

Economical and environmental friendly cleaning :

Rockwell Automation has chosen *Amsonic*

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Introduction

Industrial cleaning is becoming an important step within the production of many components. The technological development of chlorine free hydrocarbons under vacuum is an important stage in the cleaning techniques. Leaders of the industry has chosen this new swiss technology. The application at Rockwell in Aarau (Switzerland) is described hereafter.

Surface treatment at Rockwell

The american multinational Rockwell has decided to emphasize the ecological processes within its production. Degreasing and cleaning of components was done till March 2001 with perchlorethylene. This equipment had to be modified to comply with the swiss legislation of toxic solvents, but also in order to be in conformity with the ISO 14000 certification.

Components such as electrical casings are stamped and their surface must be cleaned prior to assembly, soldering and plating. The cleanliness is important as the Rockwell products will be used in various industries, like electronics, aeronautics and medical industry.

The project group has analyzed the various solutions, in water based or hydrocarbon technology. The technology of hydrocarbons with a flame point $>56^{\circ}\text{C}$ (called AIII) has been chosen.

Claude Vincent, project leader summarize the reasons of this choice.



What are the reasons for choosing the hydrocarbon technology?

Perchloroethylene is among the toxic products which are either prohibited or eventually tolerated in the production techniques of Rockwell. We chose the most restrictive legal compliance of the countries in which we have production sites for all our activities. The price of perchloroethylene has doubled it is a toxic solvent and it is not environmental friendly. We therefore have chosen chlorine free hydrocarbons.

How many suppliers have you contacted ?

Four companies were selected in a first approach.

Why did you choose Egaclean ?

Two companies had not fulfilled the quality criteria. Among the remaining two companies, Amsonic manufacturer of the equipment had the better result of our decision table. The most important elements of decisions have been the price of the equipment and its operational cost situation, the cleaning quality (measured as the tensile strength with a target at 51 mN/m) the security, the automatic conveyor system and the after sales service.

Egaclean by Amsonic was chosen. Rockwell uses an equipment using hydrocarbon of the first generation (purchase date 1994) to clean polymer components.

Requirements

Table 1 shows the various requirements valid for the period 2001 till 2005.

Number of components	352
Hourly production	400 kg
Baskets per cleaning cycle	4 baskets 475 x 320 x 154mm
Process	Semi-automatic
Material	Copper alloys, steel, aluminium
Soils	Mineral oils, abrasives
Cleaning requirements	Tensile strength >50 mN/m according to DIN 53 364 Result : 52 mN/m
Movement of the baskets	Static, oscillation, rotation
Cycle time	10 to 15 min
Operations before cleaning	Stamping, soldering, turning, bending, surface treatment
Operations following the cleaning	Assembly, plating, soldering, bracing

Table 1 : Production data

Decisional process

The project group has proceeded to various tests with actual components issued from production. The cleaning quality achieved is higher than in the open perchloroethylene equipment purchased in 1982. This is a proof of the Egaclean quality achieved with hydrocarbon under vacuum, as it is commonly accepted that open chlorinated solvent machines clean much better than modern encapsulated equipments using per or tri. Other processes following the cleaning operation such as plating or PVD deposition show the high quality standard of the Egaclean technology.

Moreover these solvents avoid all risks of corrosion during 2 to 4 weeks. Tests have shown that the protection against corrosion is equivalent to that achieved when adding corrosion inhibitors to a water based detergent.

Cleaning of connectors has shown the advantage of the high temperature cleaning with hydrocarbons. Pieces are cleaned first in a hydrocarbon equipment working at 40°C without vacuum followed by a vapour phase. The

components are then cleaned on the Swiss clean equipment. This results in a perfect cleaning of blind holes of 0,3 mm and 5 mm depth. These soils could not be removed before, when using chlorinated solvents.

The advantage of the Egaclean technology (patented) is in the use of a high temperature AIII solvent, because it enhances the degreasing and throwing power capability of this solvent.

The processor of the equipment allows for a change by the user of cleaning or drying time, temperature, functions of the cleaning, like ultrasonics or microfiltration. Rockwell uses basically two programmes :

Short programme :

Cleaning with the working tank, with ultrasonics and microfiltration

Vapour phase

Drying under vacuum

Cycle time : approx. 10 minutes.

Precision cleaning :

Cleaning with the working tank, with ultrasonics and microfiltration

Cleaning with the clean tank, with ultrasonics and microfiltration

Vapour phase

Drying under vacuum

Cycle time : approx. 15 minutes.

The programme will be chosen as a function of the requirements regarding cleanliness, soils and geometry of the components. Short programmes will be used for inter-operation cleaning or components of simple geometry.

Precision cleaning applies to components with blind holes, heavy soils and high cleaning requirements.

Mr.Vincent's statement about the investment:

Did you achieve the economical, qualitative and ecological requirements ?

The requested quality, productivity, costs and ecological balance are in conformity with our requirements.

What about savings ?

The forecasted costs of operation and maintenance are in line with the quotation of Egaclean.

Cycle times are shorter than with Per for small pieces. Per cycle time was 18 minutes against 13 minutes with Egaclean. Components with higher mass require a slightly longer time in hydrocarbon cleaning. It must be stated that the per equipment was not equipped with a control probe (legal requirement in Germany and Switzerland) locking the door of the machine as long as the concentration of solvent is over 1 g/ m³ in the cleaning chamber. By adding this feature, the process time would be definitely longer. The Per machine was not modified in the recent years. Globally, the productivity is comparable on both equipments.

What experiences have you made in this project ?

It is important to define precisely the requirements. The conveyor and the baskets must be chosen carefully. The automatic unloading of the baskets allows for a gain in productivity and will be installed soon.

What about the maintenance ?

The operator spends about one quarter of an hour per week for various checks (water heating, coarse filter, emptying the distillator and controlling the input to the distillator). Some controls of the level of solvent have also to be done based on the display of messages.

Half an hour is spent monthly to clean the cooling aggregate, the ultrasonic generator. Every 500 hours, we change the oil of the vacuum pump other elements of the vacuum pump are replaced on a yearly basis.

What are the differences between cleaning in hydrocarbon versus chlorinated solvent ?

We could not establish a difference in quality. The overall productivity is slightly lower than in an open Per machine. The reliability of the equipment is excellent

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Mr.Hürzeler, the operator of the Egaclean machine is enthusiastic about the machine. No odour, easy maintenance and no contact with a toxic solvent represent for him a great step forward

The process of the equipment is defined in table 2.

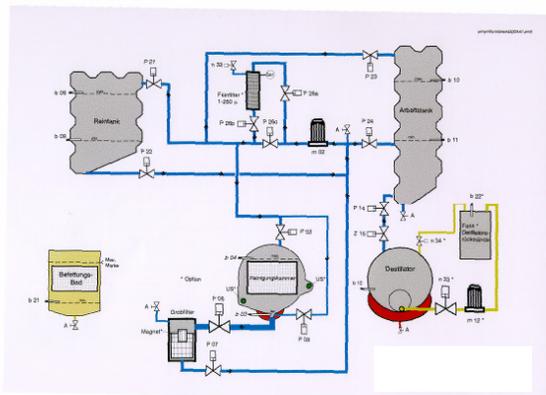
The characteristics are shown in table 3. The equipment is in conformity with CE regulations and certified by the swiss labour insurance agency (SUVA).



Dimensions LxWxH	2560x1495x2050 mm
Volume of solvent	750 litres
Distillation capacity	100 l/h
Installed power	54 kW
Basket dimensions	670x480x320 mm
Maximum weight of the basket	200 kg
Cleaning functions	Ultrasonics-injection, filtration 1 µm
Emissions	Vapours of solvent: not measurable Distillation sludge : burned in cement factories

Table 2 : Technical characteristics

Table 3 : Schematics of the flow of solvent



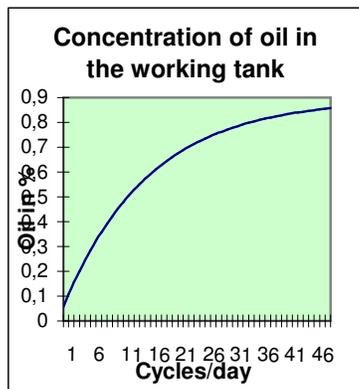
The **Egaclean** equipment may use other AIII solvents but it will generally operate with isoparaffine without an additive. This has many advantages :

- Cheaper than modified alcohols or isoparaffine with additives.
- Continuous distillation does not require any change of solvent as it is the case with chlorinated solvents in encapsulated machines (every 1-2 months). The solvent cannot become acidic.
- Easy control of the solvent's quality by visual check (colour, particles in suspension). For specific soils, we modify slightly the distillation parameters.
- Perfect separation of water, thus avoiding any risk of corrosion on the components
- No toxicity, no chlorine, fluor, sulfur or aromatics.
- Very low consumption of solvent.

Chemical formulation	Mix of isoparaffinic hydrocarbons C ₉ – C ₁₂
Boiling point	173 – 103°C
Flash point (PMCC)	>56°C
Density	0,77 kg/dm ³
Pressure of vapour (20°C)	0,1 kPa
Solubility in water	<0,1% weight
Toxicity class	no applicable
MEV	300 ppm (recommendation)

Table 4 : Isoparaffinic solvent

The distillation of the solvent is the heart of the *Egaclean* process. It guarantees a continuous regeneration and therefore a constant quality of the cleaning. The solvent is not modified chemically by the vacuum distillation and can therefore be used indefinitely. The modification of the solvent's pollution in both tanks (working and clean tank) is shown in table 5 to 7. The solvent can be polluted by oil, as shown in table 5 and 6 with a ratio of about 0,2 litres of oil per basket or approximately 6 liters of oil per day. The precision cleaning leads to a transfer of polluted solvent in the clean tank of about 1 liter. The pollution is shown after 1 day. The automatic distillation outside of the working hours makes it possible to reduce the pollution under 80 ppm of oil. The precision cleaning requires a maximum of 100 mg/m² of hydrocarbons and can be achieved with a solvent having less than 10 mg/liter, i.e 1%. The maximum pollution achieved by *Egaclean* is 25 times lower. When cleaning only with short programmes there is practically no pollution of the clean tank.



tank.

Table 5 : Quality of the solvent in the working tank

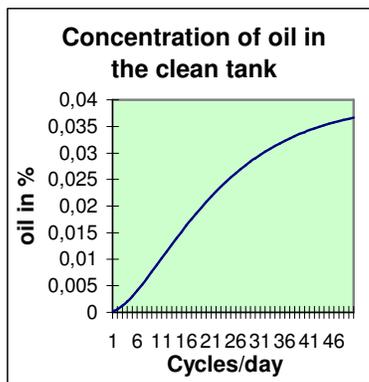


Table 6 : Quality of the solvent in the clean tank

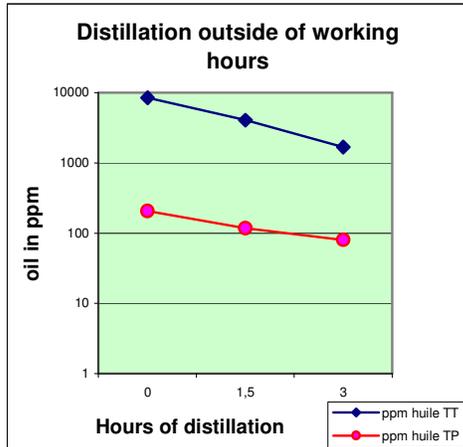


Table 7: Oil concentration

Industrial application

The equipment has been delivered in March 2001. The consumption of perchlorethylene of the old equipment was 3900 kg per year against 38 kg hydrocarbon in the *Egaclean* equipment.

Operating costs	€	€/kg
Solvent 20 l * 2 €/l	40.--	
Energy 20 kWh * 800 h * 0,04 €/kWh	640.--	
Maintenance (8 hours)	160.--	
Maintenance (spare parts)	250.--	
Total	1090.--	0,006

Table 8 : Operational costs to clean 180 tons.

The eco-balance of the Egaclean technology is very favourable, when compared to water based or chlorinated systems. Water based systems have in general a much higher energy consumption. The waste water treatment can also be very expensive, especially when aluminium or copper alloys are cleaned. In such cases, the copper or aluminium ions represents a toxic charge for the water. The chlorinated solvent tri, perchlorethylene or methylene chloride are toxic and the laws of many countries prohibit their use. The Egaclean technology has achieved a high level of acceptance by the market. The equipment is used in Sweden by turned parts manufacturers and by Sandvik Coromant. Other leaders of the industry in France, Germany and Great Britain use swiss clean. It can replace water based or chlorinated solvents in practically all cleaning applications.