Boockmann
Engineering GmbH

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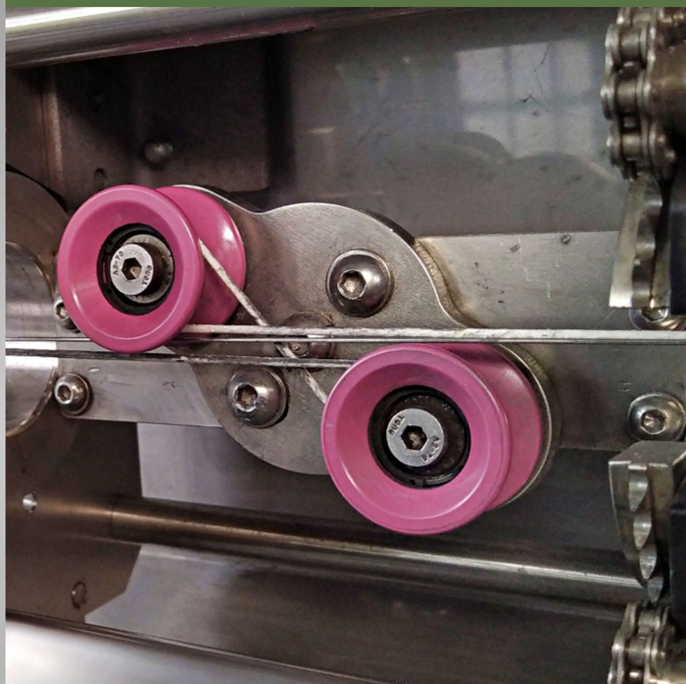

# HELICORD®

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# HELILUB®

# HELICORD®

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# I. HELICORD®

## 1 HELICORD® Principle

Following the principle of our logo, the HELICORD® principle is based on friction between a fast-moving wire and a textile cord wound around a wire, strand or insulated cable multiple times, moving rather slowly under push-pull-controlled conditions. This creates a multiple 360° contact between a constantly renewed cleaning medium (i. e. the cord) and the wire.

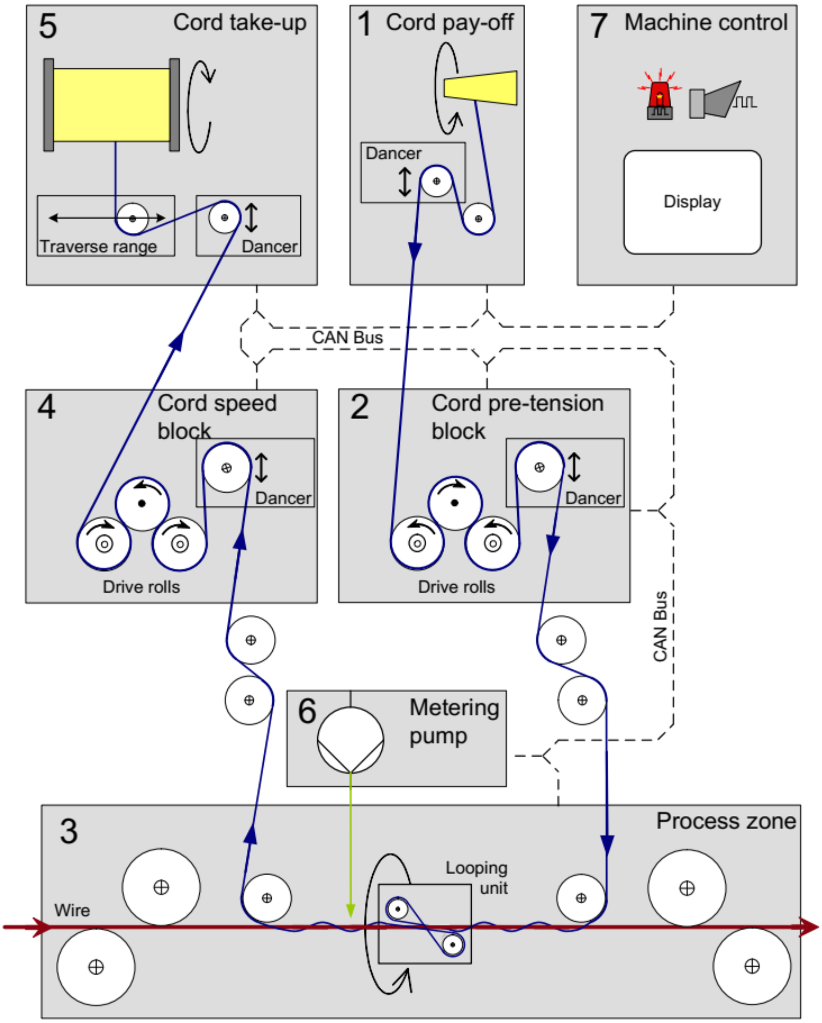



Fig. 30: Flow chart of the HELICORD® process

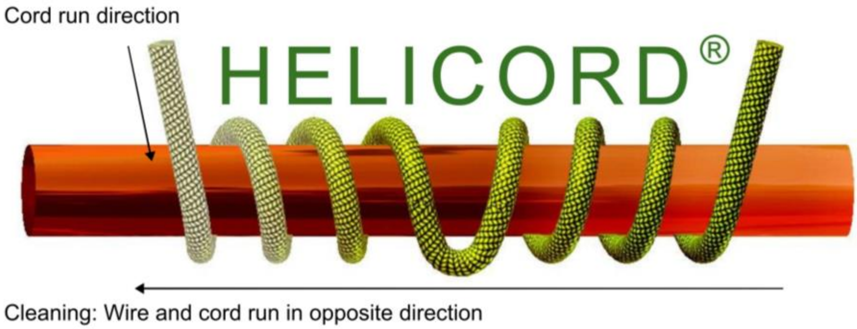
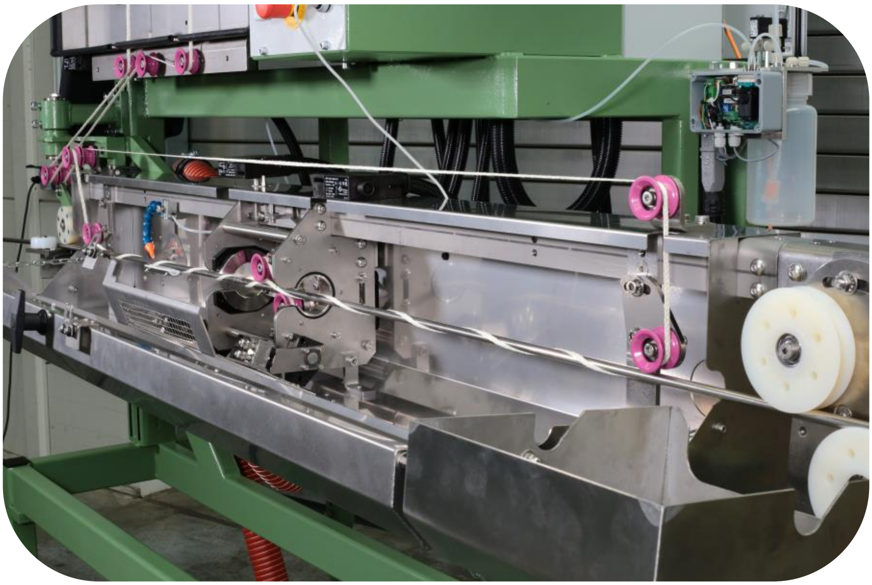



Fig. 31: Wire and cord running in opposite (top) and same (bottom) direction



Picture 1

The friction applied to the wire equals the difference between cord tensions before and after the process zone. It is determined by the cord pre-tension, i.e. the tension on the cord supply side, and the number of loops of cord around the wire when the machine is operated in fixed-number-of-loops mode; or by the cord pre-tension on the cord supply side and tension on the cord take-up side when the machine is operated in friction-controlled mode.

Friction power on the wire increases linearly with the wire speed. This means the friction energy per wire surface unit and thus also efficiency is independent of the wire speed (refer to BE1437 „Essentials of the HELICORD® Process“) and can be run at drawing speeds.
For most applications, cord and wire run in opposite directions. Cleaning and coating in the same process may be possible, depending on the exact requirements of the application in question. In coating-only applications, wire and cord may run in the same direction only on very clean or already enameled wire.
The HELICORD® process, machines and consumables were developed beginning in 1996 and protected for Boockmann GmbH by patents from 2000 on. In the following years, it became an industrial standard for a large number and variety of applications and is now in use in over 300 production lines.

## 1.1 Why the Efficiency of HELICORD® is Independent from Wire Speed (Compared to Other Technologies)

### 1. HELICORD® Treatment

The cleaning power (or friction power in the case of HELICORD®) increases proportionally to the wire speed. The friction energy applied per surface unit is calculated according to:

$$\frac{\text{Friction force} \times \text{Wire speed}}{\pi \times \text{Wire - Ø} \times \text{Wire speed}} = \frac{\text{Friction power}}{\text{Wire surface/Time}} = \frac{\text{Friction energy}}{\text{Wire surface}}$$

⇨ The friction energy applied per wire surface unit is ***independent*** from the wire speed.

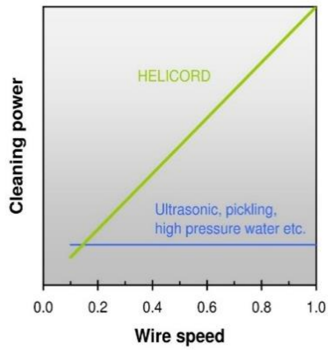



Fig. 25

⇓

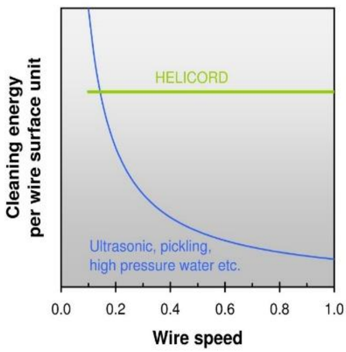



Fig. 26

### 2. Ultrasonic Treatment

The cleaning power is the applied ultrasonic power, which is proportional to the power input, but constant at different wire speeds. The ultrasonic energy applied per surface unit is calculated according to:

$$\frac{\text{Ultrasonic power}}{\pi \times \text{Wire - Ø} \times \text{Wire speed}} = \frac{\text{Ultrasonic power}}{\text{Wire surface/Time}} = \frac{\text{Ultrasonic energy}}{\text{Wire surface}}$$

⇨ The ultrasonic energy applied per wire surface unit is **inversely proportional** to the wire speed.

Remark: In many applications, ultrasonic energy can only affect the wire surface partially, since most of it is absorbed by floating particles before.

### 3. Chemical Treatment (Pickling/Etching)

The chemically induced abrasion of material per time unit (understood as cleaning power) is independent from the wire speed. Thus the degree of cleaning of a specific wire length is determined by its exposure time in the bath.

⇨ The amount of material eroded per wire surface unit is **inversely proportional** to the wire speed.

### 4. High Pressure Water Cleaning

The available cleaning power of the water jets is constant at different wire speeds.

⇨ The cleaning energy per wire surface unit is **inversely proportional** to the wire speed.

## 1.2 Why the Efficiency of HELICORD® is Independent of Time (Compared to Other Technologies)

### 1. HELICORD® Treatment

Because of the constant movement of the cord, the wire is always in contact with fresh, clean cord at the end of the process zone.

⇨ The efficiency of the HELICORD® process is ***independent*** of the time.

### 2. Ultrasonic Treatment

The cleaning liquid is constantly contaminated with soluble and solid residues removed from the wire surface.

In order to avoid useless absorption of ultrasonic energy, floating particles have to be filtered out continously.

Despite such a costly filtration, the intensity of cleaning constantly decreases due to the accumulation of (soluble) pollutants, until the liquid is exchanged.

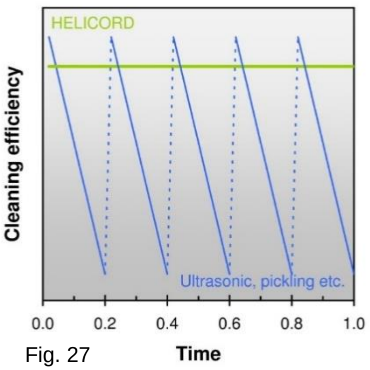


Fig. 27

⇨ The efficiency of ultrasonic cleaning shows a **saw-tooth**-like behaviour when plotted against time.

### 3. Chemical Treatment (Pickling)

The chemical bath is constantly polluted with non-reactive, solid residues as well as it is used up increasingly by the chemical reaction with the wire surface. Accordingly, the intensity of cleaning constantly decreases until the chemical bath is exchanged.

⇨ The efficiency of chemical cleaning shows a **saw-tooth**-like behaviour.

### 4. High Pressure Water Cleaning

The circulating water is constantly contaminated with soluble and solid residues removed from the wire surface. Despite costly filtration, the intensity of cleaning constantly decreases due to the accumulation of pollutants until the liquid is exchanged.

⇨ The efficiency of high pressure water cleaning shows a **saw-tooth**-like behaviour.

Remark to points 2 – 4: The dependence of time of the efficiency of these processes could be moderated by continuous addition of cleaning liquid following a counterflow principle. That would cause high costs and therefore did not assert itself in industrial practice.

## 1.3 Essentials of Abrasive Cleaning

Abrasive cleaning considerably reduces the amount of hydrocarbons on the wire surface originating mainly from drawing soaps. Also loosely adhering particles are removed.

Abrasive cleaning prior to further wire processing requires a subsequent cleaning step in order to remove especially residual abrasive grains and other pollutants.

For abrasive two-step treatment of wire, a HELICORD® machine NB58 has to be used as follows:

In the first step, an abrasive cord (see also „Abrasive Cord Overview“, BE1524) removes loosely adhering particles and solid drawing lubricant residuals.

In the second step, a dry braided cord (see also “Overview of Dry Cords”, BE1414) and possibly metered  small quantities of cleaning liquid is used for final cleaning.

The second step can also be used to apply a wire finish: Either an impregnated cord (see “HELICORD® - W Overview of Cords”, BE1518) and solvent, or a dry cord (see above mentioned BE1414) with metering of liquid finishing material is used.

Fig. 28:Two-step HELICORD® machine NB58

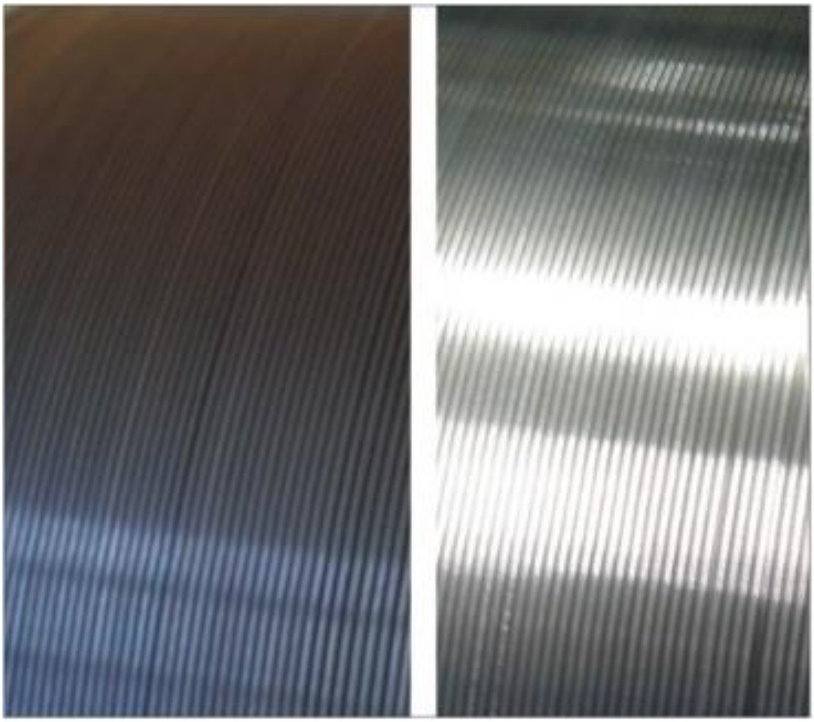


Fig. 29: Wire appearance after two-step HELICORD® treatment

## Application Range

- Solid wire with heavy contamination with residuals from drawing soaps
- Preparation of wire for copper-coating
- Simultaneous cleaning and finish application to solid stainless steel wire
- Simultaneous cleaning and finish application to mild steel welding wire

# 2 Applications of HELICORD®

## 2.1 HELICORD® in the Welding Wire Industry

### 2.1.1 Reasons for Using HELICORD® in the Welding Wire Industry

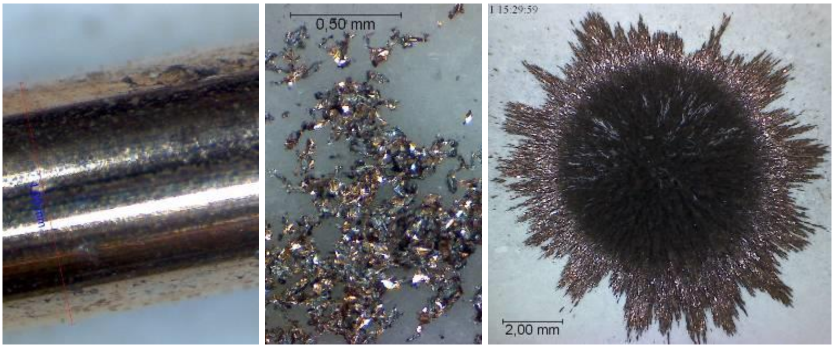
Welding wire finishing is a type of wire surface treatment developed specifically to improve welding properties and performance of welding wire.
The most important factors are cleaning and application of active components. Coatings can improve factors such as plasma stability, feedability, corrosion resistance and ignition behavior.
The HELICORD® process provides a very advanced method of welding wire finishing. The unique advantage of this technology is the possibility of cleaning and applying a coating in one process step.

In the welding wire industry, the following applications are most common:

- Wiping off excess drawing lubricants or feed-aid media
- Removing excess drawing oil from Al-wire
- Abrasive treatment for removing large quantities of Ca-stearates, especially from filled wire
- Removing drawing lubricant residues before copper-plating
- Application of oil as feed-aid on solid wire
- Application of anti-corrosive waxes on mild steel filled wire
- Application of feed-aid dispersions containing e.g. graphite or molybdenum disulfide (and similar)

### 2.1.2 Types of Welding Wire and Their Particular Properties and Improvement Possibilities by HELICORD® Surface Treatment

Removal of particles (Fig. 32) and surface contaminants, as well as achieving specific, consistent sliding properties are most critical for any type of welding wire surface finishing. Particles and drawing lubricant residues will block the liner or contact tip of a welding gun, causing plasma interruptions or micro-fusing with wire stops, finally resulting in interruptions in welding. In order to avoid redundancy, the following table only presents the particular properties and requirements specific to each type of welding wire, and the appropriate, recommended HELICORD® processes.



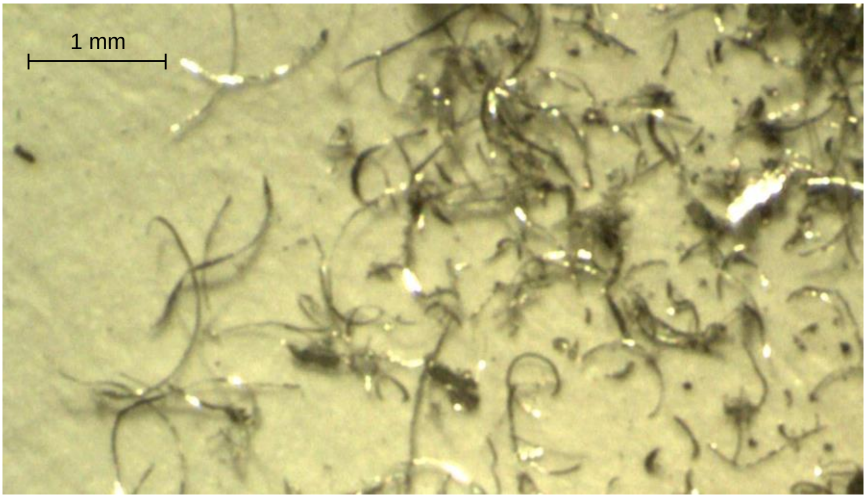

a. b. c.

Fig. 32: Particles (b) taken off a commercial copper-coated wire G4Si1 (a) using a polyamide-based cord (a). About 750 g of particles were taken off 800 m of wire. The copper-colored particles are magnetic (c), and thus must be copper-coated ferrous particles. Apparently the wire was not cleaned sufficiently before copper coating.

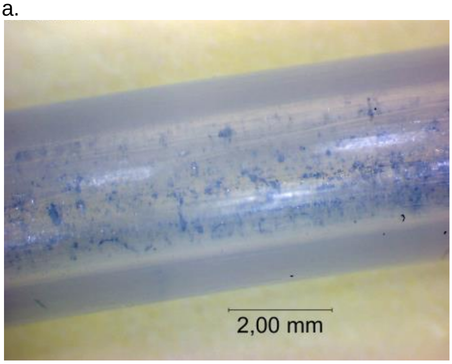
| Type of Welding Wire | Typical Properties and Most Common Issues | Solution | Recommended Treatment |
|---|---|---|---|
| copper-coated, steel (low- or non-alloyed, cored with welded seam or solid) | only occasional contact issues due to too many loosely adherent particles | removal of particles by liquid-supported cleaning | 1-step HELICORD® treatment for removal of particles and simultaneous liquid-supported application of a wax-type finish containing corrosion inhibitors suitable for ferrous and non-ferrous metals and plasma stabilizer |
| | feeding issues in long liners | liquid-supported extractive application of wax-type lubricants | |
| | corrodes easily | liquid-supported extractive application of corrosion inhibitors suitable for ferrous and non-ferrous metals, supported by application of wax as a lubricant | |
| | arc instability | liquid-supported extractive application of high potassium finish for plasma stabilization | |
| | feeding issues in the contact tip caused by particles | removal of particles by liquid-supported cleaning or/and coating with anti-wear component | |

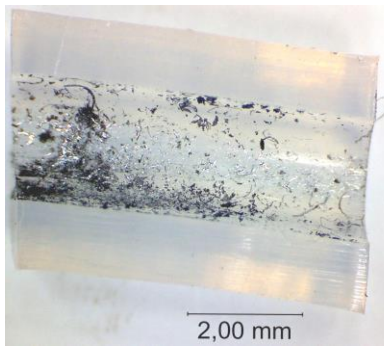
| Type of Welding Wire | Typical Properties and Most Common Issues | Solution | Recommended Treatment |
|---|---|---|---|
| copper-free, steel (low- or non-alloyed, cored with welded seam or solid) | high tendency to fuse in the contact tip | liquid-supported extractive application of a finish acting as a separating agent (NB82C300) | 2-step HELICORD® treatment for (possibly abrasive) removal of drawing lubricant residues and particles, and liquid-supported extractive application of a wax-based lubricant containing corrosion inhibitors for ferrous metals, plasma stabilizer and a separating agent (NB82C300) |
| | improvement of sliding properties needed | liquid-supported extractive application of wax-type lubricants after abrasive pre-treatment | |
| | contact issues due to drawing lubricant residues | dry removal of drawing lubricant residues by abrasive pre-treatment | |
| | corrodes easily | liquid-supported extractive application of corrosion inhibitors | |
| stainless steel, solid (high alloy or Ni-based) | bad quality of the weld seam caused by drawing lubricant residues | 2-step HELICORD® treatment:<br>step 1: abrasive pre-treatment<br>step 2: liquid-supported extractive application of lubricant and simultaneous removal of drawing lubricant residues (NB80Z000) | |
| cored wire with open (not welded) butt or overlap seam (high-, low- or non-alloyed) | sharp edge of the seam causes feeding issues and contact tip erosion | lubrication after abrasive pre-treatment | 2-step HELICORD® treatment for abrasive cleaning, and liquid-supported extractive application of lubricant (NB82C300) |
| | feeding issues in very long liners | | |
| | corrodes easily | application of lubricant and corrosion inhibitors after abrasive pre-treatment | |
| | diffusible hydrogen | 2-step HELICORD® treatment consisting of abrasive pre-treatment and liquid-supported cleaning | |
| aluminum, solid | porosity caused by high amount of hydrocarbons | 1-step HELICORD® treatment for particle removal and application of anti-wear agent after washing | |
| | cold welding between wire layers on the spool | | |
| | feeding issues caused by self-supported particle formation in the liner | | |
| special alloys, e.g. Zn spray wire or Cu alloys, solid | feeding issues in the contact tip caused by particles | 1-step HELICORD® treatment for particle removal and application of corrosion inhibitors and anti-wear agents | |

Table 8




a.




b. c.

Fig. 33: Aluminum welding wire: Long particles taken off a Ø 0.9 mm aluminum wire (a), that had been shaved before final drawing. Particles (b), (c) stuck in a PTFE liner that had been cleaned on the inside.These particles create more particles in an avalanche effect, blocking the liner and contact tip.

### 2.1.3 Alternative Processes

In the following chapters, the above-mentioned HELICORD® processes for improvement of welding wire properties will be explained in detail and remarks about industrial applications will be made: Chapter 2.1.3.1 will focus on cleaning processes, chapter 2.1.3.2 will focus on application of active components onto the wire surface.

a.


b.


Fig. 34: Braided round (a) and flat (b) cord wound around a Ø 1.2 mm wire.

#### 2.1.3.1 Cleaning Processes

##### 2.1.3.1.1 1-step Dry Cleaning

Using an NB57 HELICORD® machine (see chapter 4) and round (NB65…, NB67…) or flat (NB87…, NB88…) braided cords (see Fig. 34), liquid contaminants, e.g. drawing emulsions or oils, and loose metal particles can be wiped off the wire surface. It is also possible to wipe off an excess of solid drawing lubricant residues to a certain extent or, using suitable process parameters, to distribute them more consistently on the surface.

##### 2.1.3.1.2 1-step Liquid-Supported Cleaning

Adding small amounts (a few ml/min) of cleaning liquids (water with tenside or organic solvents) onto cord and wire, cleaning of the wire surface can be intensified. On rough surfaces, the use of liquids also increases surface penetration.

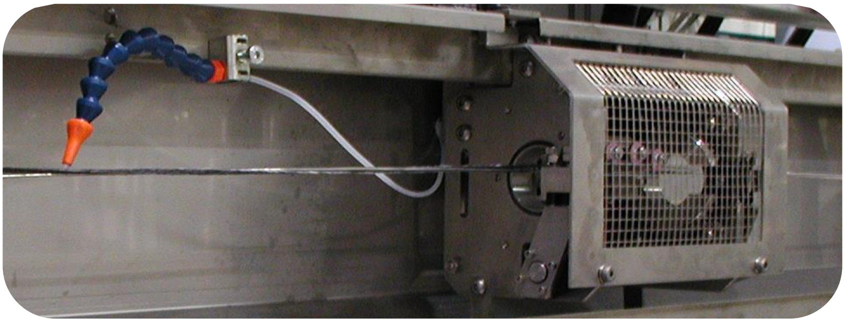


Fig. 35: Metering outlet in a HELICORD® process zone (including the looping unit)

#### 2.1.3.1.3 Dry Abrasive Cleaning

Cords impregnated with abrasive particles ($Al_2O_3$), designed to grind or polish the wire surface, have been proven successful in removing adherent particles or large amounts of dry drawing lubricant residues coming off as powder, and smoothing the edge of the open seam of cored wire. Round and flat abrasive cords (Fig. 36) impregnated with polishing grains of different grit sizes are available. Setting the optimum value of friction force is another critical factor.

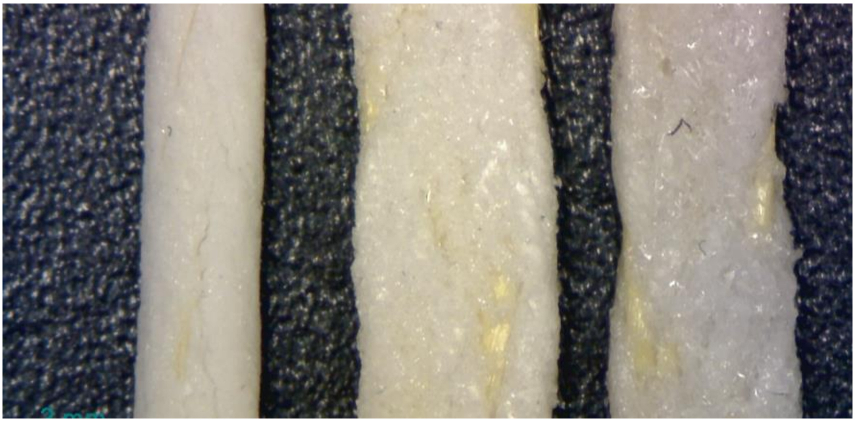


Fig. 36: Viscose-aramide-based abrasive cords with $Al_2O_3$ particles: round with small grains (left), flat with medium-sized grains (middle) and large grains (right)

In a second process step, residual contaminants and polishing particles remaining on the wire surface after the first process step can be wiped off, dry or supported by use of a cleaning liquid.
For abrasive cleaning, typically a 2-step HELICORD® machine NB58 is used (see chapter 4).

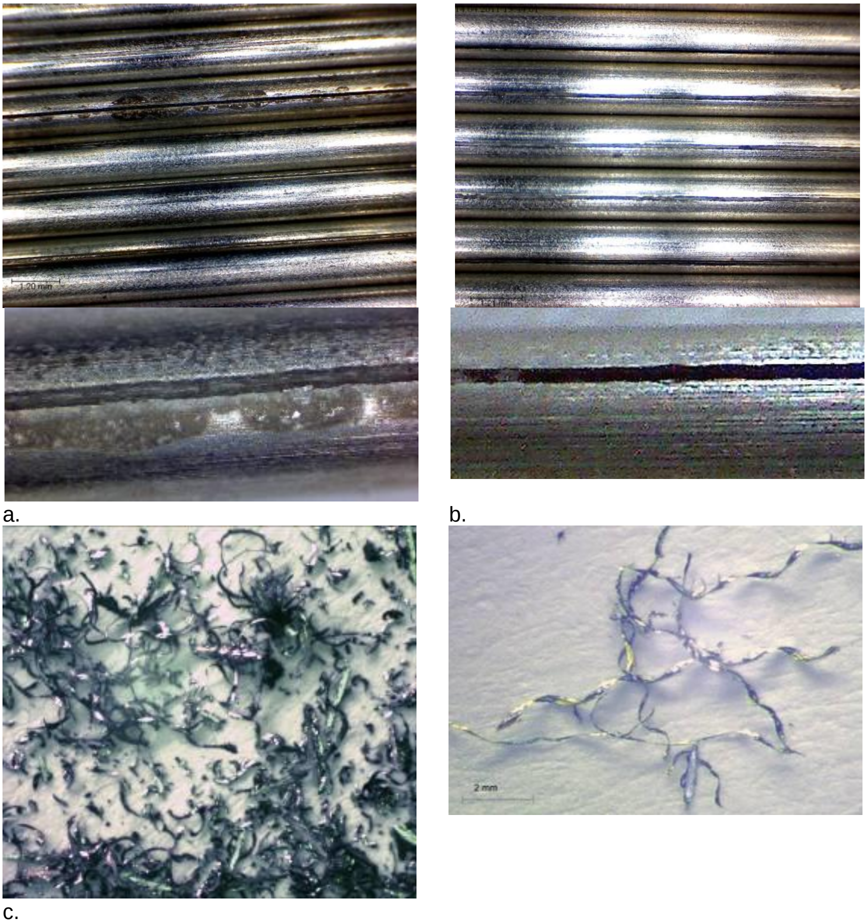



Fig. 37: Open seam of a 309 LT stainless steel FCW, Ø 1.2 mm in different magnifications before (a) and smoothed after (b) abrasive cleaning. Long spiral particles (c) collected during abrasive cleaning in different magnifications.

### 2.1.3.1.4 <u>Liquid-Supported Abrasive Cleaning</u>

In order to avoid clogging the cord when cleaning abrasively, water-based or organic cleaning liquids could be added to the process, if need be at an excess rate.  Suitable and sufficiently durable cords are still being developed.

As described in chapter 2.1.3.1.3, residual contaminants and polishing grains must be wiped off the wire surface in the second process zone of a HELICORD® machine NB58 (see chapter 4).

### 2.1.3.2 Application Processes

#### 2.1.3.2.1 Application of Liquid Finishing Materials

Consistent application of liquid finishing materials, such as oils, is possible using a pump to precisely meter said liquids onto a dry cord in the process zone of a HELICORD® machine. The metering amount is controlled proportionally to the wire speed. Cord and wire are preferably run in opposite directions in order not only to coat the wire, but also to clean it more efficiently at the same time. Setting a fixed number of loops (instead of running the machine in friction-controlled mode) for this application will keep the loops from „wandering“ and thus ensures that their position will not change in relation to the position of the metering outlet.

#### 2.1.3.2.2 Extractive Application Processes

A clear advantage of solid finishing materials (waxes or film-forming materials) is their better adherence compared to oil-based or other liquid finishing materials which is why, even at high wire speeds, they will not spray off at wire guide pulleys due to centrifugal forces. Once applied, their distribution on the wire surface is consistent over time, whereas liquid finishing materials have a tendency to flow even on wire spools, due to centrifugal forces on the winder, or due to gravitation and capillarity during storage. Also, dust will stick to liquid-coated surfaces much better than to surfaces with a solid finish.

a. b.

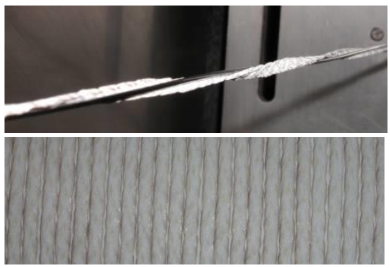


Fig. 38: Pre-impregnated cord for application of PTFE: in the process zone, wrapped around the wire (a), and on a supply spool(b). Extraction can be improved by using solvent.

The following chapters will give details on how to apply soluble, dispersible or meltable solid finishing materials to the wire surface out of pre-impregnated cords.

##### 2.1.3.2.2.1 Solvent-supported Extractive Application

Polar or non-polar solvents, or mixtures thereof, can be used for extraction of finishing materials out of pre-impregnated cords, similar as for liquid-supported cleaning (chapter 2.1.3.1.2). The amount of liquid used must be

sufficient to dissolve a sufficient amount of finishing components to be applied to the wire out of the cord. However, as the friction heat occurring in the process improves solubility of organic finishing materials, the amount of liquid required is still relatively small (as compared to other processes using solvents in the wire industry).
Any solvent should evaporate mostly before the first wire guide pulley after the wire leaves the process zone in order to prevent the finishing material from spraying off at the pulley. The amount of solvent used must be accordingly low, or the evaporation rate sufficiently high.
The HELICORD® machine is operated with a fixed number of loops and with wire and cord running in opposite directions for the same reasons as in chapter 2.1.3.2.1.
When using flammable solvents, the process zone and main unit, which holds the used cord on the take-up spool, must be evacuated sufficiently under controlled conditions in order to avoid formation of flammable vapor concentration.

#### 2.1.3.2.2.2 Heat-supported Extractive Application

In order to avoid using organic solvents, it is possible to use cords pre-impregnated with meltable finishing materials. In a heated process zone, the finishing material is melted on the cord and applied to the wire surface in a liquid state. It should solidify before the first wire guide pulley after the wire leaves the process zone in order to prevent the finishing material from spraying off at the pulley.
Wire and cord can run in the same or opposite directions. Running wire and cord in opposite directions in addition to applying of a welding wire finishing material also provides more reliable removal of loosely adherent particles at the same time. The extraction rate, however, will be lower than when running cord and wire in the same direction.

#### 2.1.3.2.2.3 Extraction by Friction

Extraction just by friction between the wire and cord is possible. The degree of extraction, however, is lower than of liquid- or heat-supported extraction. It usually results in a very low variance in the amount of finishing material applied.
The friction force is most critical for this application. It is determined by the difference between the cord tension and pre-tension and can be set within the limitations of the machine.

### 2.1.3.3 Possible Setups

| Basic Model | Specific Equipment | Application/Remarks |
|---|---|---|
| NB57 / NB55<br>(1-step HELICORD® machine = one process zone) | - fixed process zone<br>- length of process zone 1 or 1.6 m<br>- total length of machine in-line (depending on length of the process zone) ca. 1.5 or 2.1 m | - Finishing (liquid or wax- / polymer-based finishing materials suitable for solvent-supported extraction) and simultaneous particle removal, if applicable |
| | - traversing process zone, can be connected to the traverse of a spooler (for narrow places of installation)<br>- length of process zone 1 or 1.6 m<br>- total length of machine (depending on length of the process zone) ca. 1.4 or 1.9 m | |
| | - aluminum machine frame for installation on a drum coiler or similar<br>- fixed process zone<br>- length of process zone 1.6 m<br>- 2nd operating panel (optional)<br>- total length of machine in-line 2.1 m | - Finishing (liquid or wax-based finishing materials suitable for solvent-supported extraction) and simultaneous particle removal, if applicable<br>- fits Lämneå Bruk drum spooler |
| NB58<br>(2-step HELICORD® machine = two process zones) | - machine frame with two successive process zones<br>- 2nd process zone fixed<br>- length of 2nd process zone 1 or 1.6 m<br>- total length of machine (depending on length of the 2nd process zone) ca. 3.3 or 3.9 m | - Abrasive wire surface treatment for removal of particles and solid drawing lubricant residues, and to smoothen the edge of cored wire with open seam in the 1st process zone<br>- Final cleaning, dry or liquid-supported, and possibly simultaneous application of liquid or wax- / polymer-based finishing materials suitable for solvent-supported extraction |
| | - machine frame with two successive process zones<br>- 2nd process zone traversing, can be connected to the traverse of a spooler (for narrow places of installation)<br>- length of 2nd process zone 1 or 1.6 m<br>- total length of machine (depending on length of the 2nd process zone) ca. 3.3 or 3.9 m | |
| | - machine frame with two process zones atop each other (for limited space, suitable only for smaller wire diameters)<br>- 2nd process zone fixed<br>- length of process zone 1.6 m each<br>- total length of machine ca. 2.6 m | |

| Basic Model | Specific Equipment | Application/Remarks |
|---|---|---|
| | - machine frame with two atop each other process zones (for limited space, suitable only for smaller wire diameters)<br>- 2nd process zone traversing, can be connected to the traverse of a spooler (for limited space availability of installation)<br>- length of process zone 1.6 m each<br>- total length of machine ca. 2.6 m | |

Table 9: Overview of HELICORD® machines

#### 2.1.3.4 Applications in the Industry

The following table presents some examples of welding wire finishing applications, giving information on the type of wire, wire diameter, wire speed and the most important HELICORD® parameters and process data.

List of abbreviations:
$D_D$ = wire diameter in [mm]
$v_D$ = wire speed in [m/s]
$F_V$ = cord pre-tension in [N]
$F_C$ = cord tension in [N]
$v_C$ = cord speed in [cm/min]
M = metering amount of liquid („drip rate“) in ml/min

| Application | Parameter Zone 1 | Parameter Zone 2 |
|---|---|---|
| 1-step liquid finish (oil) application on copper-coated welding wire before the precision spooler<br>$D_D$ = 1.0 – 1.4 mm,<br>$v_D$ = 25 - 35 m/s | cord: NB87V002<br>$v_C$ = 10 cm/min<br>customer-specific oil<br>M = 1 ml/m²<br>wire and cord run in opposite directions | |
| 1-step finish application on copper-free welding wire<br>$D_D$ = 1.2 mm, $v_D$ = 20 m/s | cord: NB82C301 (ke59/126)<br>$v_C$ = 10 cm/min<br>customer-specific oil<br>M = 1 ml/m²<br>wire and cord run in opposite directions | |
| 2-step cleaning, removing dry drawing lubricants and particles from solid stainless steel welding wire<br>$D_D$ = 1.2 mm,<br>$v_D$ = 10 -15 m/s | cord: NB77V002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | cord: NB88V002<br>$v_C$ = 10 cm/min<br>customer-specific pickling liquid M = 1 ml/m²<br>wire and cord run in opposite directions |

| Application | Parameter Zone 1 | Parameter Zone 2 |
|---|---|---|
| 2-step finishing treatment on solid stainless steel welding wire: abrasive removal of dry drawing lubricants and particles; application of low hydrocarbon finish<br>$D_D$ = 0.8 – 1.6 mm, | cord: NB78F001 or NB78F002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | cord: NB38V001<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions |
| finish application on Al-welding wire<br>$D_D$ = 0.8 – 1.6 mm,<br>$v_D$ = 10 m/s | cord: NB37F006<br>Isopar/Isobutanol 1:1<br>M = 1 ml/m$^2$<br>wire and cord run in opposite directions | |
| finish application and simultaneous removal of particles from zinc spray wire<br>$D_D$ = 2.0 – 2.5 mm,<br>$v_D$ = 5.5 m/s | cord: NB37F004<br>$v_C$ = 10 cm/min<br>NB10H008, M = 1 ml/m$^2$<br>wire and cord run in opposite directions | |
| 1-step egalization of drawing lubricants (graphite, $MoS_2$) on cored wire<br>$D_D$ = 1.0 – 1.6 mm,<br>$v_D$ = 20 m/s | cord: NB67V014<br>$v_C$ = 10 cm/min<br>Isopar/Isobutanol 1:1<br>M = 1 ml/m$^2$<br>wire and cord run in opposite directions | |
| 2-step finishing treatment on mild steel cored wire with open seam: abrasive removal of dry drawing lubricants; application of molten wax<br>$D_D$ = 1.2 mm,<br>$v_D$ = 10 -15 m/s | cord: NB78F002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | cord: NB67V002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions |
| 1-step removal of dry drawing lubricants and particles before ultrasonic cleaning from solid welding wire<br>$D_D$ = 1.2 mm,<br>$v_D$ = 20 m/s | cord: NB87V002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | |
| 2-step removal of Na stearates 7 dry drawing lubricant and particles from solid mild steel welding wire<br>$D_D$ = 1.2 mm,<br>$v_D$ = 10 -15 m/s | cord: NB77V001<br>$F_V$ = 20 N, $F_C$ = 140 N<br>$v_C$ = 30 cm/min<br>wire and cord run in opposite directions | cord: NB67V002<br>$F_V$ = 20 N, $F_C$ = 60 N<br>$v_C$ = 40 cm/min<br>wire and cord run in opposite directions |
| Finish application and simultaneous removal of particles from Ni-based welding wire<br>$D_D$ = 1.0 – 1.6 mm,<br>$v_D$ = 10 m/s | cord: NB88V001<br>$v_C$ = 10 cm/min<br>customer-specific finishing liquid, wire and cord run in opposite directions | |

| Application | Parameter Zone 1 | Parameter Zone 2 |
|---|---|---|
| 2-step finishing treatment on solid stainless steel welding wire: abrasive removal of dry drawing lubricants and particles; PTFE application<br>$D_D$ = 1.2 mm,<br>$v_D$ = 10 -15 m/s | cord: NB78F002<br>$F_V$ = 20 N, $F_C$ = 110 N<br>$v_C$ = 20 cm/min<br>wire and cord run in opposite directions | cord: NB38F001<br>$F_V$ = 10 N, $F_C$ = 65 N<br>$v_C$ = 30 cm/min<br>customer-specific finishing liquid, wire and cord run in opposite directions |
| 2-step removal of dry drawing lubricants and particles from solid stainless steel welding wire<br>$D_D$ = 1.6 mm,<br>$v_D$ = 30 m/s | cord: NB77V002<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | cord: NB88V001<br>$v_C$ = 10 cm/min<br>customer-specific pickling liquid, M = 1 ml/m$^2$<br>wire and cord run in opposite directions |
| 1-step finish application and simultaneous removal of particles from stainless steel welding wire<br>$D_D$ = 1.0 mm,<br>$v_D$ = 20 m/s | cord: NB38F001<br>$v_C$ = 10 cm/min<br>wire and cord run in opposite directions | |
| 1-step abrasive cleaning of stainless steel cored wire E308 LT-1<br>$D_D$ = 1.2 mm,<br>$v_D$ = 5 m/s | cord: NB78F002<br>$F_V$ = 20 N, $F_C$ = 90 N<br>$v_C$ = 20 cm/min<br>wire and cord run in opposite directions | |
| 1-step finish application and simultaneous removal of particles from stainless steel welding wire<br>$D_D$ = 1.2 mm,<br>$v_D$ = 25 m/s | cord: NB38F001<br>$F_V$ = 20 N, $F_C$ = 90 N<br>$v_C$ = 30 cm/min<br>wire and cord run in opposite directions | |
| 2-step finishing treatment on solid copper-free welding wire: abrasive removal of dry drawing lubricants and particles; PTFE application<br>$D_D$ = 1.2 mm,<br>$v_D$ = 10 -15 m/s | cord: NB78F002<br>wire and cord run in opposite directions | cord: NB37F004<br>wire and cord run in opposite directions |

Table 10

## 2.2 HELICORD® in the Cable Industry

In the cable industry, the following applications are most common:

- Removal of copper dust after rod break-down, especially before resistance annealer in order to prevent contamination of all following steps by copper dust
- Cleaning of conductors before extruder head from dust and spikes for solid wire and strands up to Ø 25 mm e. g. for very thin insulation, high frequency cables, antenna cables, communication cable, high voltage submarine cables
- Cleaning of plastic-insulated conductors before second insulation layer cover for winding wire of submarine pumps, e.g. on oil platforms
- Cleaning of copper tubes before extruder for submarine fiber optics
- Application of very thin PTFE-coating on insulated conductors as anti-adhesive and release agent (replacement of talcum powder) (see following chapters for details)
- Application of insulation-compatible waxes on bare strands for adjustment of insulation adhesion
- Cleaning of conductors before enameling
- Cleaning of superconductors as preparation for enameling or plating
- Removing lubricant from an enameled superconductor
- Cleaning of protection steel tube for fiber optics
- Removal of faulty prints from cable surface (see following chapters for details)
- Removal of drawing lubricants from superconductors before annealing
- Cleaning of superconductor surface after intermediate annealing
- Removing oily particles from braided shielding
- Coating with primer for improved adhesion

### 2.2.1 Conductor and Cable Cleaning

Both drawing lubricant residues and metal particles from drawing and stranding can severely disturb the extrusion process in cable production, and have a highly negative impact on performance of the finished product in the field. Therefore most applications in the cable industry are cleaning applications.

As most bare wire is made of copper or copper alloys and other soft metals, cleaning usually requires a one-step process, using only soft dry cords. Abrasive cleaning as part of a two-step process is necessary only very rarely in this part of the wire industry, mostly on rather specific alloys.

If cleaning is required in order to improve an extrusion process, it should be done directly before the extruder in order to avoid secondary contamination or formation of new particles in spooling and re-spooling. In the case of stranded wire, this is particularly critical, as every pulley touching and thus putting pressure on the strand will squeeze out contaminants from the inside

of the strand towards the surface again, recontaminating the surface after cleaning.
On single wire, cleaning can be facilitated by using solvents to help dissolve lubricant residues and lower adhesion of particles to the wire surface. Solvents used include various types of organic solvents, but also tensides in water-based solutions. On stranded wire, solvents should not be used at all, as they will creep inside the strand and make contaminants „wander" from the inside towards the surface within very short time, even if used right before the extruder, and disturb the extrusion process.

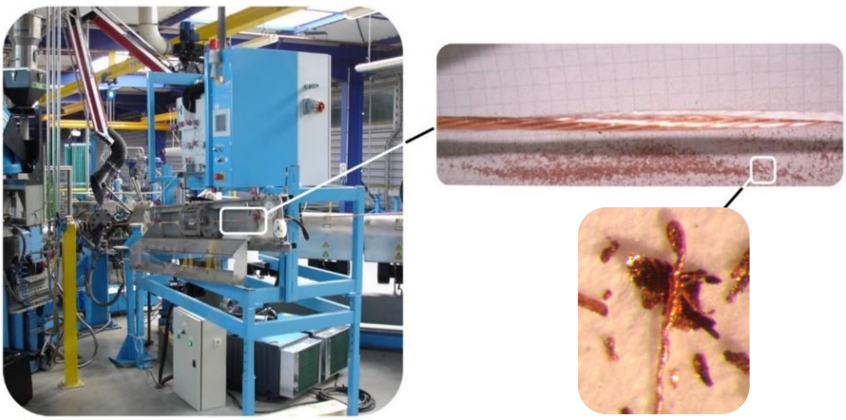


Fig. 39

### 2.2.2 Misprint Removal

Misprints on cable jackets may occur on one to five per mill of the cable production of any given producer. Discarding of these finished products would cause considerable economical loss as well as other expenses for scrapping and recycling. Therefore, removing the misprint and reprinting the cable jacket usually pays back.

Up to now, such misprints were removed semi-automatically at best, but in many cases manually at accordingly high labor cost. Additionally, the direct contact of operators with volatile organic solvents, necessary for removing the printing ink, should be avoided for health and hazard reasons.

Removal of misprints can be better achieved by using HELICORD®-technology:

- Multiple 360° contact between cable and cleaning media
- Effective cleaning by cable and cord running in opposite directions, and continually refreshed cleaning media
- Adjustable liquid metering at up to five outlets in the process zone
- No Permanent supervision by operator required in normal operation
- Process zone and housing of the basic unit prepared for connection of exhaust ventilation (interlock of liquid metering with exhaust ventilation is necessary)
- Cable speed up to 70 m/min, limited only by the required time of exposure to the solvent
- Health and hazard protection of the machine operator

Cables up to diameters of about 10 mm can be treated in a process zone of 1.6 m length, cables up to 25 mm in a process zone of 3 m length.

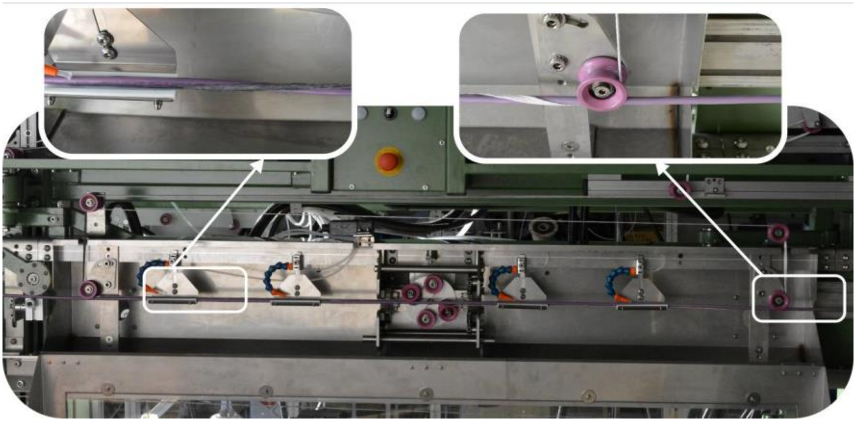


Fig. 42: HELICORD® machine NB57 with special looping unit and multiple liquid metering outlets for removal of misprints from cable jackets. Display details before (left) and after (right) removal of the misprint

## 2.2.3 PTFE Application

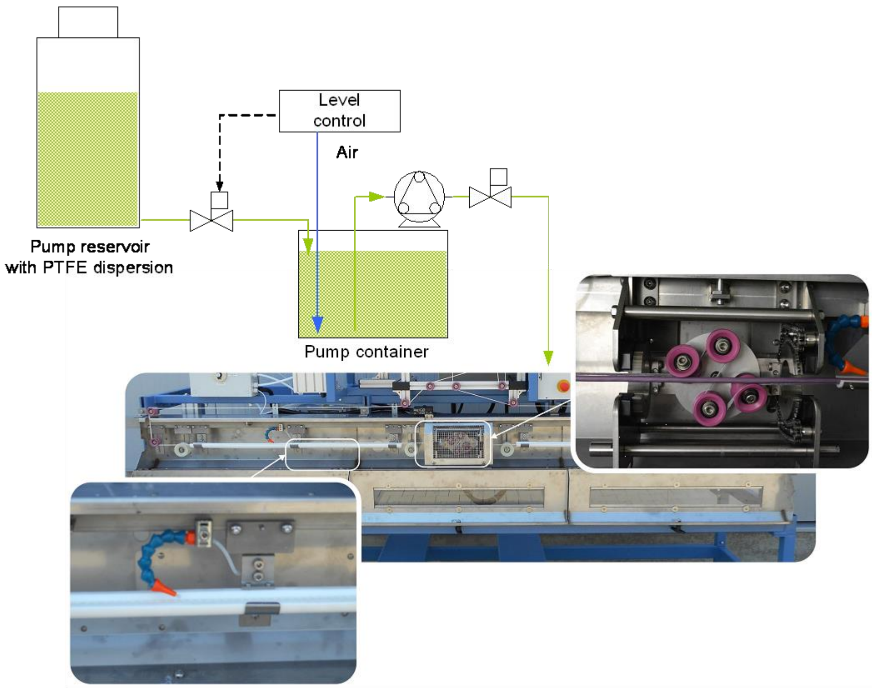



Fig. 41

Insulated conductors are often encapsulated into electrical windings. At the exit from the encapsulating compound, the insulation could break. Conductors coated with PTFE reduce this risk. Moreover, in many cable applications a defined strip force of the jacket is required. This is obtained by application of release agents to the insulated conductors. Talcum, which is commonly used, besides dust formation has the disadvantage that in many cases the strip force cannot be precisely adjusted. PTFE coatings have better performance properties.

However, aqueous PTFE dispersions cannot be handled by common metering pumps, because they coagulate under shear stress, and pumps as well as valves are quickly clogged.

HELICORD® machines NB57 can be equipped with a peristaltic pump that meets the particular requirements of this application in order to bring the PTFE dispersion into the HELICORD® process zone under low pressure and minimal shear force without coagulating in the tubes and valves.

By use of HELICORD® with a peristaltic pump, adhesion and strip force can now be reduced more easily than ever before due to precise metering of an aqueous PTFE dispersion to the insulated single conductors of the cable.

The HELICORD® principle is based on controlled friction between conductor and cord and leads to coagulation of the PTFE on the conductor. The multiple 360° looping provides consistent application to the whole conductor or cable surface and compensates the low but inevitable pulsation of the peristaltic pump at low metering amounts.

If necessary, the pump container and reservoir can be equipped with stirrers in order to prevent settling of the dispersion.

## 2.3 HELICORD® in Other Industries

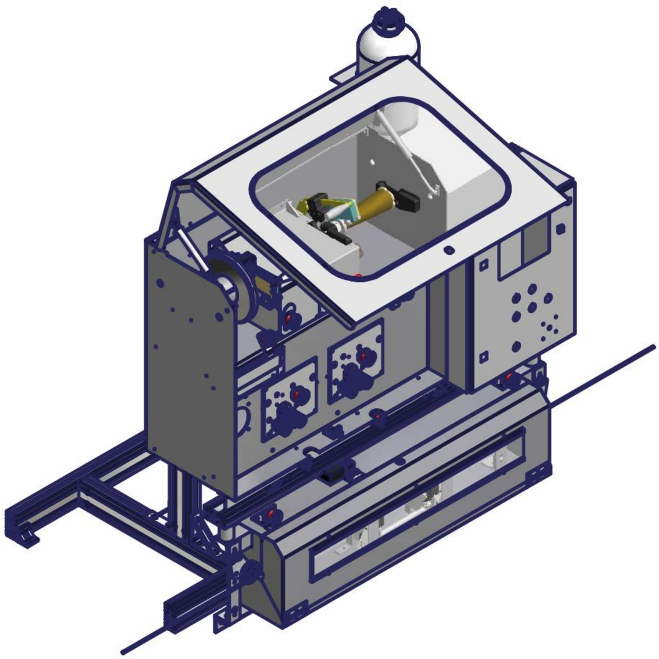
### General Applications

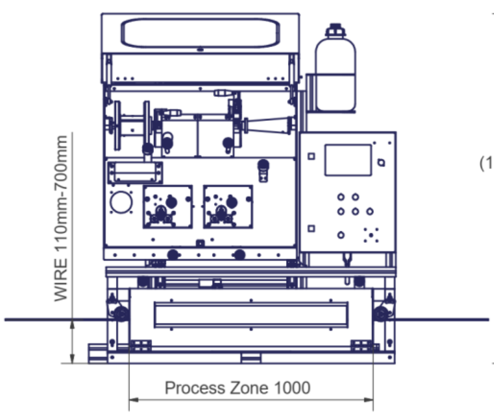
- Cleaning precision stainless steel wire
- Lubrication of precision stainless steel wire
- Application of waxes or PTFE dispersion on wire for the food industry
- Application of primers for drawing lubricants
- Cleaning wire before chemical or electrolytical plating
- Finishing / cleaning silver-clad wire for medical use
- Cleaning of fine wire (diameters below 0.1mm) e.g. for medical use
- Removing loose particles from plated wire
- Preparation before plasma annealer

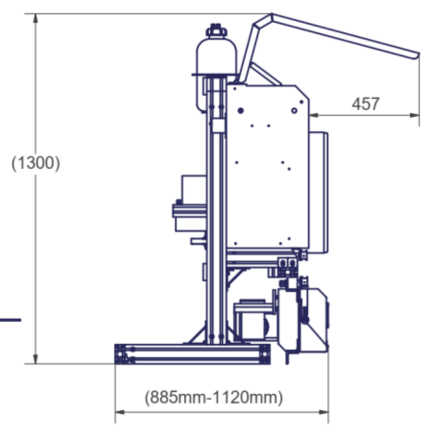
# 3 HELICORD® Machines

## 3.1 HELICORD® - Standard Models

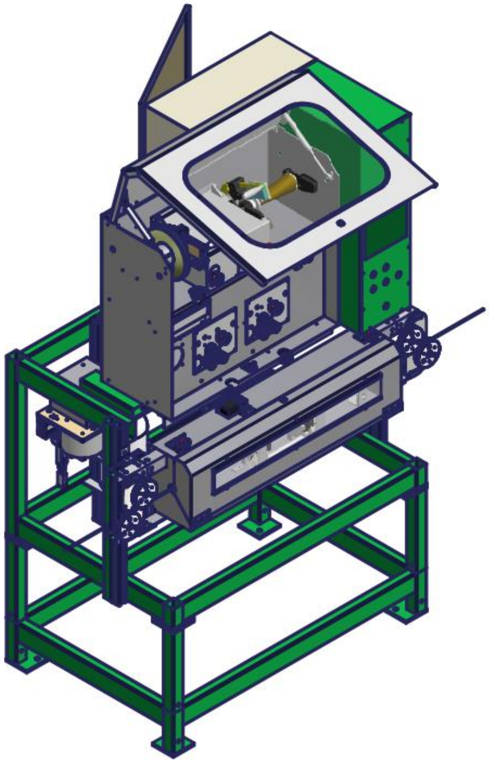
NB55 – for installation on a drum spooler

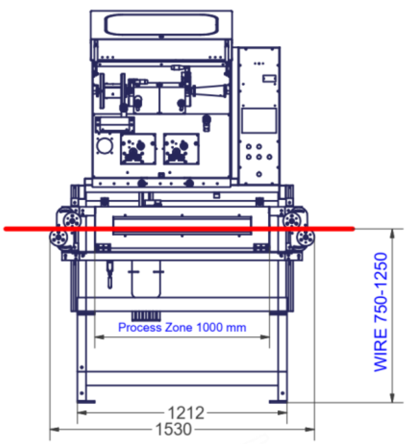


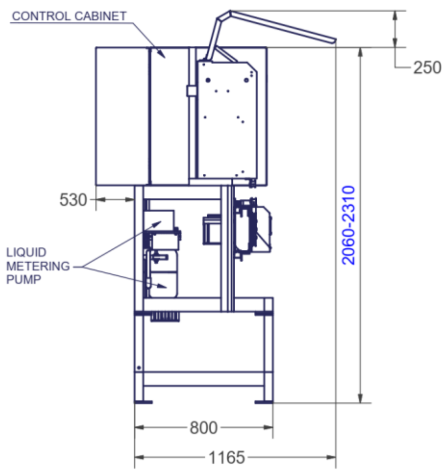


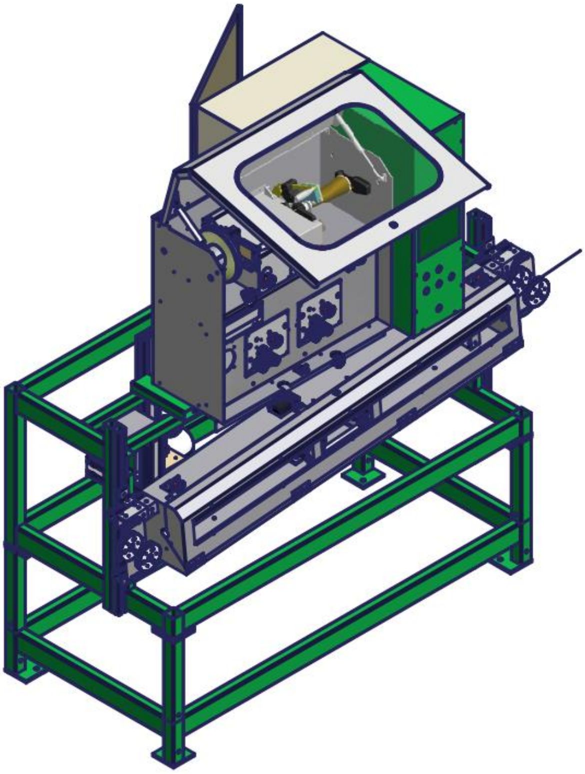
NB57 – 1200

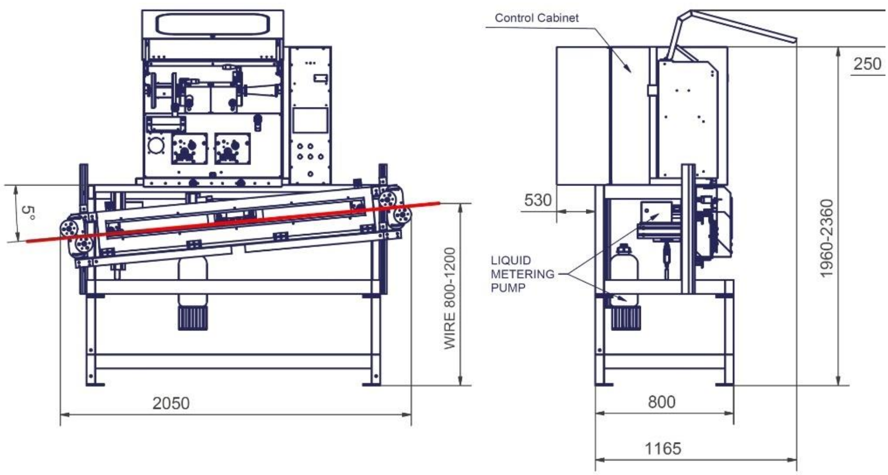



Process Zone 1000 mm
WIRE 750-1250
1212
1530


CONTROL CABINET
250
530
LIQUID
METERING
PUMP
2060-2310
800
1165

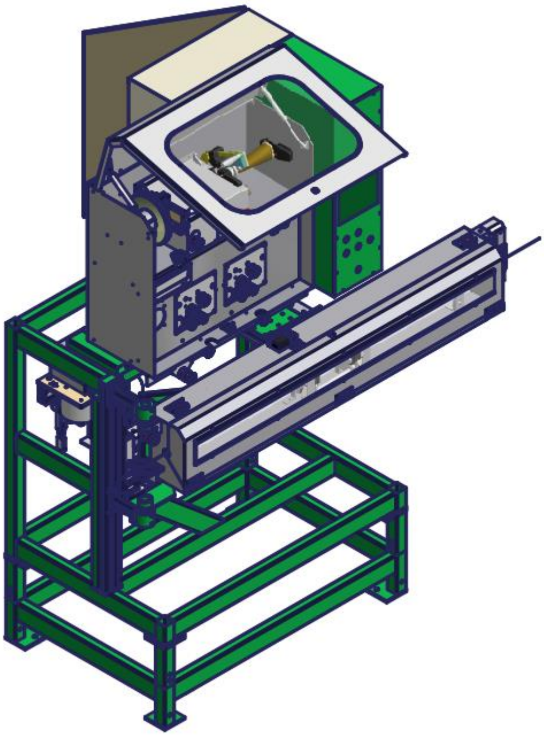
NB57 – 1700

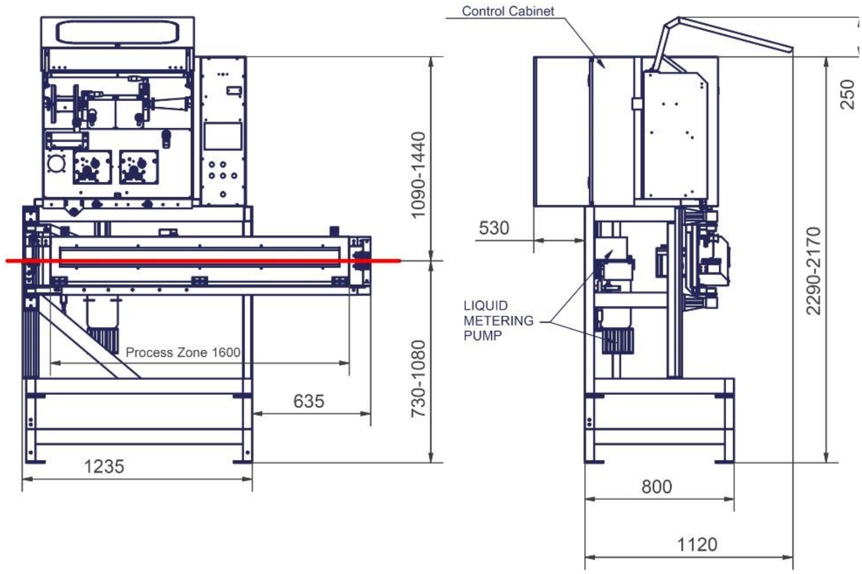




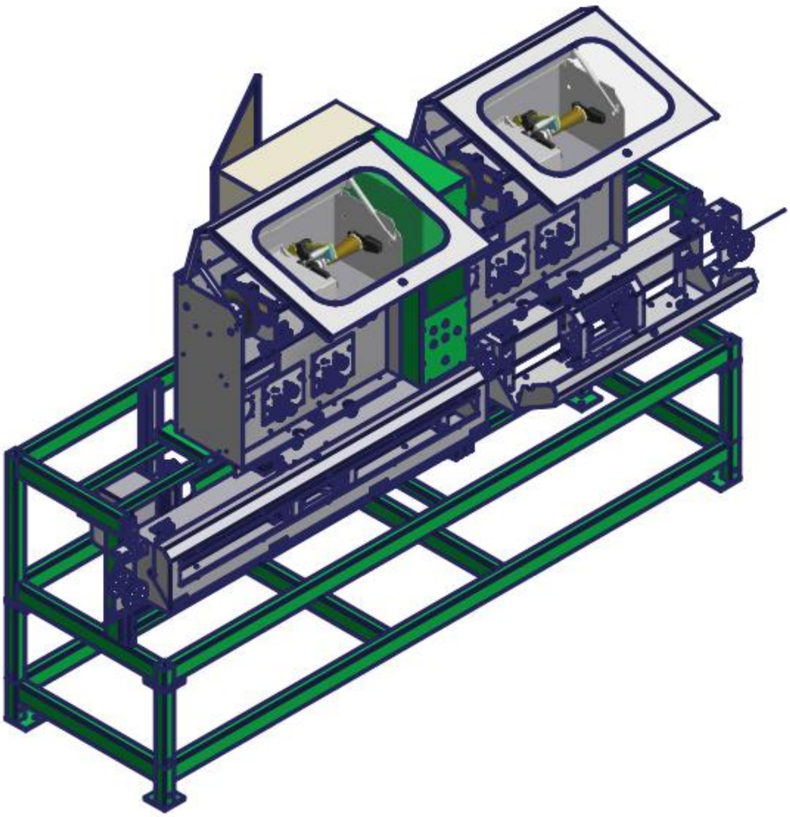
Control Cabinet
250
5°
530
LIQUID
METERING
PUMP
WIRE 800-1200
1960-2360
2050
800
1165

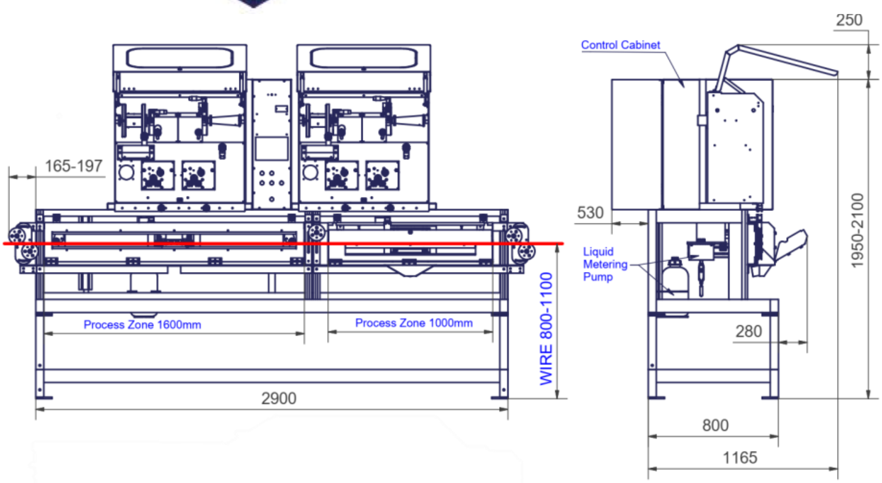
NB57W (passively traversable process zone)



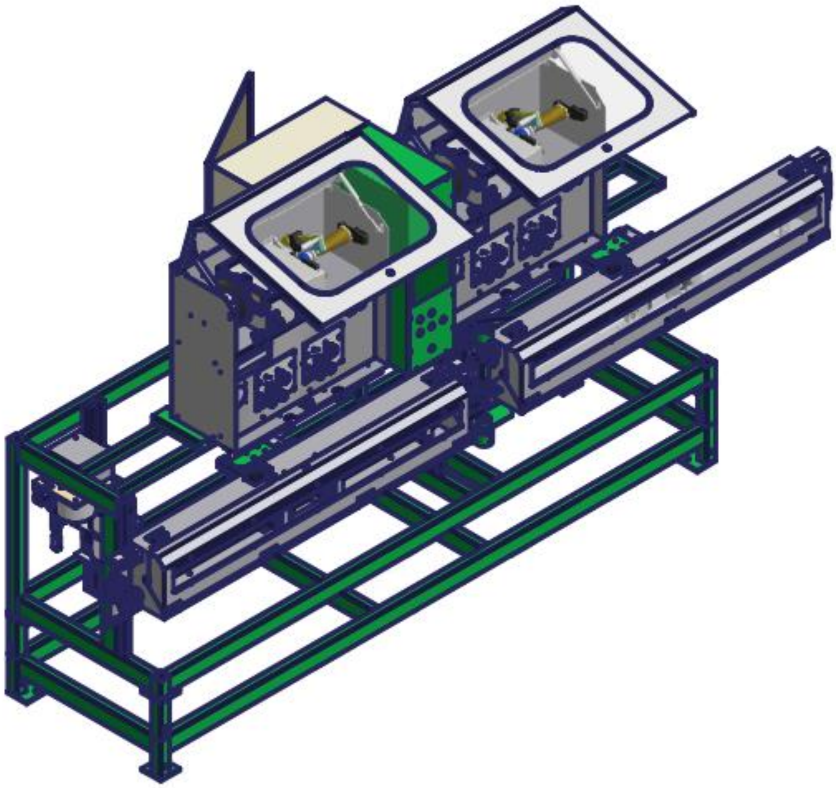


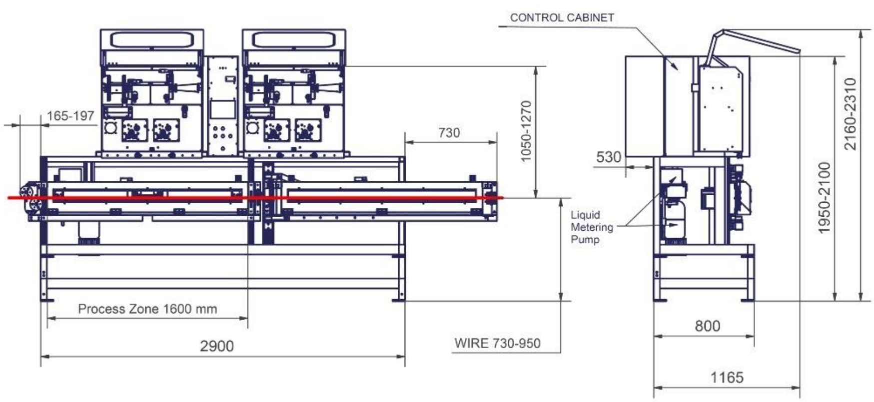
NB58 – stretched form





NB58W – stretched form (passively traversable second process zone)





## 3.2 HELICORD® NB57 for removing misprints

Picture 17

## Technical Data

| | |
|---|---|
| Equipment | - Process zone with dust cover, length 1.6 or 3.0 m<br>- Anti-statically stainless steel cord and cable guide pulleys and support rolls<br>- Automatic looping unit<br>- µ-processor-controlled<br>- Liquid metering device with outlets in up to 5 positions<br>- Steel frame<br>- Connection to the production line is possible |
| Application | Removal of soluble ink misprints from cable jackets (PVC, PUR) |
| Technical Data | |
| Recommended cable diameter (mm) for length of the process zone 1.6 m<br>3.0 m | ≤ 10 mm<br>≤ 18 mm |
| Recommended cable speed (m/min) | 30 – 60 (depending of the required time of exposure to the solvent) |
| Preferred friction force (N) | about 40 |
| Applied organic solvents | mostly acetone, MEK (methyl ethyl ketone) |
| Maximum cord pretension (N) | 100 |
| Adjustable metering quantity (ml/min) | 2.0 to 10.0 (for each nozzle) |
| Adjustable cord speed (cm/min) | 10 - 120 |
| Control | All parameters are µ-processor-controlled, and displayed on operator touch panel |
| Power connection | 16 A, 3 P+N+E, 380 V, 50 Hz (other options on request) |
| Power consumption (W) | max. 500 |
| Input signal of cable speed from the line control | 0 – 10 VDC |
| Connection of external control | optional |
| Acoustic Alarm | 110 dB in 1 m distance, 2,500 to 3,000 Hz, alternating current, acknowledgeable |
| Optical Alarm | Red flashing light |
| Dimensions H × W × D (mm)<br>for process zone length: 1.6 m<br>2.6 m | 2,400 – 2,600 × 2,100 × 1,330<br>2,400 – 2,600 × 3,000 × 1,330 |
| Operating temperature | + 10 to + 45°C |
| Storage and transportation temperature | – 20 to + 60°C |
| Relative air humidity | 5 to 70 % at 25°C (not condensing) |
| Environmental air pressure | 860 to 1,080 hPa |

Table 11

## 3.3 HELICORD® NB57 for PTFE application

## Technical Data

| | |
|---|---|
| Equipment | - Process zone, length 3 m, with dust cover<br>- Automatic looping unit<br>- µ-processor-controlled<br>- Metering unit with low shear stress for aqueous PTFE dispersions<br>- Steel frame |
| Application | Application of aqueous PTFE dispersions to insulated conductors |
| Technical data | |
| Range of application | Conductor or cable jacket up to diameters of about 25 mm |
| Line speed (m/min) | About 50 to 200 (according to current experience) |
| Friction force (N) | about 40 |
| Applicable PTFE dispersion | NB10H027, NB10H037 |
| Max. cord tension at pay-off (N) | 100 |
| Adjustable flow rate (ml/min) | 1 to 40 |
| Adjustable speed of HELICORD® (cm/min) | 10 to 120 |
| Control | All parameters are µ-processor-controlled, and displayed on the operator-panel. |
| Connection power | 16 A, 3 P+N+E, 380 V, 50 Hz (other options on request) |
| Power consumption (W) | max. 500 |
| Input signal of cable speed from the line control | 0 to 10 VDC |
| Connection of external control | optional |
| Acoustic Alarm | 110 dB in 1 m distance, 2,500 to 3,000 Hz acknowledgeable |
| Optical Alarm | Red flashing light about 85 flashes/minute |
| Dimensions H × W × D (mm) | 2,095 – 2,235 x 3,300 x 910 |
| Operating temperature | + 10 to + 45°C |
| Storage and transportation temperature | – 20 to + 60°C |
| Relative air humidity | 5 to 70 % at 25°C (not condensing) |
| Environmental air pressure | 860 to 1080 hPa |

Table 12

Picture 3

## 3.4 HELIVIBE

**Task**

Wires with oxidized surfaces (e.g. rod wire) or dry drawn in graphite or $MoS_2$, require intense abrasive cleaning for the preparation of subsequent production steps. Brushing, sanding with revolving abrasive belts or pickling suffer from the fact of “static” cleaning means with degrading cleaning efficiency at increasing time of use.

**Solution**

The newly developed HELIVIBE machine is based on our well-established HELICORD® technology with multiple 360° contact between the wire and cleaning medium, consistent quality of the cleaning medium, and therefore consistent cleaning efficiency. In addition, the cord is oscillated back and forth with up to 4.5 revolutions per second in order to clean the wire surface more intensely.
The machine can be optionally equipped with a process zone with dust discharger.
As cleaning means we offer different abrasive cords.

## Technical Data

| | |
|---|---|
| Equipment | - Machine derived from HELICORD® NB57 providing<br>- Process zone (length 1,6 m, dust cover)<br>- Motorized looping unit<br>- Micro-processor control<br>- Interface for connection to a production line<br>- Main unit and process zone with dust cover<br>- Cord oscillating rotor with cord length compensation |
| Recommended wire diameter (mm) | Steel: 0.8 – 8 |
| Max. wire speed (m/s) | ≤ 2 |
| Cord pretension range (N) | 5 – 50 |
| Cord tension range (N) | 5 – 150 |
| Max. friction force (N) | ≤ 145 |
| Adjustable cord speed (cm/min) | 1 - 120 |
| Oscillation frequency (1/sec) | 0 – 4,5 |
| Control | All process parameters are µ-processor controlled and are displayed in the control panel |
| Electrical connection | 380V AC/50Hz (3P+N+E) – 16 A (three-phase) |
| Connection power (kW) | 1 |
| Operating temperature (°C) | +10 to +45 |
| Storage /and transport temperature (°C) | - 20 to +60 |
| Rel. air humidity (%) | 5 - 70, not condensing |
| Ambient air pressure (hPa) | 860 - 1080 |
| Weight (kg) | ~ 700 |

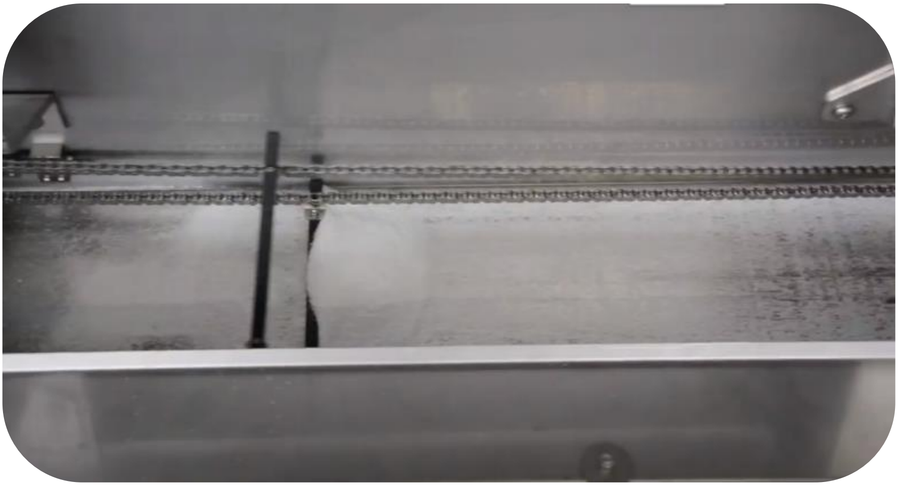
## 3.5 Dust Discharge

**Task**

HELICORD® machines that dry-abrasively clean wires often produce large amounts of dust. These may have to be removed from the process zone several times a day by the operators, with a corresponding expenditure of time.

**Solution**

HELICORD® machines can now be equipped with a dust discharge. It continuously collects the debris mechanically in the process zone and transports it to one of its ends in order to minimize the required cleaning effort during production.
The debris can be removed through a pipe socket by means of an on-site extraction system that can be connected to it.
We recommend the dust discharge particularly for applications where large amounts of contaminants are removed from the wire surface.



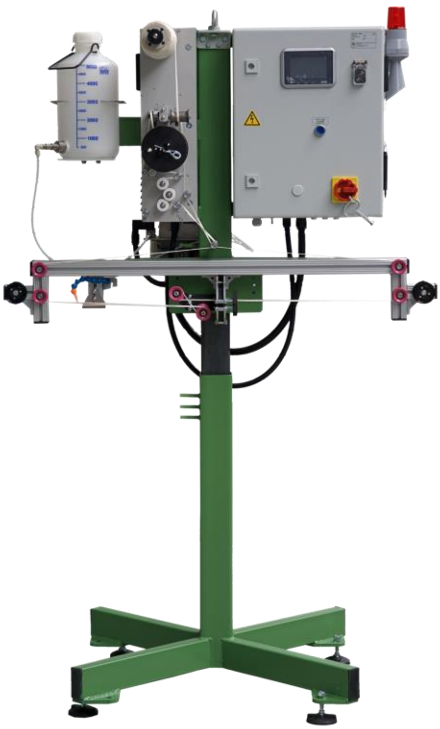
## Technical Data

| | |
|---|---|
| Equipment | - Process zone, length 1,6 m, dust cover<br>- Motorized looping unit<br>- Micro-processor control<br>- HELICORD® main unit with dust cover<br>- Interface for connection to a production line<br>- Dust discharge unit |
| Recommended wire diameter (mm) | 0.8 – 1.6 |
| Max. wire speed (m/s) | ≤ 40 |
| Cord pretension range (N) | 5 – 100 |
| Cord tension range (N) | 5 – 250 |
| Max. friction force (N) | ≤ 245 |
| Adjustable cord speed (cm/min) | 1 - 120 |
| Adjustable speed of dust discharge (cm/min) | 0 - 180 |
| Control | All process parameters are µ-processor controlled and are displayed in the control panel |
| Electrical connection | 380V AC/50Hz (3P+N+E) – 16 A (three-phase)<br>or<br>100 – 240 V AC – 50/60 Hz (single-phase) |
| Power consumption (kW) | 1 |
| Operating temperature (°C) | +10 to +45 |
| Storage /and transport temperature (°C) | - 20 to +60 |
| Rel. air humidity (%) | 5 - 70, not condensing |
| Ambient air pressure (hPa) | 860 - 1080 |
| Weight (kg) | ~ 450 |

## 3.6 HELIFIL Machines

HELIFIL machines provide:

- Active cord release for constant pretension and minimum slippage
- Service-reduced, high torque stepping motors for friction forces up to 35 N
- Continuous cord tension control at take-up
- Individual µ-processor control, programmable via CAN-bus data exchange
- Power supply: 24 VDC/1.5 A
- Two drive rolls and a pressure roll provide constant cord speed at minimum slippage
- Opposite wire and cord run
- Cord tension monitored by force sensor
- Adaptable to a wide range of wire diameters and speeds
- Suitable for dry wiping, or solvent-supported cleaning (optional pump required)
- Small unit for applications where limited space is available
- Suitable for small wire diameters and friction forces less than 35 N



Picture 4

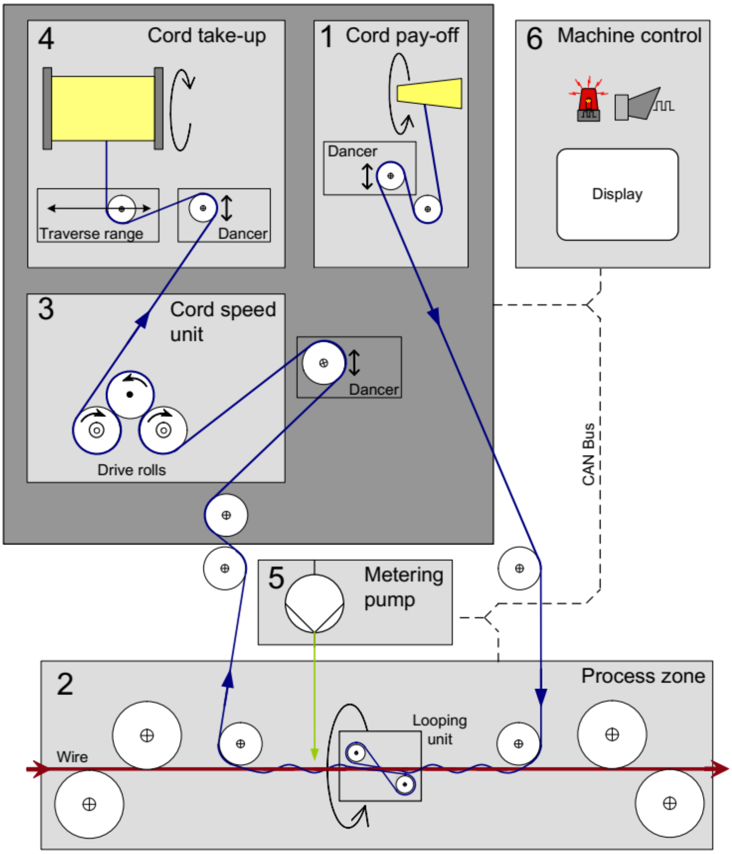
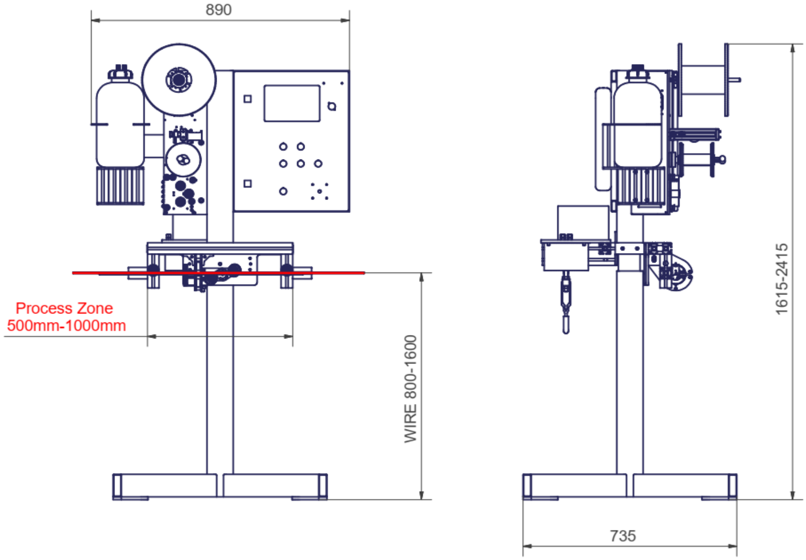


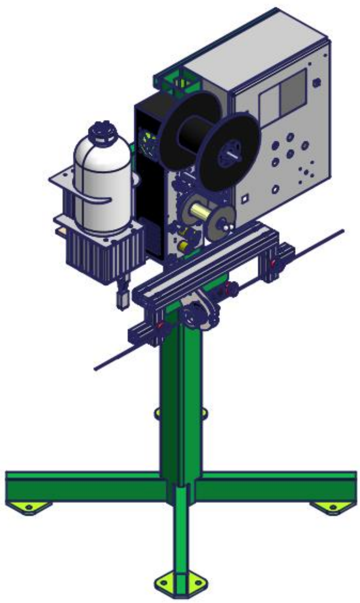

Fig. 49: Schematic of the HELIFIL® process

## Technical Data

| | |
|---|---|
| Recommended wire diameter (mm) | soft metals: 0.3 – 3.0; other options for smaller diameters available upon request |
| Max. cord tension (N) | 35 |
| Cord tension at pay-off (N) | 0.5 - 6 |
| Max. cord tension at take-up (N) | 0.5 - 6 |
| Adjustable cord speed (cm/min) | 1 - 100 |

Table 13


890
Process Zone
500mm-1000mm
WIRE 800-1600
735
1615-2415



## 3.7 Magnet Wire Cleaning with HELICORD® before Enameling

### Earlier Issues with Bare Wire Cleaning before Tube Annealers

Picture 2

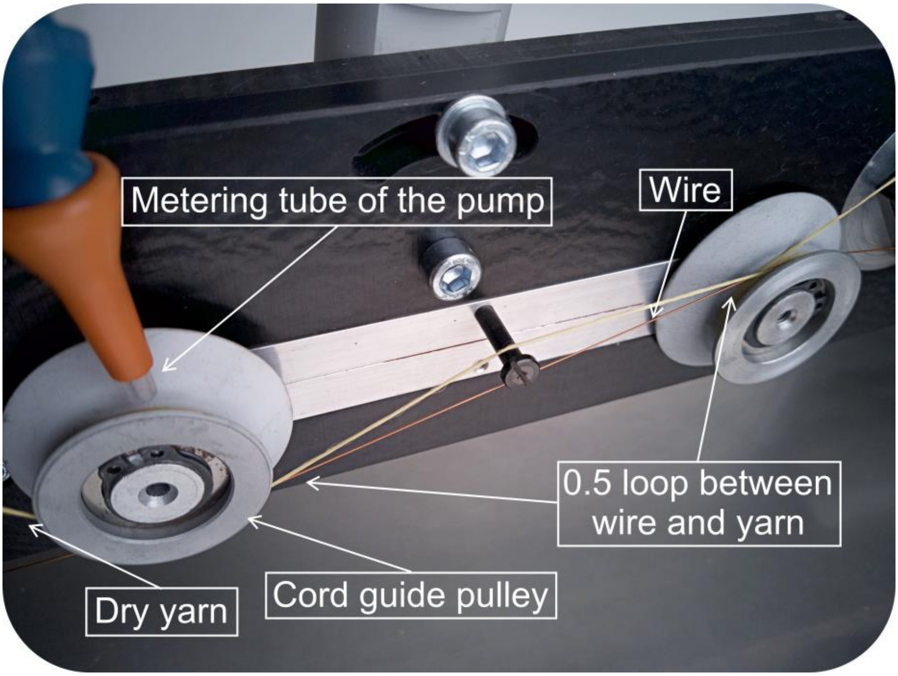
- Without additional capstan, wire gets elongated or even breaks due to softening by heat
- Re-pollution of the wire during annealing and cooling
- For a long time, no adapted HELICORD® devices were available with respect to
  - narrow wire spacing
  - required friction forces
  - economical questions for multi-line applications

### Installation between Annealer and First Enamel Application

- Cleaning contaminants from drawing, annealing and cooling off the wire
- Avoids carry-over of contamination to and agglomeration in the enameling section
- Reducing high voltage failure counts by a factor of up to 10
- Improved enamel adhesion on the wire
- No wire elongation or even cracks at reasonable friction forces

### 3.8 Fine Wire Cleaning

Fusing different Boockmann technologies, even fine and ultra-fine wire (diameters below 0.1mm) can be cleaned reliably without elongating or otherwise damaging the wire. In order to do this, a HELILUB® machine type NB53G0 for ultra-fine wire (refer to chapter II 4.2.1), dry yarn, a liquid metering pump used in the HELICORD® machine family and minimum amounts of a suitable solvent are used. A setup similar to what is used for fine wire lubrication provides fully dircumferential cleaning of the wire surface without creating excessive friction and thus high tensile forces.




Picture 16

# 4 HELICORD® and HELIFIL Consumables

## 4.1 HELICORD® – Overview of Dry Cords

| | NB65V014 | NB67V002 | NB80N001 | NB87V002 | NB87V006 | NB88V001 | NB80Z000 | NB80Z002 |
|---|---|---|---|---|---|---|---|---|
| **Type of braiding** | | | | | | | | |
| Flat | - | - | X | X | X | X | X | X |
| Round | X | X | - | - | - | - | - | - |
| **Textile basis** | | | | | | | | |
| Viscose | - | X | - | - | X | - | X | X |
| Aramide | - | X | - | X | X | X | X | X |
| Polyamide | X | - | X | X | - | X | - | - |
| **Range of application** | | | | | | | | |
| Dry cleaning | X | X | X | X | X | X | X | X |
| Liquid-supported cleaning | - | - | X | X | X | X | X | X |
| Aluminum welding wire | - | X | - | - | X | - | - | X |
| Ferrous welding wire | - | X | X | X | X | X | X | X |
| Solid wire | X | X | X | X | X | X | X | X |
| Stranded wire | X | - | X | X | - | X | X | X |
| For cleaning before high temperature extrusion and extrusion on pre-heated wire: special types of cord available upon request | | | | | | | | |
| **Technical data** | | | | | | | | |
| Minimum cord length per cone [m] | 1,700 | 920 | 770 | 1,640 | 1,440 | 740 | 829 | 3,300 |
| Total weight of the cord [mg/m] | ~ 1,190 | ~ 2,410 | ~ 3,050 | ~ 1,575 | ~ 2,320 | ~ 3,215 | ~ 3,300 | ~ 1000 |
| Packing unit | carton (4 cones) | | | | | | | |

Table 14

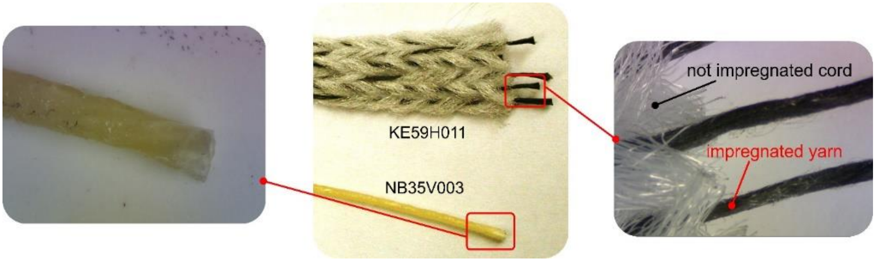
## 4.2 HELICORD® – Overview of Abrasive Cords

| | NB77V009 | NB77V011 | NB78F001 |
|---|---|---|---|
| | | | |
| Flat | - | - | X |
| Round | X | X | - |
| | | | |
| Viscose | X | X | X |
| Aramide | X | X | X |
| Polyamide | - | - | - |
| **Range of application** | | | |
| | Non, low- or high-alloyed steel wire, solid wire or flux-cored wire with open or closed seam, Not recommended for plated (e. g. copper-coated) wire! | | |
| **Technical data** | | | |
| Grit size | F150/F360 | F360 | F40/F80 |
| Cord length per spool [m] | 1,550 | 1,550 | 930 |
| Total weight of the cord [mg/m] | ~ 2,800 | ~ 2,600 | ~ 4,100 |
| Packing Unit | carton (2 spools) | | |

Table 15

## 4.3 Welding Wire Finish Cords

HELICORD® W cords were designed for application of finish materials onto wire surface. Their braided design provides wear resistance and high tensile strength. Using different individually impregnated fibers and/or impregnating the finished cords, even non miscible compounds can be combined. They can be extracted by means of solvents or heating.




Picture 5: Heat-extractable HELICORD® NB35Vxx versus liquid-extractable HELICORD® W, showing individual impregnated yarns in the braid

The special advantage of HELICORD® W is the possibility to clean and lubricate simultaneously due to the fact that HELICORD® W process allows operation with wire and cord running in opposite directions.

Thus, loose and loosely adherent particles and scales from the drawing process or other preceding process steps are thoroughly removed. This improves the properties of welding wire regarding lifetime of the liner and contact nozzles.

| | NB37F004 | NB81V000 | NB82K300 | NB82C300 |
|---|---|---|---|---|
| | | | | |
| Flat | X | X | X | X |
| Round | - | - | - | - |
| | | | | |
| Viscose | - | X | X | X |
| Aramide | X | X | - | - |
| Polyamide | X | - | X | X |
| | | | | |
| Wax-like lubricant | X | - | X | X |
| Lubricant with low hydrocarbon content | - | X | - | - |
| Corrosion inhibitor | X | - | X | X |
| Plasma stabilization | X | - | X | X |
| Separating agent | - | - | - | X |
| | | | | |
| Steel (low-alloyed and non-alloyed) | X | - | X | X |
| Steel (high-alloyed) | X | - | - | - |
| Aluminum | - | X | - | - |
| | | | | |
| Cord length per cone/spool [m] | 1,070 | 1,260 | 700 | 700 |
| Total weight of the cord [mg/m] | ~ 2,560 | ~ 2,390 | ~ 5,300 | ~ 6,750 |
| Packing unit | Carton (4 cones) | | | |

Table 16

# 5 Liquid Consumables

## General Information

We offer a number of liquid consumables for various applications.
In the cable industry, dispersions are used as slide, strip or feed aids.
Welding Wire Finish dispersions and oils are liquid lubricants for welding wire surface preparation. The formulae were designed specifically for improvement of copper-coated low alloy and mild steel wire. They improve the welding properties of wires with respect to:

- **Feedability**

Due to the base material - a thin, low-volatile fatty acid derivative or PTFE - a good coefficient of friction, i.e. low feed resistance of the coated wire is achieved.

- **Storage Stability**

The decrease of feedability of oil-lubricated welding wire upon storage is a well-known phenomenon caused by oxidation and volatility of the oil, whereas PTFE coatings are almost inert. Boockmann’s oil-based Welding Wire Finishes contain an antioxidant delaying the degradation of sliding properties caused by oxidation of the lubricant during storage under exposition to air. The decline of feedability caused by volatility of the lubricant cannot be changed by use of additives. This decline becomes evident to a measurable degree upon open storage over more than 6 months. Only vapor-impermeable packaging, such as aluminum compound foil, will help.

- **Corrosion Protection**

Another group of additives has anti-corrosive influence not only on the copper surface, but also on the iron base which is not completely protected by the copper coating. These anti-corrosive agents delay the first appearance of rust points from several hours to up to more than one week in warm and humid climate. Thus, it will be possible to leave the wire spool unprotected on the welding machine, e.g. during the weekend, also in tropical climate.

- **Welding Arc Stabilization**

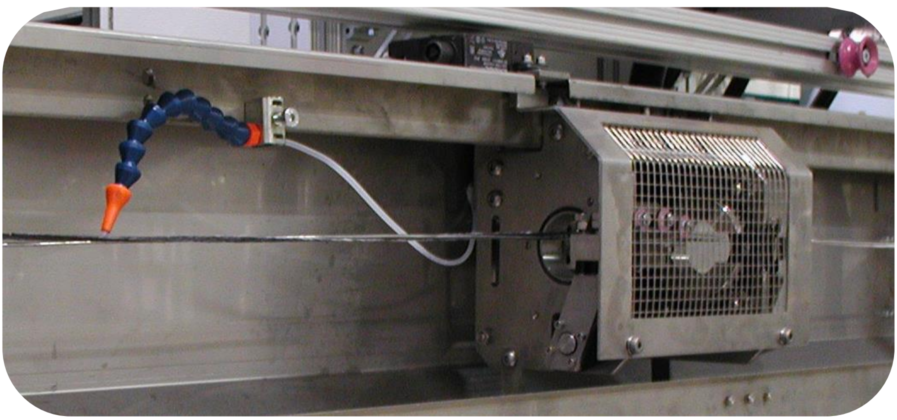
An additive stabilizes the electrical discharge. For wire with such a coating, the noise level and spray welding inception voltage are measurably lower. Thus, the energy input into the melt will be reduced and welding of thinner sheets enhanced. Spattering of the melt is also reduced. This leads to less vibration of the handle, reduced formation of deposit in the gas nozzle, and especially loss of material by spattering of several percent of the material used is reduced considerably. The monetary savings of material overcompensate the higher cost of the lubricant.

## Application Process of Welding Wire Finish

Welding Wire Finish dispersions and oils can be applied in the skim pass after copper-coating or by conventional application means (wiper, pump-felt, roller-felt, spray methods). During application by HELICORD® process, besides better uniformity, removal of loose particles (from the drawing process or copper-coating) can be achieved simultaneously, thus improving welding properties with respect to clogging of the liner and deposit in the contact tip.

| Product number | Type of liquid | Chemical basis | Components | Applications |
|---|---|---|---|---|
| NB10H020 | Finish oil | Ester oil | Ca. 6,3 % Potassium, corrosion protection | Finishing of Copper-coated welding wire |
| NB10H027 | Dispersion | De-ionized water | 20 % PTFE | Slide, strip and feed aid for bare and already insulated conductors and cables |
| NB10H037 | | | 10 % PTFE | |

Table 20



Picture 15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