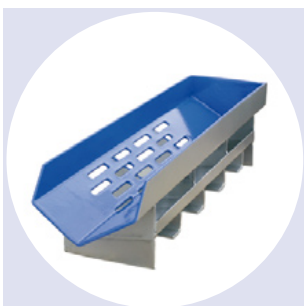


MetaLine® Series 700 - Cartridge Spray System

Edition: M700UR.3

Self-applicable, sprayable FDA conforming polyurethane (PUR)

- Company profile
- MetaLine philosophy
- Details of the "MetaLine" process
- Questions regarding processing
- Marketing target group „Feeder bowls“



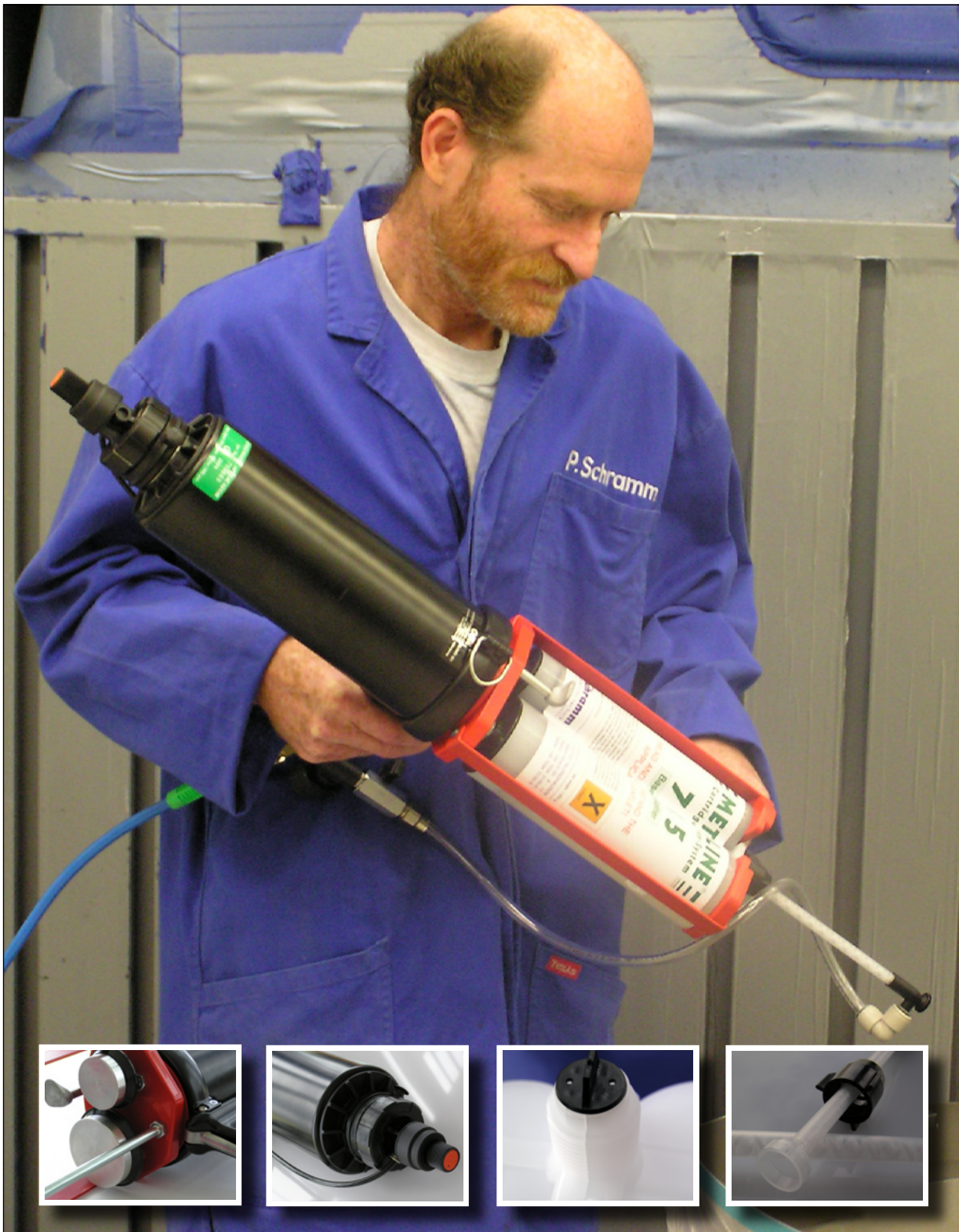
MetaLine®

protect ▪ repair ▪ save

proven coating systems since 1960

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MetaLine® Series 700 - Cartridge Spray System



Introduction

Company Profile

MetaLine Surface Protection GmbH is a family operated business in its second generation. It is located in southern Germany in the Böblingen/Stuttgart region. The company was founded in 1960 by Ing. (Grad.) Alfred Schramm. Since 1983 it has been under the management of his two sons, Dipl.-Ing. Thomas and Peter Schramm. 18 permanent employees. The export quota is approximately 60%. The company is the owner of the European trademark "**MetaLine**".

The core function is the further development, marketing and application of synthetic repair and coating materials. There are two interacting fields of activity available for this:

1. Material Sales - Consulting, sales and user training throughout Europe for self-sprayable polyurethane (PUR) based coatings

2. Coating Services - In-house coating services based on polyurethane (PUR) materials for individual pieces, prototypes or small production lots

The objective is the material and "**Application Know-How transfer**" to the industrial end user. In times of extremely short delivery deadlines, machine manufacturers (OEM) should be less dependent on time intensive "outsourced" coating work. For this purpose, FDA conforming, sprayable liquid polyurethane materials (PUR) are almost exclusively used.

MetaLine Philosophy

Various processes and materials for **elastomeric surface linings** have been available to engineers for a long time. The most common form is still the glued, screwed or vulcanized rubber lining with seams. **Self-applicable, professional** elastomeric spray-coatings are however still reserved for a few large-scale users or external coating shops. This is notwithstanding the fact that the areas of

- Surface protection
- Wear prevention
- Extending service life
- Scratch / mark protection

are increasing in technical and financial importance.

The "**MetaLine concept**" stands for permanently elastic, seamless protective coatings, **individually** adjusted to the wear conditions. These can be applied quickly, safely and permanently by the OEM. Individual adjustments mean the variation of:

- | | |
|----------------------|--------------------------|
| ■ Material hardness | approx. 60 - 95 Shore A |
| ■ Static friction | $\mu(0)$ from 0.2 to 0.6 |
| ■ Material thickness | 0.5 mm to unlimited |
| ■ Surface structure | smooth to structured |
| ■ Color | light to dark |

In its fully cured state the basic characteristics of MetaLine cannot be distinguished from the familiar sheet or molded polyurethanes!

MetaLine stands for a new method to achieve a common objective - quickly, safely and easily!

Engineering Details

MetaLine is a material based on elastomeric characteristics. Structural details from the rubber/elastomer technology should therefore be taken into consideration. Basically, flexible wear protection acts like a **shock absorber**. The destructive attack deflects into the coating, is stopped and the kinetic energy is absorbed by the coating. The absorbed energy must then directly dissipate into the substrate. If this „dissipation“ is not possible or only possible with limitations, the elastomeric coating is heated and becomes rapidly brittle. This is the case with bolted or glued wear protection plates only partially connected to the substrate.

The coating thickness and the material hardness are of significant importance in the elastomeric wear protection concept! The coating thickness acts as an **energy storing device** on one hand (analog to a shock absorber). On the other hand, the coating thickness must promote an adequately deep immersion of the impact effect without directly contacting the substrate (stamping problem). The temporary **material compression** occurring during the impact should not exceed **20 %** of the original coating thickness (Bashore Resilience).

An **expansion** and a return to the original material condition must also occur (release) after the impact. If the release is technically limited (e.g. long cycle times during gripping processes) or even impossible (e.g. during extreme permanent centrifugal forces), premature embrittlement and deterioration of the material will occur.

Service life therefore increases **exponentially** with an increasing coating thickness, provided that simultaneously the angle of load impact is greater than 45 °! Coatings which are too thin can already be penetrated and destroyed with the first impact stress.

What must be taken into account, with regard to the **impact angle** of the load, is that various impact angles result in very different wear behavior:

- 90 ° impact - minimal wear
- 40 ° - 90 ° impact - increasing angle / less wear
- 10 ° - 40 ° impact - above average wear
- 00 ° - 10 ° impact - minimum gliding and rolling wear

Compressive strengths cannot be defined in elastomeric materials due to the flow characteristics. All important material parameters are therefore bundled in the **tensile strength** (depending upon a possible prestressing of the material). Increasing material hardnesses result in increasing tensile strengths.

Chemical Description

From a chemical aspect, the MetaLine materials are aliphatic **polyether-based** polyurethanes born out of PTMEG / TDI or HMDI. The reaction occurs exclusively **exothermally** with the objective to produce a cross-linked, permanently elastic, non-porous, duroplastic material. MetaLine is **not** inclined to foaming, even at increased humidity, and as a result cannot be used to manufacture PUR foam. MetaLine is not available as thermoplastic coating powder.

Polyurethane / Polyurea

In addition to polyurethane (PUR), so-called polyurea (also polycarbamide or aminoplast) coatings are known as well. These are elastomers in which urethane groups are exchanged for urea groups. Single characteristics of a coating can therefore be objectively improved - however NOT the important totality of all physical parameters!

Polyurea systems are clearly inferior to pure original polyurethane, especially in the wear resistance in dry and wet environments. Polyurea products are primarily used in the construction industry as concrete or flat roof sealant.

Coating Thickness

The minimum coating thickness is approximately 500 μm . Thinner coats increase the risk of pin-hole development. There is no limit to the maximum coating thickness. Approx. 95% of all MetaLine coatings are applied within a coating thickness of 1 to 5 mm. The deciding factor to determine the required coating thickness is the prevention of a mechanical penetration upon impact.

Contour Accuracy / Edge Cover

MetaLine Series 700 is a **manually** operated low pressure spraying process. It is not surpassed by any other polyurethane spraying process in regards to accuracy. Accuracies of ± 0.2 mm per mm thickness can be achieved depending on the application routine. A radius development on edges or corners of approx. 1.5 (for each mm coating thickness) can not be avoided.

Surface Structures

MetaLine coatings can be applied with a surface smoothness and quality that is similar to car paint. A structured surface (similar to an orange-peel) can be produced as an alternative by a variation of cartridge temperature and the degree of the atomization. Further textured coatings (haptic coatings) are not possible due to the lack of a thixotropic material behaviour.

Coloring / Pigmentation

MetaLine Series 700 cartridges are basically **light grey** in their delivered state. It is possible to **dye** the heated base cartridge with MetaLine 930 pigment prior to the spraying process. Pigments in black, blue, green, red, light ivory, yellow and orange are available for this purpose. Pre-dyed cartridges are available in a closed quantity of 150 units. The delivery time is approximately 8 weeks. Precise RAL shades are not possible due to the large coating thicknesses.

Thermal Resistance

There are numerous single experiences with an overall thermal rating of up to + 140 °C (dry) in contrast to the nominal **continuous temperature resistance** of the prepolymer of +95 °C (dry). The medium temperature of +60 °C must not be exceeded under immersion conditions. If chemical substances are present in addition to the thermal impact, a detailed observation of the overall resistance must be performed.

Polyurethane has an extraordinarily good low temperature behaviour and is recommended for very low temperatures of down to -50 °C (**frost/defrost cycle resistance**). MetaLine is resistant to cold shock blast cleaning with, for example, nitrogen pellets ("Drice process" TM).

Chemical Resistance

The chemical resistance of MetaLine may be described as limited - analog to other soft elastomers. An intensified chemical attack occurs based on the enlarged surface (under tensile stress). As a rule of thumb there is good chemical resistance within a **pH range of 3 -11** at room temperature. No resistance is given for the effect of organic solvents or for highly concentrated acid or alkaline solutions.

Weather Resistance

The weather resistance and especially resistance against UV/IR rays can be described as limited. No special stabilizers are added for purity reasons (FDA conformity). Discolorations (**yellowing**) and surface damages (embrittlement) can be anticipated during intense exposures.

Mechanical Resistance

The most prominent characteristic of polyurethane is its especially high wear resistance as opposed to dynamic effects in form of **impact, collision, abrasion, erosion and cavitation**. Furthermore, it exhibits excellent shock elasticity with little temperature dependency, as well as a minimum of permanent deformation. Polyurethane is generally deemed to be significantly more resistant than wear protective rubber. MetaLine can be used both in dry and wet wear applications. Wet applications are preferable because of the additional cooling.

Although MetaLine does not have any hardness in a metallic sense, it has good, if not excellent, **cutting resistance**. Sharp-edged damages do NOT tend to "gap open", but close automatically at the end of the force effect.

Radiation Resistance

MetaLine has an excellent resistance to radioactive radiation (especially Gamma rays). Decontamination capabilities are present. In addition, a special MetaLine type is approved for the interior sealing of concrete structures and surfaces in **nuclear power plants** (Model Candu VI, deuterium oxide reactors).

Mechanical Processing Capabilities

MetaLine is machinable and can be finished by **grinding**. The application has to be completed with sufficient oversize. Processing to 1/10 mm is possible after the solidification. No significantly higher dimensional accuracy is possible due to the elastic displacement and/or the lateral yielding behaviour.

A rougher surface structure generally results from processing than in metallic materials, as well as greater tolerances. The allowable dimensional tolerance is +/- 0.5 mm at nominal dimensions of up to 160 mm. Basically the shaping process of a medium soft rubber is very similar. In this respect the processing parameters of rubber can be implemented.

The lower the material temperature, the higher the processing accuracy. Processing in a frozen state, however, is absolutely not recommended.

Sharp-edged hard metal tools are recommended for milling processes. The gear feed should be between 0.05 and 0.15 mm. An insufficient feed results in a rough surface finish; larger feeds lead to a grooved surface profiling. The speed may vary between 800 and 1.500 m/min. Asynchronous processing should be preferred over synchronous processing.

Electrical / Anti-static Properties

MetaLine Series 700 materials show a surface resistance of $> 10^{10}$ Ohm in their delivery condition. They are therefore considered to be **electrical insulators** according to ISO standards. The dielectric strength is > 5 KV per mm of coating thickness. MetaLine cannot be electroconductive nor anti-static equipped. Use in explosion-endangered areas is not possible!

An electrical charge build-up and flux, anti-static properties or insulation values depend to a considerable extent on the respective design as well as on the climatic and thermal conditions (such as humidity). Coatings that are to have a defined electrical behavior due to safety reasons must therefore be subjected to an **individual case test** after processing.

Thermal Weldability

MetaLine types with a Shore hardness under 80 A are conditionally thermally **weldable**. However, wherever necessary, we recommend gluing (for example, with MetaLine 910) instead of welding.

Sterilizing Capability

The **steam disinfection** (steam up to 100 °C) has been technically proven. The resistance against a **steam sterilization** (steam of 105 - 134 °C) depends on the curing time and the cycle. Positive tests are available for a cycle intensity of 1 hour per week. More intensified stress is not recommended. In every case a maximum adhesion and with it a careful blasting process of the substrate are a mandatory requirement. Open material edges must additionally be prevented or reduced to a minimum dimension.

Cleanability

Cleaning of polyurethane surfaces should take place by use of **water-based** household cleaners without coloring additives. Isopropyl alcohol and a soft cloth can be used for disinfecting. Excessive scouring and excessively long working times can lead to a loss of gloss and an increase in static friction. All forms of ethanol, solvents or gasoline are unsuitable. High-pressure steam cleaning of up to 100 bar and a temperature of up to 100 °C can be used as an alternative.

Clean Room Capability

MetaLine coatings are technically suitable for use of up to a **clean room classification 6** (100,000 particles per cft at a particle size of < 0.5 µm) according to customer tests. The testimonies are not accessible to us, since they are financed by our customers.

Noise-reducing Properties

A coating of MetaLine between two solid bodies prevents a direct contact and can therefore effect a considerable **sound deadening**. However, the resonance action of the coated object (structure-borne sound) is NOT affected by this. The reduction of already developed noise (airborne sound) is also NOT possible. Depending on the weight of the object, wall thickness, surface structure, material and the coating thickness of the polyurethane coating, a maximum **noise level reduction of up to 5 dB(A)** is realistic.

Flammability

MetaLine feeds flames and does not have any extinguishing properties, if it was ignited by an external source. It can therefore NOT be classified as flame-retardant or self-extinguishing.

Corrosion Protection Properties

MetaLine is not an electro-chemically active anti-corrosion system. Its protective function is based on a completely **atmospheric encapsulation** of the metallic component and therefore an exclusion from corrosive influences. The effect can be neutralized in the event of damages or an interruption in the encapsulation. If necessary an initial treatment with an approved electro-chemically active coating must be done on metallic structures. MetaLine is applied over this. The adhesive compatibility must be tested beforehand.

Bonding / Adhesion

MetaLine can be applied on almost all solid or elastic materials. Specifically on steel, stainless steel, aluminum, brass, polyamide, epoxy, ABS, plexiglass, wood, concrete, ceramic, rubber or polyurethane. The bond strength is up to **18 N/mm²** depending on the substrate and the surface roughness. Surfaces to be coated must be rough, dry, clean and free from grease/oil.

Test Coatings

The option exists to spray a thin **removable** coating without a permanent adhesion and without a blast cleaning treatment of the substrate. This would only have an adhesion of approx. 2 N/mm². However, it is fully functional for a limited time at light to average loads. Tests or preliminary inspections can be performed on the component without any irreversible permanent adhesion. Afterwards the coating is simply peeled out.

The entire substrate preparation and specifically the primer are relinquished for the test coatings.

Visual Wear Control

MetaLine can be applied in different colors on top of each other within one coating work. A visual **wear indicator** can be effortlessly integrated in the combination of contrast tones, such as gray/blue. Wear can be checked and residual service life can be predicted with the color gradation.

Surface Preparation

The substrate should preferably be blast cleaned with corundum (sharp-edged granules). The **roughness depth** must be at least 50 μm . Glass pearl or bead blasting are completely unsuitable. Smaller surfaces or elastic components can be prepared with roughing and grinding tools or sharp wire brushes. Objects that are not coated must be covered with an adhesive tape. Moreover, dust removal and **residue-free degreasing** must also be performed.

Nonpolar plastics such as POM, PE or PP must also be subjected to a thermal shock treatment after the mechanical pre-treatment and degreasing.

One coat of **MetaLine 900 Universal Primer** is required on metallic surfaces (brushed, rolled or air sprayed). A double coat application with **MetaLine 910 Rubber Primer** (brushed) is required on elastomeric substrates. The flash-off time is always approx. 1 hour. Afterwards the application of MetaLine polyurethane shall start immediately.

Mixing

The stoichiometrically correct mixture of the **base and solidifier** components is the prerequisite for a complete chemical reaction and a perfect material quality! Every double cartridge therefore receives a mixing and spray nozzle with 24 mixing elements in its package contents. The atomization occurs via air in a low pressure process (approx. 3-4 bar). The spray jet has a round shape with a diameter of approximately 150 mm at 300 mm spraying distance.

Processing

Initially, the cartridges are heated in a conventional microwave between 2 and 4 minutes up to a temperature of 50-70 °C. The heating process serves to **lower the viscosity** and to improve the spray pattern. This is followed by the assembly of the flow restrictor, as well as the mixing/spray nozzle.

The mixture begins automatically as soon as the trigger on the cartridge gun is activated and the components flow separately into the nozzle. The material exiting during the first 15 seconds must **NOT** be used for the coating process. The mixture and the mixing ratio must first level out.

The spraying process should not be interrupted in order to maintain the mixing parameters. If an interruption is required, the first 15 seconds of spraying after restarting must **not** be used for this purpose. Otherwise, quality losses (blistering) may occur. If the spraying process is interrupted for more than one minute, the mixing/spray nozzle, as well as the flow restrictor must always be replaced.

The entire cartridge and nozzle concept is based on a **one time use**. The plastic parts cannot be cleaned and reused for technical reasons.

The application can be completed in one work cycle in every required coating thickness. The maximum over-coating time is 15 minutes. Past that time a primer coat has to be applied.

MetaLine Series 700 can be **overcoated** with itself at any later point in time! However, a MetaLine primer has to be applied. A single application of MetaLine 900 Universal primer is sufficient for lightly loaded applications. Highly loaded applications are treated **in two coats** of MetaLine 910 rubber primer. Coatings that are older than 12 hours must also be roughened!

Processing Parameters

The surface temperature must be between +15 °C and +40 °C. The maximum humidity should not exceed 90 %. Halogen spotlights or direct sunlight lead to excessive yellowing during the application. The subject of the dew point (condensate development) must be considered. Fundamentally a thermal curing of the coated component is never required! However, after the application the component can be heated up to a maximum temperature of **60 °C** for an accelerated solidification/start-up.

Coverage / Application Speed

MetaLine Series 700 has a specific weight of approx. 1.05 in its mixed state. This results in a cartridge volume of approx. 950 cm³ at a net weight of 1,050 grams. The consumption (without spray mist losses) is **at least** 1.2 kg/m² for each mm of coating thickness.

The coating of 1 m² in a vertical line (wall) in a coating thickness of 3 mm requires approx. 15 minutes including the entire cartridge preparation (heating/spray-nozzle assembly). The deciding time advantage over the conventional hot spraying systems is the fact that **no cleaning or care** is necessary for the cartridge gun after coating.

Cure times / Start-up

The operation, if at room temperature (20°C), should be started after 24 hours at the earliest. Applications which are under permanent immersion (submersion) or are in contact with food must solidify for 5 days. Higher temperatures can reduce these times considerably. A temperature change of +/- 10 °C generally can cut the reaction time in half or double it, respectively.

Shelf Life

Partially used cartridges can be closed and stored after processing. Two, to a maximum of three uses of one cartridge is realistic. Self-colored cartridges must be used up immediately. Opened and new packages can be stored for at least 6 months in a closed state. The selected package sizes allow prompt and proper processing.

Safety At Work / Environmental Issues

MetaLine Series 700 is a **solvent-free** and therefore not a VOC relevant system. All components are rated as Xn (harmful) and NOT as T (toxic). Conventional precautions for „processing paints and lacquers“ must be adhered to during processing. The use of tight fitting work clothing, disposable protective gloves and especially a **respirator** is mandatory.

Solidified waste can be disposed of in household waste as PUR sheet cuttings (observe state laws). Completely empty cartridges consist of polypropylene and can be forwarded to material recycling.

Processing Conditions

Proper processing requires approx. 300 liters of compressed air at a pressure of 5 bar. The compressed air must be **oil-free**. Compressed air free of condensate is recommended. In addition, a separate working area with adequate **exhaust ventilation** (paint booth) and excellent lighting are required. A suspended paint mist develops during processing, which can otherwise lead to heavy contamination of the adjacent work areas. A conventional microwave (if possible, with a turntable) with a capacity of approx. 750 to 1,000 Watts is required to heat the cartridges.

The **MetaLine cartridge spray gun** is a necessary part of the system. The piston diameter and synchronism of the gun is precisely matched with the MetaLine cartridges and cannot be replaced by another gun model. The MetaLine cartridge gun does not contact the material and therefore does not require cleaning and is **free of maintenance and wear**.

Cost / Investments

The MetaLine process presents the potential to safely and professionally process spray polyurethane - **without an investment**. Especially pure, high quality, safe-to-store and **non-toxic raw materials** are required for this purpose.

These raw materials are noticeably more expensive than comparable industrial qualities. However, very specific and complicated multi-component high pressure, hot-airless spraying systems with an overall investment scope of 50,000 to 75,000 Euros are required to process industrial qualities of PUR raw materials (NON-MetaLine).

The MetaLine process, however, can be used by the customer at a general cost of **less than 900 Euros**.

In the overall cost consideration of raw material, material loss, man-hours and investment costs, MetaLine is shown to be **extremely economical** for small to average sized coating projects!

How To Start

Prototypes or first samples can initially be produced in our spray shop according to customer specifications. Each customer will receive individual **system training** on-site or at our location after testing and release. The theoretical, as well as the practical aspects of professional coating will be explained within this context.

Inquiries can be made by the customer at any time free of charge with regard to training, continued education and quality controls.

Marketing Target Groups - "Feeder bowl operators"

■ Electric motor manufacturers

Faulhaber, Kirkwood

■ Ball bearing manufacturers

FAG, INA, SKF, SNR

■ Precision lathe operations

Räuchle

■ Gasket manufacturers

Reinz, Freudenberg

■ Spring / valve manufacturers

Scherdel, Eaton, Alligator

■ Roller bearing manufacturers

Rhombus

■ Metal fastener manufacturers

Ejot, Textron, Fairchild

■ Dowel manufacturers

Fischerwerke, Möhling

■ Fastener technology

Ranit, HBS, Böllhoff

■ Toy manufacturers

Lego, Playmobil

■ Stamping plants

Jonas, Weiler

■ Fitting manufacturers

Geze, Hoppe, Dorma, Hettich, Hewi, Blum

■ Needle bearing manufacturers

Torrington

■ Window manufacturers

Roto-Frank, Weru, Velux

■ Rivet manufacturers

Gesipa

■ Pressure diecasting / injection molding

Wilden

■ Electrical engineering (plug, switches)

Busch+Jäger, Jung, Moeller

■ Sanitary accessories (faucets, accessories)

Hansa, Ideal Standard, Friedrich Grohe

■ Fittings manufacturers

Festo, Gardena

■ Suppliers of screw coatings

Gesi, Loctite

■ Cosmetics manufacturers

L'Oreal, Unilever

■ Manufacturers of high quality packaging

Schwan Stabilo

■ Door locking systems

Dom, Abus, Winkhaus, Kiekert

■ Light bulb manufacturers

Osram, Narva, Philipps

■ Scale manufacturers

Ishida, Mettler Toledo, Bizerba

■ Medicines (homeopathic, liquid)

DHU, Klosterfrau

■ Standard parts manufacturers

Ganter

■ Glassware manufacturers

Schott, Pilkington

■ Control engineering

Danfoss, Vaillant

■ Shock absorber manufacturers

Stabilus, Bilstein

■ Battery manufacturers

Duracell, Varta