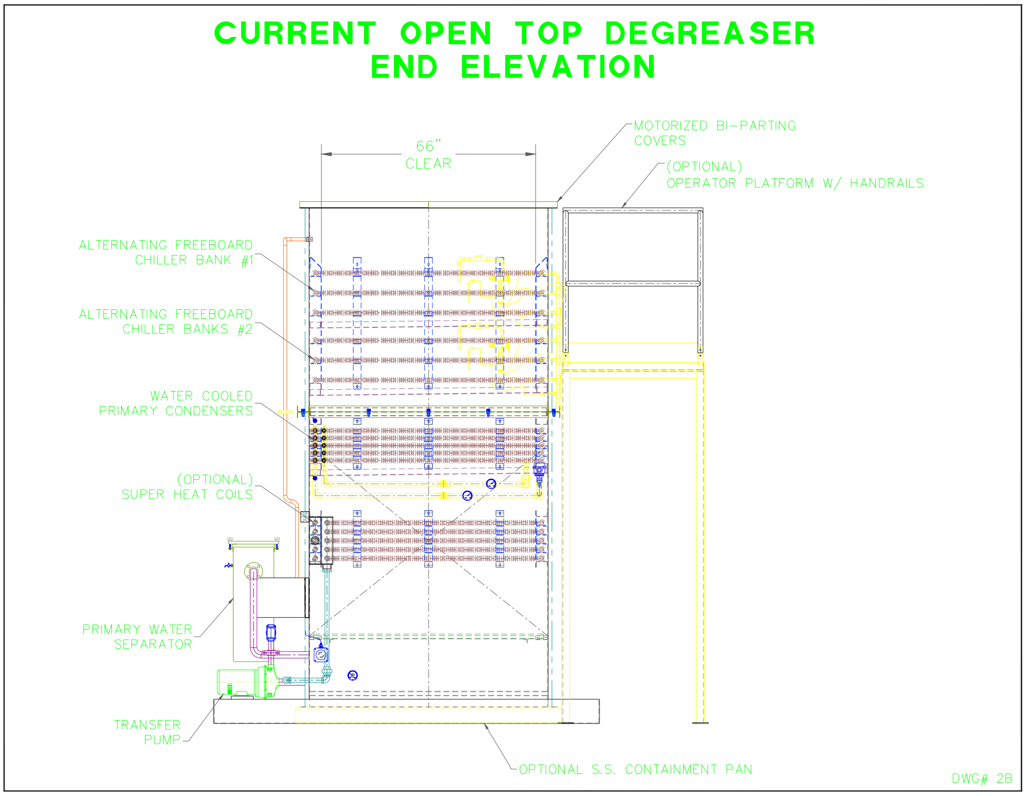
Detractions:

- Process lends itself to minimum type equipment, thus **potential exists to increase solvent drag-out based on operator control**.
- Open top area generally has **greater vapor / air interface**, thus **potential exists for increased emissive losses** over enclosed type system.
- By having unrestricted access to full tank opening, the **potential exists** for **operator to process larger size parts / baskets than the unit is rated for**, thus increasing solvent consumption via vapor displacement, vapor migration, or carryout.
- Larger size units require more efficient cooling for both water cooled primary condensers and any freeboard refrigeration devices.
- **Open top units are more susceptible to ambient temperature and air drafts** across the top of unit, thus increasing emissive losses.
- Operator has greater **potential for exposure to solvent ppm**.

Current Designs:

- **See Drawing No. 2A and 2B.**
- More effective cooling systems using more efficient materials to control vapor levels equate to lower vapor emissions.
- Modern heat controls insure a regulated heat supply with controls to sense actual equipment conditions and adjust accordingly. This area conserves energy and reduces emissive losses.
- Increased freeboard ratios in combination with tight sealing covers (mostly powered) reduce emissive losses.
- Freeboard chillers are now designed with maximum efficiency in mind. They are installed in stratifications to achieve full coverage of the areas required. With larger size units, the chiller coils are installed using alternating banks or levels that allows one part of the system to be operational (-20 F) while the alternate level is being defrosted. This feature insures that the chilled air blanket is maintained at all times, thus reducing emissive losses.
- Modern material handling devices are now recommended to be used in conjunction with all open-top degreasers (both old and new) to decrease operator interface and increase control of the process parameters such as: solvent exposure time, dwell cycles, work basket tilt to increase drainage if possible, any applied sprays, and cover operation.
- Updated water separator systems now feature increased cooling capacity to assist in water or moisture (from the process or air) removal, thus decreasing the solvent/water ratio content, which reduces emissive losses, affects solvent stability, and impacts equipment operation and structural integrity.
- Other devices such as carbon adsorption systems and super heated vapors can also assist in reducing overall solvent consumption based on specific applications and the associated parameters involved with those applications.


CURRENT OPEN TOP DEGREASER
FRONT ELEVATION
MOTORIZED COVER
SPRAY LANCE
SPRAY LANCE
14'-0" CLEAR
(OPTIONAL) OPERATOR PLATFORM W/ HANDRAILS
(OPTIONAL) ALTERNATING TREAD STAIRS W/ HANDRAIL
42" OPERATOR LEVEL
72" 100% FREEBOARD
130" O.A.
FREEBOARD WATER SEPARATOR
36" VAPOR
SPRAY PUMP
WATER SEPARATOR/ DISTILLATE RECEIVER
STEAM HEATING COIL
(OPTIONAL) SUPER HEATED VAPOR COILS
MAXIMUM WORK SIZE OF BASKET
12'-0" L X 5'-0" WIDE X 2'-0" HIGH
MAXIMUM SINGLE LOAD WEIGHT: 2000LBS
THROUGHPUT: 2-3 LOADS PER HOUR
DWG# 2A



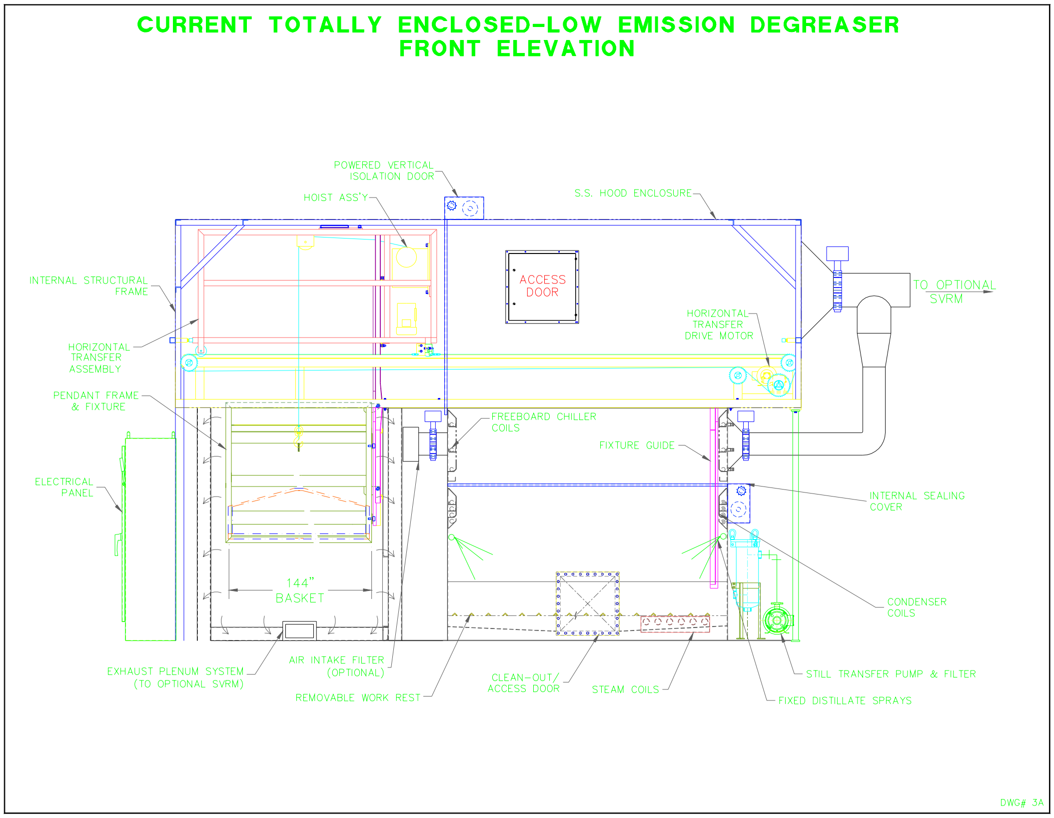
Summary:

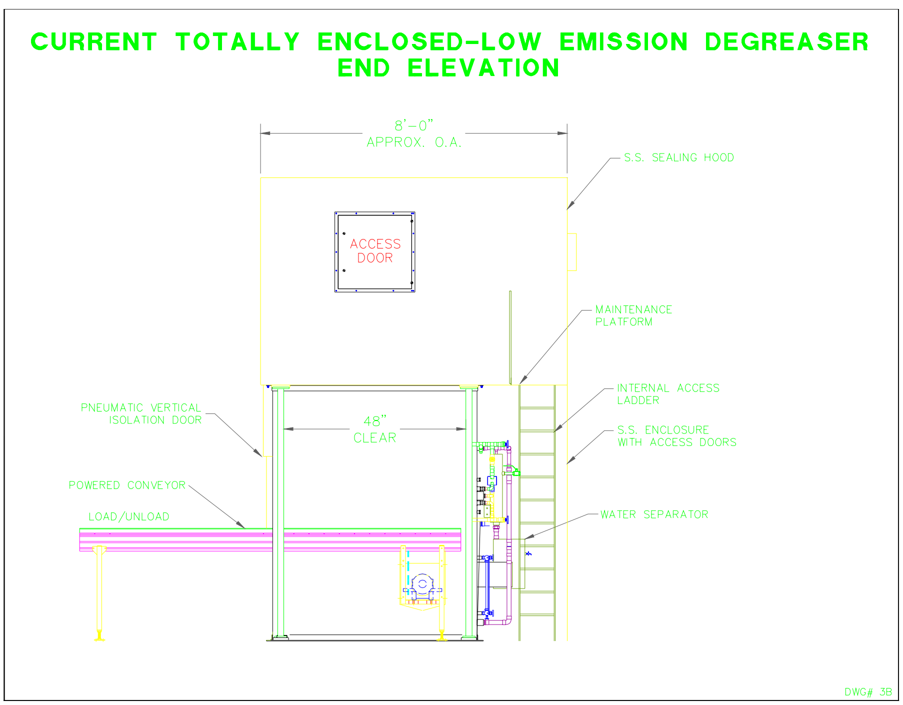
- Today's Open-Top degreasers are at the most efficient design in their history.
- The overall solvent idle emissions are at the lowest ratio per square foot of vapor / air interface ever.
- These units yield acceptable performance at generally the minimum cost.
- They are simple to operate, maintain, and generally provide more access and flexibility to the degreaser tank than any other type system.
- Yet, these units are **not** the most environmentally effective systems considering the degreaser tank (in normal operation) is generally open to the ambient atmosphere, which is subject to ambient air currents and temperature. Combine this issue with the human factor of an operator that has the potential to control the process cycle, actual machine operating conditions, and may decide what/when/how goes into the system…you get variables that may contribute to the overall solvent efficiency and environmental impact of a particular machine.

Totally Enclosed- Low Emission- Maximum Efficiency Degreasers

Attributes / Current Design

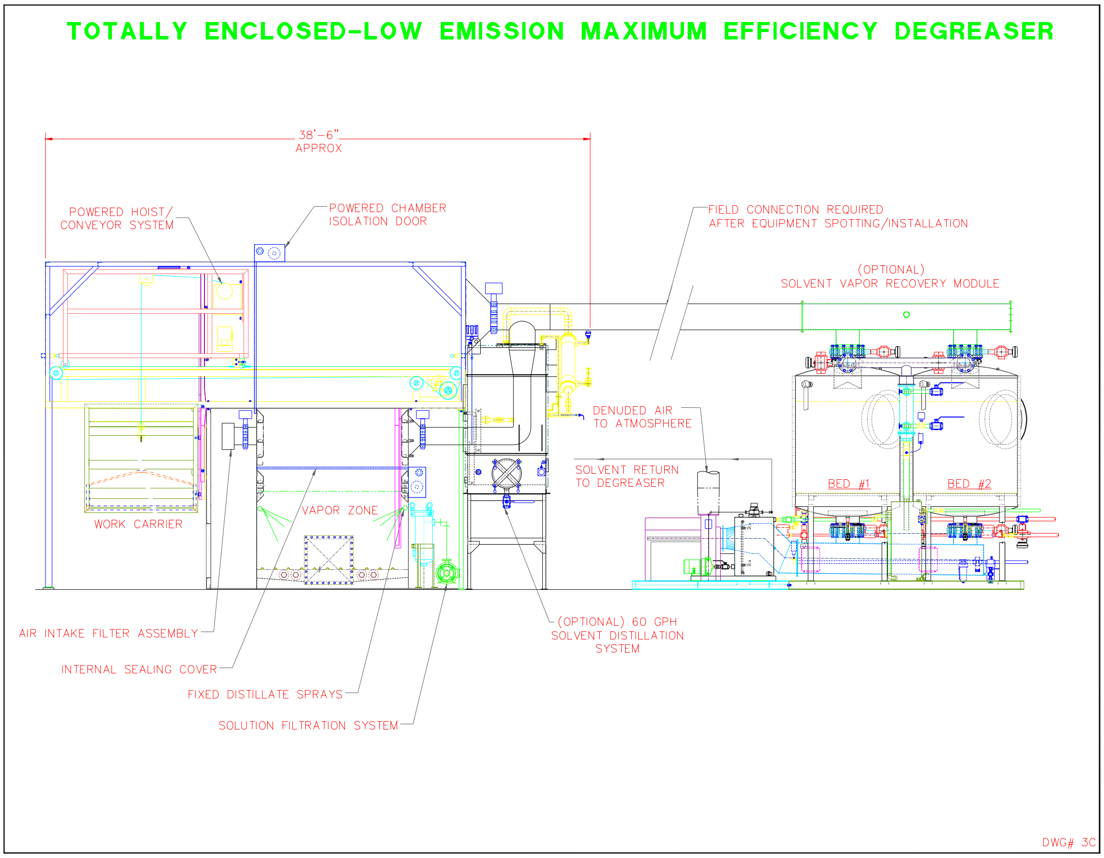
- **See Drawing No. 3A and 3B.**
- By utilizing the above stated **design enhancements** of the today's open-top units, plus when **enclosing the degreaser system** (tank(s) and load/unload area) within the confines of a cabinet, and **adding a material handling system** to automatically convey the work in/through/out of the degreaser…one gets a system that provides the required cleaning process based on set parameters and an enclosed unit that provides minimum operator interface / exposure while providing maximum environmental conservation from a system that is not subject to air drafts, provides limited operator control of the actual process, reduces vapor / air interface based on largest size work basket designed for the system, reduces ambient air/moisture entry to the system, and is more energy efficient.
- With automation controls, the work sees the same process parameters each load, with identical dwell times as established for the vapor / immersion / freeboard.
- The conveyor system is interfaced with any spray cycles to control exact timing and location, thus reducing emissive losses.
- The enclosure isolates the degreasing tank(s) from the ambient plant / operator atmosphere while providing shielding from this same environment that has the potential to influence the degreaser internal vapor layer.
- Typical powered isolation doors on the cabinet insure the degreaser is kept at a point of isolation as much a possible.
- The equipment solvent tanks are "right sized" for the workbasket applied. This generally means less solvent capacity in the system and less vapor/ air interface, thus reduced solvent emissive losses.
- Spray-under-immersion, ultrasonics, and vertical agitation enhances parts cleaning may be enhanced.
- Product rotation enhances cleaning in parts that have blind holes, passageways, complex geometry, etc. Rotation assists in removing chips, fines, and other contaminants. Rotation also helps in draining entrapped solvent from the parts/basket as they are rotated above the liquid tank(s), thus reducing solvent carryout.
- The enclosure will decrease the emissive losses due to the degreaser tank having limited contact with the outside atmosphere and it also allows the addition of solvent recovery devices such as carbon adsorption systems that will capture the emissive losses as well as carry-out solvent entrained in the parts if properly applied. By incorporating these devices, one will obtain **Maximum Efficiency.**


CURRENT TOTALLY ENCLOSED-LOW EMISSION DEGREASER
FRONT ELEVATION
POWERED VERTICAL ISOLATION DOOR
HOIST ASS'Y
S.S. HOOD ENCLOSURE
INTERNAL STRUCTURAL FRAME
ACCESS DOOR
TO OPTIONAL SVRM
HORIZONTAL TRANSFER DRIVE MOTOR
HORIZONTAL TRANSFER ASSEMBLY
PENDANT FRAME & FIXTURE
FREEBOARD CHILLER COILS
FIXTURE GUIDE
ELECTRICAL PANEL
INTERNAL SEALING COVER
144" BASKET
CONDENSER COILS
EXHAUST PLENUM SYSTEM (TO OPTIONAL SVRM)
AIR INTAKE FILTER (OPTIONAL)
REMOVABLE WORK REST
CLEAN-OUT/ ACCESS DOOR
STEAM COILS
STILL TRANSFER PUMP & FILTER
FIXED DISTILLATE SPRAYS
DWG# 3A


CURRENT TOTALLY ENCLOSED-LOW EMISSION DEGREASER
END ELEVATION
8'-0" APPROX. O.A.
S.S. SEALING HOOD
ACCESS DOOR
MAINTENANCE PLATFORM
INTERNAL ACCESS LADDER
PNEUMATIC VERTICAL ISOLATION DOOR
48" CLEAR
S.S. ENCLOSURE WITH ACCESS DOORS
POWERED CONVEYOR
LOAD/UNLOAD
WATER SEPARATOR
DWG# 3B

Maximum Efficiency Process

- **See Drawing No. 3C.**
- When one processes parts through a traditional vapor degreaser, there is generally an amount of solvent remaining on the parts after they are removed.
- This solvent varies in volume based on the parts or even the workbasket itself and can be found in liquid and/or vapor form inside the parts or as a film coating the outside of the product.
- This solvent will eventually evaporate as the parts/basket are exposed to the atmosphere.
- By delaying the removal of these parts until the solvent can be extracted from them, the user achieves the **maximum efficiency** possible within the process time frame and equipment used.
- There are several methods of extraction but a carbon adsorption system provides the most efficient means to **remove** and **recover** solvent before it reaches the atmosphere external of the degreaser enclosure.
- By incorporating a **carbon adsorption system into the enclosure**, one can isolate the work from the degreaser tank after cleaning, thus insuring that solvent is not extracted from the working tank.
- The clean work with entrained solvent is then exposed to an air stream that pulls across/through the work **extracting solvent** with it as the air and solvent mixture is pulled into the carbon recovery unit's vessels.
- Make-up air is pulled from the ambient area outside the tank to provide a cooler temperature air, which mixes with the solvent for better adsorption efficiency.
- By virtue of this air being pulled across and through the parts/basket, **the residual solvent is scrubbed/removed by this air stream.**
- The solvent laden air is then pulled into the carbon vessels for future recovery based on time cycles. This reclaimed solvent is then transferred back into the degreaser for use.
- Thus the solvent is extracted from the parts prior to these parts reaching the outside atmosphere. The solvent is recovered and reused. This results in lower solvent usage, lower emissive losses, lower plant /operator exposure limits, and maximum efficiency.
- Results have proven the carbon recovery system's efficiency at 98% and better in some cases. Actual solvent purchases have been reduced by 50% in one year's time as reported by actual users.


TOTALLY ENCLOSED-LOW EMISSION MAXIMUM EFFICIENCY DEGREASER
38'-6"
APPROX
POWERED HOIST/
CONVEYOR SYSTEM
POWERED CHAMBER
ISOLATION DOOR
FIELD CONNECTION REQUIRED
AFTER EQUIPMENT SPOTTING/INSTALLATION
(OPTIONAL)
SOLVENT VAPOR RECOVERY MODULE
DENUDED AIR
TO ATMOSPHERE
SOLVENT RETURN
TO DEGREASER
BED #1
BED #2
VAPOR ZONE
WORK CARRIER
AIR INTAKE FILTER ASSEMBLY
INTERNAL SEALING COVER
FIXED DISTILLATE SPRAYS
SOLUTION FILTRATION SYSTEM
(OPTIONAL) 60 GPH
SOLVENT DISTILLATION
SYSTEM
DWG# 3C

Detractions:

- Work processed is **limited to size of workbasket applied**.
- Throughput is generally reduced based on time required to convey parts into the system, open and close isolation doors, control cycles, and convey finished parts out of system over a traditional open-top.
- More complex systems generally require a regular scheduled thorough maintenance.
- **Decreased flexibility in other applications utilizing the tank** area.
- Decreased tank access.
- Decreased solvent consumption requires attention to solvent condition inside the unit.
- **Equipment cost increase** over traditional open-tops.
- Typically **increased plant floor area** is required.

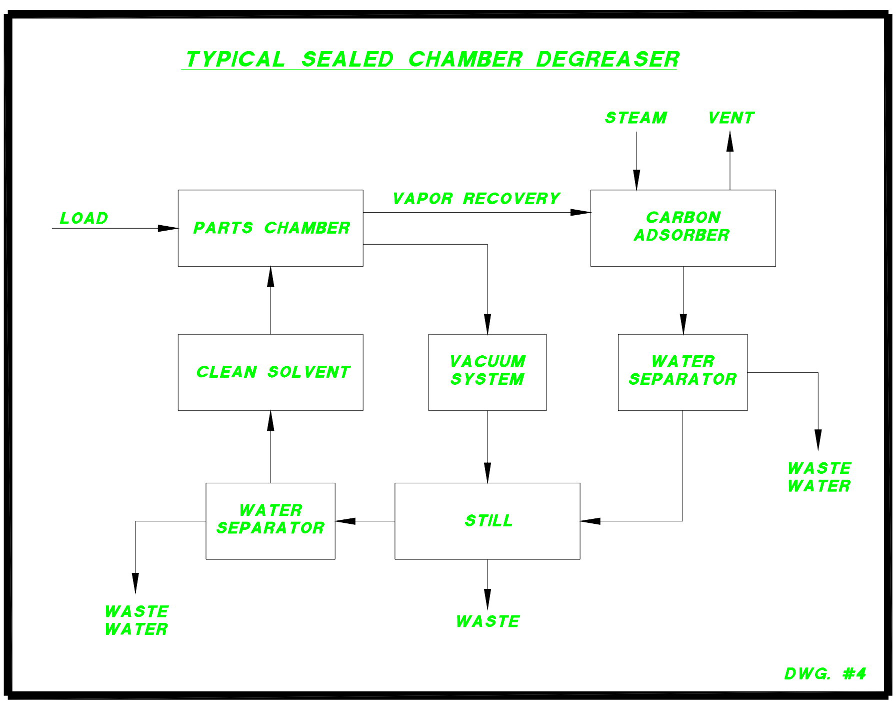
Summary:

- Today's totally enclosed solvent degreasers yield the lowest emissions and provide maximum efficiency from an enhanced atmospheric vapor degreaser design.
- Plant atmosphere and operator exposure is reduced to minimum and can be further reduced by adding solvent conservation devices.
- These units provide a controlled repeatable performance automatically.
- These units generally provide higher throughput than an airless or vacuum type but sometimes less than an open-top.
- These units meet the most current environmental regulations concerning solvent degreasers and offer the user a winning combination of performance, throughput, solvent conservation, environmental shielding, and process control on the market today regarding atmospheric degreasers.

Sealed Chamber (Airless or Vacuum Type) Degreasers

Attributes / Current Design

- **See Drawing No. 4.**
- The enclosed cleaning chamber is sealed while the work is exposed to the solvent either in a vapor or liquid form using various processes.
- By utilizing a sealed chamber, the plant atmosphere and operator are not exposed to any solvent while the work is being processed.
- When the cleaning cycle is completed, the solvent is typically transferred to an isolation chamber, the work is exposed to hot air drying or a vacuum process to remove as much as the solvent possible within a given time period, work is then withdrawn from the chamber with minimum solvent residue remaining on the work, thus solvent emissive losses are very low.
- Most of these units use solvent conservation devices such as carbon adsorption systems built-in to capture the vapors and reduce solvent emissive losses to the ambient plant area as the work is withdrawn.
- These units meet the current environmental regulations for solvent degreasers and in most cases will meet low pounds per hour or per day limitations as imposed by certain geographical governing bodies.



Detractions:

- Process lends itself to **high cost / complex equipment**.
- **Typically work chamber size** is small based on equipment design regarding vapor extraction, time for effects versus chamber size, and cost of process.
- Throughput is generally very **limited**. Typically **one (1) load per hour** based on process parameters, part complexity, cleanliness specifications, solvent used, and time required to extract solvent.
- The **potential for solvent degradation is increased** due to usage factor.
- The complexity of the system leads to increased maintenance. If not properly and periodically maintained, then damage to the actual equipment may occur.
- Additional waste streams due to solvent recovery device. Example: If a sacrificial carbon bed is used to capture the solvent vapors being extracted from the work prior to being withdrawn from the unit, this vessel will become saturated with solvent and have to be replaced to meet the EPA ppm discharge limits. The replacement frequency of this hazardous waste stream will be based on amount of solvent entering the vessel, amount of work processed per hour or day, and other variables.

Summary:

- Similar to the totally enclosed systems, these units yield minimum emissive losses and lowest actual solvent usage at a generally lower throughput.
- The equipment costs is generally higher due to equipment design and process devices installed.
- The user that must meet strict environmental regulations and needs solvent processing might consider these units if the work size restrictions, limited throughput, and financial aspects are not prohibitive.

<u>Solvents</u>

The solvents on today's market are a mixture of old and new. We still have some of the typical chlorinated degreasing fluids that have been used for years while others have been regulated out of existence. New solvents have been formulated while others not generally thought of as degreasing fluids are now being used for that purpose. **Environmental impact is the major deciding factor for most solvents today**. While certain fluids react better with specific contaminants, any solvent considered should be evaluated for regulatory compliance, high performance, ease of operations, and of course, cost! Many important factors to consider are:

- Safety
- Performance
- Compatibility with substrates to be cleaned

- Global Warming Potential
- Ozone Depletion Potential
- SNAP approval
- VOC content
- Flammability range
- AEL (average exposure limit) for personnel
- Purity: Virgin solvent or Reclaimed
- Contaminants: Petroleum distillates typically have trace amounts of contaminants such as nitrogen, hydrocarbons, sulfur, etc that can react with moisture or other components on the substrate to be cleaned that may cause detrimental effects.
- Availability / price
- Technical assistance
- Lots of issues – but help is readily available today!

Solvent Overview Chart

	Karui-Butanol Value	Boiling Poing Deg F	Surface Tension Dynes/cm	Vapor Pressure Mm Hg 25 C	HAP's	Flash Hazard Value
Trichloroethylene	129	188	28.7	70	Yes	None
Perchloroethylene	90	250	32.3	20	Yes	None
Metheylene Chloride	136	104	27.2	350	Yes	None
n-Propyl Bromide	125	160	25.3	111	No	None
HCFC (AK-225 AES)	41	126	16.8	291	No	None 5
HFC (Vertrel XP)	9.4	126	15.1	253	No	None
HFE-71IPA	10	131	14.5	207	No	None
Acetone		133	22.7	229	No	-17
Cyclohexane	58	177	24.9	95	No	-20
Isopropyl Alcohol		180	21.7	40	No	0.6
N-Methyl Pyrrolidone	350	400	40.7	0.24	No	93
D-Limonene	67	309	25	2	No	121F
Trans-1,2-Dichoroethylene	117	118	27.5	330	No	2.2

Current Regulations

The most current regulations, regarding solvent degreasers and the solvent that is used in them, that affect many users today are:

- EPA regulations: Clean Air Act / Title V permitting / Hazardous Waste Streams.
- OSHA: Health Assessment of fluids to operators / ppm exposure limits.
- NESHAP compliance for equipment (Federal minimum guidelines).
- Record keeping for NESHAP compliance.
- Local Environmental Regulations can exceed Federal regulations.
- MACT control technology for equipment.
- LAER control technology for equipment.
- SNAP approval for listed solvents.

There are other issues to consider but the above listed items are the most frequently addressed items by the degreaser end user, environmental permitting agencies, equipment manufacturers, solvent suppliers, and regulatory field inspectors.

Market Trends for Solvent Cleaning

The equipment suppliers are seeing a limited increase of solvent degreasers based on the need for modern environmentally compliant degreasers. While this market will never reach the level it once was, there is a definite need / demand for solvent cleaning in specific applications that require this proven process. From the sheer size of some of the products to be cleaned and the cleanliness criteria that today's aerospace / military / medical industry demands; solvent offers a simple yet effective solution.

- Some of the buyers are replacing existing dated solvent systems.
- Some of the new systems are replacing aqueous systems that were purchased to replace the old degreasers but didn't perform as expected or proved to be to labor intensive or operational cost prohibitive.
- Some of the buyers must now clean that didn't clean before and at a fast rate while meeting increased cleanliness specifications. Typically solvent is an easier choice to resolve this issue.

It is apparent that the environmental impact is driving the equipment design toward totally enclosed systems where possible. The enclosed design, whether atmospheric shielded tank or hermetically sealed chamber, is the choice of many companies. When one looks at the cost of lower solvent usage and emissive losses combined with a controlled process that yields repeatable results with minimum operator interface, the advantage of these systems becomes readily apparent. One still has to determine the required throughput, process parameters required to yield clean parts, material handling aspects, selected fluids, and the system that best suits their needs from an overall scope**. But this is getting easier in today's world**.

Today's current generation of degreasers are designed with many factors considered. Among them are performance, environmental compliance, solvent conservation, reliability, and market demands. These factors can be placed in any priority based on the individual user and his needs. There are many factors to consider when purchasing a solvent degreaser system. Please seek out professional knowledgeable assistance to provide you with information that you will need to make your decision.

<u>Crystal Ball</u>…"What is the future of solvent cleaning from today's view?"

There are several ways to answer this question. While we manufacturers readily admit that the market has shrunk over the last decade, it is not dead! The industry as a whole is seeing new machines being ordered. The smaller size units tend to be standard in design based on work chamber size versus production requirements and options desired. The larger size units tend to be more custom based on specific applications.

- We are seeing large systems for aerospace applications in particular that most users would not have considered several years back based on the future environmental outlook.
- We are seeing small precision cleaning applications that want totally enclosed systems featuring automation that will minimize operator interface while conserving as much solvent as possible.
- **The old adage that solvent cleans better, faster, and in more restrictive places than water can ever reach is still true!** The fact that today's cleanliness specifications for critical cleaning cannot have any contaminant residue or rinse water residue on the end product drives some users toward solvent.
- The cost to clean is a part of this equation. The cost for environmental compliance is another part. The end user confidence is yet another. Some applications can go either solvent or aqueous.
- In some cases, one process is generally perceived as superior based on several different inputs. That's why there are alternate choices for all.

- This is also why the government recognized the need for solvent cleaning and enacted certain laws to preserve this process until a better method is discovered.

The solvent equipment manufacturers believe the existing process will remain viable for many years into the future. We know the equipment will evolve as well as the solvent that goes into them. The basic process will remain similar. The improvements will come in material handling concepts, solvent recovery systems, and even tighter environmental compliance. As I previously stated, just like the automobile, today's systems are more reliable, perform better, and use less fluids!

Closing

Thank you for your time. I wish to "thank" the AESF for inviting me to speak today. I will be available after we adjourn to address any questions you may have or if you need any additional information, please request this through the AESF coordinator and I will be pleased to forward it to them.