Automatic Wax Collector
Principles & Characteristics of the Machine

Douglas Tomkins & Dr. Martin Leduc, MagChem Inc.,
Boucherville, Quebec, Canada

In one simple step, a technologically advanced wax collection system collects more than 95 percent of plating wax before it reaches the costly dissolving oil bath stage. Wax-coated parts are immersed in hot demineralized water. As they warm up to the bath temperature, wax gradually melts and floats to the surface. A surface flow of water skims off floating wax and carries it first to a collecting trough and then to a secondary tank where it accumulates. Water from that tank is continuously pumped back to the dewaxing section, leaving the wax behind. Because a constant maximum level of water is maintained in the secondary tank, excess wax is recuperated as it overflows out of that tank. Using DI water, this modular unit has already proven to quickly pay for itself in oil-saving and recycling benefits.

For more information, contact:
Douglas Tomkins
Business ManagerÑAerospace
MagChem Inc.
1271 Ampere
Boucherville, QC, J4B 5Z5 Canada
dtomkins@magchem.com
www.aerochemicals.com

One important step in the plating operation is to protect the surface of a part that you do not want to be affected by plating. This can be done by masking parts with non-conductive materials such as tape or wax. When the surface of a part is not planar, wax is usually the material of choice because it covers the region that should be difficult to protect with tape-type material.

The process of waxing a part is done by first immersing the part into a hot liquid wax tank, then cooling down its temperature to solidify the wax. The operation can be repeated until the desired thickness is obtained. Following the immersion operation, the operator manually removes some areas of wax to plate the desired surface.

The most significant problem that occurs with wax in a plating shop, is its removal following the plating operation. One classical method of wax removal consists of dissolving wax with a chlorinated or brominated solvent (usually 1,1,1-Trichloroethane) in a vapor degreaser.[1] Although the method is very efficient, it uses solvents that are not environmentally friendly and sometimes expensive. Also because of carry out, evaporation and saturation of wax in solvent, a large amout of solvent in addition to expensive waste treatment are necessary in that process. When dissolving wax in this process, the wax is completely consumed and lost.

Another popular method, described in Figure 1. is a three-step process consisting of immersing the part in a hot liquid wax tank to keep only a thin layer of wax, followed by an immersion in an emulsifiable mineral oil to dissolve the remaining wax. Then a final wash in an alkaline cleaner to remove the emulsifiable mineral oil. Even though this method does not involve solvents, as a result of drag out and saturation of the emulsifiable mineral oil with wax, additions to the immersion tanks and waste treatment are necessary. Wax cannot be recuperated in this process.

The present article features a new process of wax removal that minimizes waste treatment, and maximizes the life of chemicals involved in addition to allowing the capability of wax recovery.

Fig. 1 – Three-step process to remove wax.

The process consists of integrating a new step using a patented machine[*] into the three-step process previously described in the introduction. The new four-step process, described in Figure 2., now consists of an immersion in a hot wax tank, followed by an immersion in the wax collecting machine. The subsequent steps, as described in the three-step process included an immersion in an emulsifiable mineral oil and a final wash in an alkaline cleaner.

---

[1] Metal Handbook Ninth Edition–Volume 5 Surface Cleaning, Finishing and Coating, America Society for Metals, Metals Park, Ohio, 1982, p. 44

[*] The Automatic Wax Collector,® **Mag**Chem Inc., U.S. Patent 6,432,215 (2002)

Fig. 2 – Four-step process to remove wax with the patented wax collector.

When the part is immersed in the collection machine, the wax is floated to the surface of the tank and automatically skimmed-off, to be recovered in a container, rather than being simply dissolved. The principle of the machine will be explained in more detail in a later section. After this collection step, almost 99% of the wax is already removed. The emulsifiable oil then removes the remaining wax, which is sometimes trapped in holes of a part. Finally, an alkaline cleaner is necessary to remove the emulsifiable oil.

The chemicals used in the automatic unit will vary depending on the conditions indicated below:

<u>1- Melting point of the wax below 85 C (185 F), parts not susceptible to rust.</u>

In this case, the chemical used can be deionized water but precautions have to be taken to insure that parts have no chance of rusting.

<u>2- Melting point of the wax below 85 C (185 F), parts susceptible to rust</u>.

Chemical can be deionized water with a 2 to 5% concentration of a flash rust inhibitor*.

<u>3- Melting point of the wax above 85 C (185 F).</u>

Glycol solvent** is recommended because the wax will not melt significantly enough with water above 85 C (185F). The glycol solvent also contains corrosion inhibitors that protect parts from corrosion.

<u>4- Other chemicals involved in the process.</u>

The mineral oil*** used in step three of the process (Figure 2), should contain emulsifying agents and corrosion inhibitors to avoid any rust corrosion.

In the final step, the alkaline cleaner**** should contain a proper blend of surfactants, penetrants and corrosion inhibitors. These three characteristics are crucial for the successful removal of remaining emulsified oil and some wax. Agitation is also recommended to enhance the performance of the alkaline cleaner in the final step.

---

* Corrotek – **Mag** Chem Inc., Boucherville, QC., CANADA
** Kemsol-606 – **Mag** Chem Inc., Boucherville, QC., CANADA
*** D-Solv – **Mag** Chem Inc., Boucherville, QC., CANADA
**** Soluwax – Solution 10% in water – **Mag** Chem Inc., Boucherville, QC., CANADA

The first benefit of the process is to avoid using unhealthy solvents such as chlorinated solvents in the process. The main goal of most plating firms is trying to reduce consumption of chlorinated or brominated solvents to comply with new Environmental and Health & Safety regulations. By using this method instead of a vapor degreaser for example, their solvent consumption can be reduced significantly while meeting newer, more stringent standards.

Another significant benefit of the process is the possibility of recovering more than 99% of the wax at the end of the process, that wax can be treated on site for re-use or simply sold. Thereby generating a net economic advantage compared to the old method where wax was dissolved or emulsified, then lost.

A third benefit of the process is to reduce chemical consumption and waste treatment. Because all the wax in the collection unit is floated instead of being dissolved or emulsified, there is no saturation of the wax removing chemicals in the wax collector (deionized water or glycol solvent). The collector also has an optional condenser unit, which is used with the glycol solvent to minimize evaporation. The only way for glycol solvent to be consumed is by carry out. More importantly, because almost 99% of the wax is removed from the parts, the emulsifiable mineral oil and alkaline cleaner solution will both last more than 10 times longer than with the three-step process. This will reduce the number of discharges required, the annual consumption of the chemicals and the annual amount of waste, resulting in considerable economical savings for the plating firm.

The wax collector is a fully automatic unit. After initial fill-up and start-up, it can be left operating on its own for as long as power and demineralized water or glycol solvent is available. Figure 3. shows an overview of the machine principals and key characteristics which will be explained in this section. For simplicity, the condenser which would be used when glycol solvent is required is not shown in Figure 3, but would be placed directly over both tanks as seen on the top of the unit shown in the picture included in Figure 4. The condenser is required when the glycol solvent is used as the primary de-waxing chemical in both the process and wax separator tanks, to minimize evaporating and maximize the life of the glycol solvent in the machine.

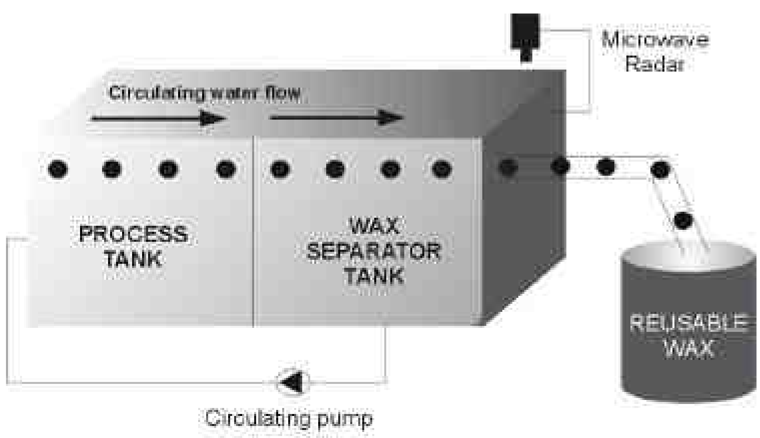

Fig. 3 – Illustration of an automatic collector – Version shown is for waxes with a melting point below 85 C and not susceptible to rust.

A microwave controller maintains a constant minimum level of DI water or glycol solvent in the secondary tank, allowing space for variation in water level of both tanks as different volume parts are immersed. The circulating pump with a flow rate of 56 L (14.79 gallons) at 71.7 kPa (0.71 atmosphere), ensures an adequate fluid level in both the process and wax separator tanks, in addition to creating a circulating water flow. Since a constant minimum level of water is maintained in the secondary tank, excess wax is recuperated as it overflows out of the tank when parts are immersed. The machine also has a built-in safety mechanism, whereby the circulating pump will be switched off automatically if the level of deionized water or glycol solvent drops below minimum in the wax collecting compartment, or if the pump loses suction. A conductivity controller assures of water quality by bleeding off part of the deionized water or glycol solvent in both tanks, when contaminants from the plating process accumulate beyond a preset level. The preset level for best functionality has been determined to be 1 Mohm. If a rust inhibitor is required, as in point 2. of the chemical description for a melting point of wax below 85 C (185 F), when deionized water is used as the de-waxing agent in the machine, a small chemical pump must also be added. This small chemical pump will add the rust inhibitor proportionnally to the amount of water being bled off at a concentration of between 3 and 5% by volume. Finally, a sensor with a thermostat keeps water temperature within an optimum range to obtain fast and thorough wax removal at a maximum temperature of 121C (250 F). The water can be heated either electrically with two 15 KW elements or through an integrated low pressure steam heating dimple jacket in each dewaxer and wax accumulating compartments.

Figure 4. – A collector with condenser for plating waxes with melting points above 85 C (185 F).

The Return On Investment (ROI) for the patented wax collector was prepared and calculated over a five-year term and broken down into three worksheets represented in Figures 5., 6. and 7. Figure 5. examines the present case scenario of the most common three-step wax removal process using primarily an emulsifiable oil. For this cost study, the total tank capacity for the three-step wax removal process is equivalent to the largest unit currently in use and was used as the foundation of the study at a total capacity of 1,620 L (428 gallons). An exchange rate of $1.59 US / $CDN Dollar was applied to all three worksheets. The cost of the initial charge of emulsifiable oil for a basic three-step process was calculated to be $4,528.80 US, based on a requirement of 8 drums (170 kg/drum or 205 L / drum). Furthermore, the annual consumption was calculated to be 64 drums (13,120 L or 3,466 gallons) of similar weight and volume; including drag-out, weekly rectification because of evaporation and the number of changes required following the saturation of the emulsifiable oil. With an approximate price of $3.33 US / Kg (based on current market value for emulsifiable oils in Canada), the total annual cost for the emulsifiable oil with the conventional three-step process was determined to be: $40,758 US. On the same Figure 5., the cost study was also extended to include down time cost, including a total of 6 work days or 96 hours, at a cost of $100.00 US / hr. including salary and benefits to complete the total change-out of emulsifiable oil during one year. The last cost examined for the conventional three-step process of wax removal was the cost for waste treatment. Since the emulsifiable oil is continuously being contaminated with substantial portions of plating wax, the oil must be changed frequently. The contaminated emulsifiable oil must then be handled by the plating firm's waste management department at a considerable expense. For a total annual volume of 13,120 L (3,466 gallons) of waste emulsifiable oil, a cost per liter was determined to be $0.25 US / L, based on current experience with existing clientele in the Canadian market. Other risks outlined in section D) of Figure 5. were not quantified but can contribute considerably to the total cost of the conventional three-step wax collecting process if in the eventuality of an accident. Those risks include : solution pumping at a heated temperature of 90 C (200 F) where skin burns may occur, transport risks, increased risk of drum manipulation because of the increased number of drums and possible contamination of the subsequent tank in the cleaning procedure outlined in the three-step process.

3 - STEP PROCESS		U.S. Funds
A) PRODUCT' COST		
Tank' capacity of emulsifiable oil	428 US gallons (1 620 liters)	
Cost of the initial emulsifiable oil (Based on current pricing for similar product)	8 drums @ $ 3.33/kg = 170 kg/drum	$4,528.80
Annual consumption (including: drag-out & weekly rectification because of evaporation and number of changes following saturation.)	64 drums / 13 120 liters 13 120 liters @ 0.83 = 10 880 kg	
Approximative price	approximately $ 3.33/ kg	$36,230.40
Total cost for emulsifiable oil		**$40,759.20**
B) DOWN TIME COST		
6 days (96 hours) @ $ 100.00 / hr =		**$9,600.00**
C) COST FOR WASTE TREATMENT		
Number of liters to be treated	13 120 liters	
Cost per liter	$ 0.25 / liter	
(Based on an avg. cost for waste treatment in North America from existing clientele in Canada)		
Total cost		**$3,280.00**
D) OTHERS		
Inherent risks to the solution pumping	* Must be done heated / 90 ° C (200° F)	
Transport' risks for these materials		
Various risks in excessive manipulation because of the number of drums		
Contamination of the next tank in the cleaning procedure.		
Annual total cost		**$53,639.20**

Figure 5. – Case Study, conventional three-step wax collecting process with emulsified oil.

Figure 6. examines the cost study of the wax removing process using the four-step process and the wax collecting machine to replace the conventional three-step process. Using the largest unit currently in use, at a capacity of 1,620 L (428 gallons), the case where the wax being used has a melting point below 85 C (185 F) and not requiring the use of glycol solvents. As a result of the melting point of the wax, deionized water can be used as the dewaxing agent in both the process and wax separator tanks of the collector. The initial charge of both tanks on the wax collecting unit will require 1,620 L (428 gallons) or 8 drums of deionized water at a cost of approximately $0.45 US / Kg, for a total of $738.00 US. The consumption of the deionized water was determined to be approximately double that of the glycol solvent, mainly as a result of a higher evaporation rate as a result of a lower boiling point. Therefore, annual consumption of

deionized water was calculated to be 16 drums or $1,476 US. The total cost for 1,620 L (428 gallons) or 8 drums of emulsifiable oil downstream remains the same at $4,528.80 US as in Figure 5. in order to charge the immersion tank directly following the automatic collection stage. The final cost in section A) of Figure 6. relates to the annual consumption of emulsifiable oil currently being consumed by local users of the collectors in Canada, at an amount of 8 drums per year on average for a total of $4,528.00 US. Looking at the total cost for the emulsifiable oil with the four-step process and the collector, the user is only required to spend $11,271.60 US per year. Downtime is not an issue in this case as the machine is fully automated and adds deionized water when required. Similarly, as a result of removing 99% of the plating wax with the wax collector, the emulsified oil downstream now has a much more significant yield and durability, also allowing for zero downtime and the possibility for a more organized and planned annual maintenance check. Similarly, there is no cost for waste treatment as the wax is separated in the wax collecting unit and delivered directly into a waiting pail where, depending on the type of wax, it can be reused, recycled or sold for re-use.

4 - STEP PROCESS		U.S. Funds
A) PRODUCT' COST		x-rate = 1.59
Initial cost of DI water (1620 L - total capacity)	8 drums @ $ 0.45/kg = drums of 205 kg	$738.00
Consumption of DI water (annually) *	16 drums of 205 Kg	$1,476.00
Cost of the initial emulsifiable oil	8 drums @ $ 3.33/kg = drums of 170 kg	$4,528.80
Consumption because of evaporation (Based on annual consumtions at existing clientele)	8 drums =	$4,528.80
* Based on consumption of glycol solvent, DI water will evaporate 2x faster as a result of lower boiling point.		
Total cost for emulsifiable oil		**$11,271.60**
B) DOWN TIME COST		
NO DOWN TIME		**$0.00**
C) COST FOR WASTE TREATMENT		
Total cost		**$0.00**
D) OTHERS		
No risk of accident		
Considerable reduction of drums' manipulation * Only at the beginning		
Prolong up to 20% the useful life of the emulsifiable oil		
Recover more that 99% of the masking wax, that in certain case, may be re-usable or simply sold		
Protect the environment		
Annual total cost		**$11,271.60**

Figure 6. – Case Study, using patented wax collector

The ROI for the collection unit was calculated in Figure 7. and determined to be during the third year of operation, when compared to the conventional three-step wax collecting process with straight emulsified oils. The ROI after the third year of operation was calculated to be $69,420 US. The conventional three-step process attracts an annual chemical cost of $53,635.80 US for the emulsified oil process. Whereas the annual chemical cost with the four-step collector is only $11,271.60 US in addition to the $57,682.00 US one-time initial cost of the machine. Over a five-year term, the total cost for chemicals with the conventional three-step wax collecting process is over $268,179 US, while the four-step process including the collector will only be $114,040 US. This represents a savings of over $154,139 US over the five-year period. For cases where a glycol solvent will be required in the collector as a result of using a wax that has a melting point superior to 85 C (185 F), a condensor will be necessary to prevent evaporation.

SUMMARY		U.S. Fund		
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
THREE (3) - STEP PROCESS	$53,639.20	$53,639.20	$53,639.20	$53,639.20	$53,639.20
FOUR (4) - STEP PROCESS WITH Collector					
Annual cost	$11,271.60	$11,271.60	$11,271.60	$11,271.60	$11,271.60
Approximate Machine' cost	$57,682.00				
DIFFERENCE	**($15,314.40)**	**$42,367.60**	**$42,367.60**	**$42,367.60**	**$42,367.60**

RETURNS ON INVESTMENT	
First year	**($15,314.40)**
Second year	**$27,053.20**
Third year	**$69,420.80**
Fourth year	**$111,788.40**
Fifth year	**$154,156.00**

* After 5 years	
ACTUAL COST	**PROPOSED**
$268,196.00	**$114,040.00**

PLEASE TAKE NOTE THAT THE PRICES MENTIONED IN THIS DOCUMENT ARE APPROXIMATIVES AND SUBJECT TO CHANGE

Figure 7. – Case Study , ROI for a five-year term

The wax collector was engineered to minimize the consumption of wax removing chemicals and to allow the recyclability of expensive plating waxes. For years the plating and surface finishing industries have only been able to rely on expensive emulsifiable oils as the primary removing agent for wax. The wax collection process now provides an economical solution by primarily using DI water as the first wax removing stage and furthermore, maximizes yield of the wax removing chemicals downstream in the process. As the cost analysis shows, the return on investment can generate benefits by the third year of operation; in addition to providing the possibility of either recycling or collecting plating wax in a clean and efficient manner for resale. The wax collecting process highlighted in this article is currently in use and providing significant benefits at several locations in Canada.