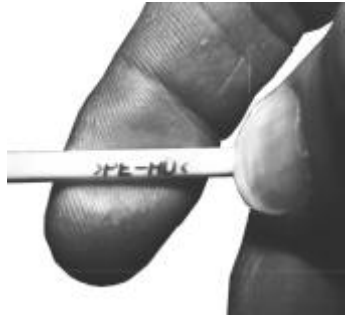


Printing on cable

## CORONA TREATMENT OF CABLE

Treating polyethylene or polytetrafluoroethylene cables with corona discharges just before a printing station eliminates insufficient wetting and insufficient adhesion of inks.

### Brilliant printing and good adhesion need sufficient wetting of the ink



The change in cable insulation material from polyvinylchloride (PVC) to polyethylene (PE) and other halogen free plastics has caused concern and discussion relative to this subject. In general, printing on PVC yields sufficient results with no further requirements. However, PE-insulated cable very often require a pretreatment before printing. Such a pretreatment can involve an open gas flame that can be installed very quickly, but is dangerous in handling and not reliable in operation. As an alternative, TIGRES offer stations for the electrical (corona) pretreatment of cable to increase wetting and adhesion.

### Sufficient surface tension is a prerequisite

If the wettability of a solid surface is high enough, a liquid will form a shallow droplet or will spread without any external forces. On surfaces with low wettability the liquid will form small globular spheres that run off. If the wettability of a cable's insulation surface is too low, the printing ink from an ink-jet or a printing wheel gets repelled. The print will not be brilliant. For example, a numeral "6" might not be distinguished from an "8" and the print can be wiped off.

The phenomenon of wetting is physically unequivocally described by the surface tensions of both the liquid and the solid substrate. The surface tension of a solid material depends on the chemical composition of its uppermost atomic layers. This means that surface tensions are influenced by the very thin layers of contaminants that originate from the migration to the surface of additives to plastic parts, or by thin films condensed from vapours like water and solvents from the surrounding atmosphere.

A rule of thumb for wetting holds:

*A solid substrate will be wetted if its surface tension exceeds the surface tension of the liquid.*

Experience has shown that typical solvent-based inks need a substrate with surface tension of 38 mN/m and water-based inks need about 45 mN/m. The table shows that except for the most common PVC, all plastics have wetting problems.

### Table:

Surface tension and corona treatability of some cable insulation materials:

Material	Abbreviation	Surface Tension	Corona Treatability
Polydimethylsiloxane	PDMS	14 mN/m	very hard
Polytetrafluoroethylene	PTFE	18 mN/m	hard
Ethylene-propylene-rubber	EPM/EPDM	22 mN/m	easy
Polyamide	PA	26 mN/m	medium
Polyethylene	PE	31 mN/m	very easy
Polyimide	PI	36 mN/m	easy
Polyvinylchloride	PVC	39 mN/m	very easy

### Boosting surface tension via corona discharges

If the surface tension of an insulation is not high enough, it can be increased very comfortably, economically and with ecological soundness by means of a corona treatment in-line just before the printing station. All corona systems use the sparks of an electrical discharge in the surrounding atmosphere for the surface modification, which results in better wetting and adhesion. The sparks of the corona discharge remove contaminating thin layers from the surface and oxidises the plastic surface to a depth of typically five atomic layers. This modification occurs without any change to the electrical, mechanical or optical properties of the cable. (Treated cable cannot be visually distinguished from non-treated cable). Also, the burning of holes in the cable insulation will not occur in a well-designed corona station.

Since the value of the surface tension depends on the degree of oxidation, the result of the corona treatment can be adjusted very precisely. For cable printing, a precise adjustment is not necessary, because the determination of the optimum size of the station is sufficient. The size of a station is determined by the electrical power, which can be fed into the discharge. The necessary power depends on the type of the plastic material and the speed of the cable. For a cable with an insulation, which is hard to treat like Fluorine containing plastics, the cable speed has to be reduced, or a bigger station has to be applied. The effect of the treatment can stay for months, but the clean, activated surface is sensible to any contamination and to friction, which occurs through mechanical handling of the cable. To achieve high reliability, in-line treatment just before the printing station is recommended. All rollers between the corona station and printer must be clean and must run without friction to the cable.

## Stations for the corona treatment of cable

The corona treatment uses voltages of over 10.000 V and occurs inside a closed housing on a length of 100 to 500 mm (3.9" to 19.7") on the cable. The housing is provided with a security switch that turns the discharge off when the station is open. Any accidental contact of the operator to the discharge is prevented. A strong blower vents the discharge atmosphere, which contains ozone in a concentration of about 50 ppm, to the outside in order to cool the electrodes. An ozone filter can be optionally used to destroy the ozone, if this is required by local regulations.

A complete corona station consists of a corona discharge tool in which the cable is treated by the discharge, a power supply which supplies the discharge with the required electrical power of 10.000 V at 20.000 up to 50.000 Hz and which controls the station, and a blower which cools the electrodes and removes the ozone. An ozone absorber is optional. Corona stations can be adapted to extruder lines, rewinding stations and cutting devices. All corona stations can be adapted to the printing with ink-jet printers or printing wheels. The corona tool needs a space of 500 mm (20") in the cable line. The station needs a 230 V power connection, exhaust gas outlet of 75 mm (3") diameter and connection from the central line control that switches the corona off when the cable stands still. Some stations also need a ground connection to the wire inside the cable to be treated.

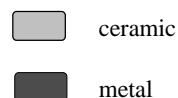
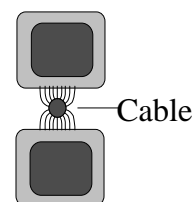
Typical applications include:

- PTFE-insulated cable with thin insulation at 60 m/min (200 fpm)
- Plastic wires
- Silane cross-linked PE-cable, 2,5 mm<sup>2</sup> (~ 13 AWG) in extruder lines at 500 m/min (1600 fpm)
- PE segment cable up to 20 mm<sup>2</sup> (~ 4 AWG) in an extruder line
- PE-cable, 10 mm<sup>2</sup> (7 AWG)
- PA tubes, 6 mm (0.24") diameter in an extruder line

## The universal corona station:

The corona station SKD-2,5<sup>2</sup> is the versatile TIGRES station for the corona treatment of thin cable. It can be applied in extruder lines, rewinding stations and other devices. Connection to the wire in the cable is unnecessary. The system can also be used for treating fibre optic cables. Since treatment occurs from all sides, the system is usable with ink-jet and offset printers.

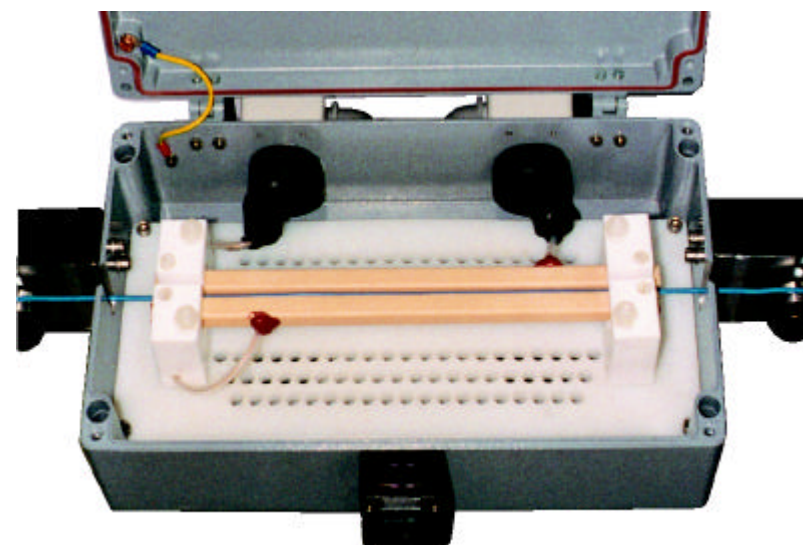
Any cable up to 4,0 mm (0.16") diameter can be treated with the station SKD-2,5<sup>2</sup>. The station consists of three components, which are adjusted to each other: treatment tool SKD-2,5<sup>2</sup>, blower A02 and power supply V06-sym that supplies 600 W. The station is delivered complete and ready to use. It needs a 230 V socket which is secured with a fuse of at least 10 A. The customer must vent the exhaust gas to the outside.



The treatment occurs at a length of about 300 mm (12"), so that a sufficient treatment is achieved for most applications. Since the discharge burns independently of a substrate between the system's ceramic electrodes, change or adjustment of electrodes is unnecessary when different cable diameters or insulation materials are run. The dielectric barrier of the ceramic coating on the electrodes prevents electric shortcuts even through a thin insulation. Ceramic electrodes also enable the treatment of uncoated wires, so that no problems occur when the extruder starts and uncoated wire runs through the

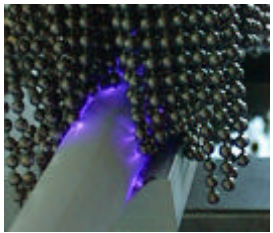


station. Knots may also run through the station, if their diameter is smaller than 5 mm (0,2").

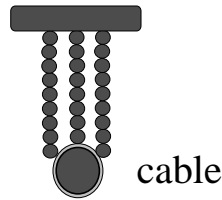


## Treatment of thick cable using chain electrodes

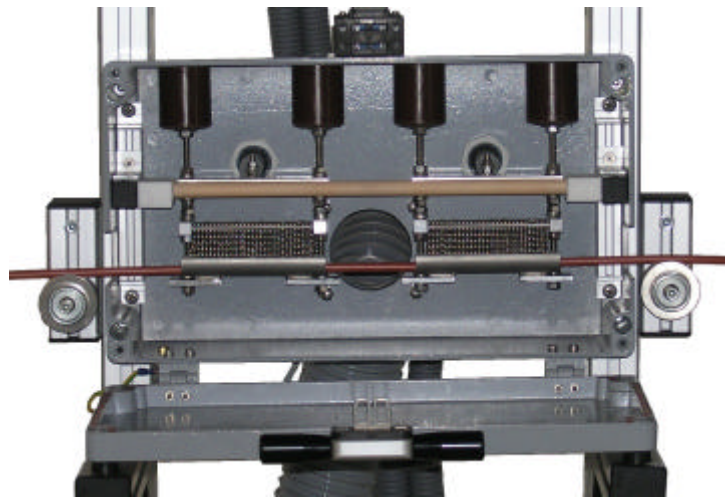
The (direct) corona treatment needs a distance from the treating electrode to the surface of the cable of no more than a few millimetres. The best distance is 1,5 mm (0.06"). For cables thicker than 10 mm (0.4"), this physical requirement cannot be fulfilled in a system with solid



electrodes, as any movement of the cable may destroy fixed electrodes. With thick cables, the design of the cable itself helps in the corona treatment because such cables usually have enough insulation thickness to act as the dielectric barrier of the corona discharge. In these cases, a curtain of flexible metallic chains that react to the

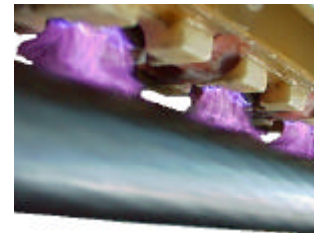


cable's movements provides an effective and reproducible corona treatment capability. These chain electrodes are used in pairs so that the discharge current does not flow through the cable outside the station. Also, an electrical contact to the cable is not necessary. Outside the station the cable is free from significant electrical currents and voltages. Specific applications may need an additional treatment with hot air in order to obtain the desired results.

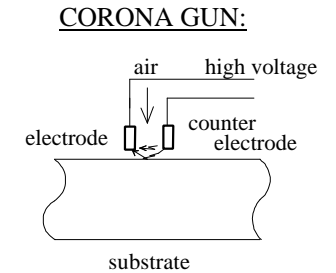


### Treatment of fibre cable

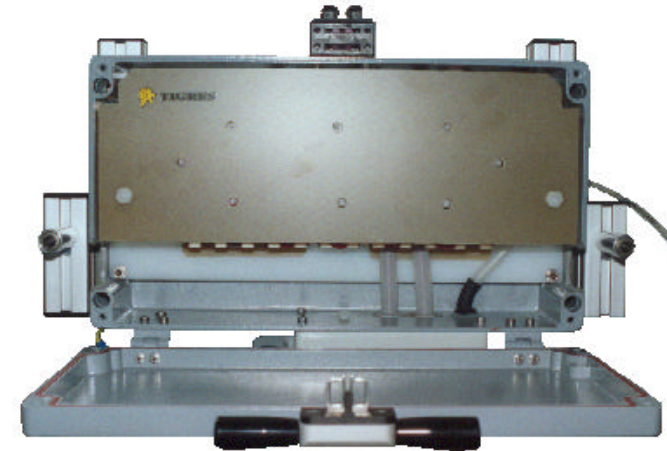
In the corona system described above, the cable itself is an active part of the discharge, because it acts as an electrode. Non-conducting substrates like fibre cables and tubes can also be treated in the station SKD-2,5<sup>2</sup>, if their diameters do not exceed 4.0 mm (0.16"). For thicker optical cable, a special system has been designed, which operates with an indirect corona discharge not needing a counter electrode.



In an indirect corona discharge, two electrodes are positioned in front of the substrate, and the sparks of the discharge are vented using pressurised air towards the surface of the cable.



The special construction of TIGRES' indirect corona electrode GUN-CKG makes it possible for the discharge to ignite at such a low power that a formation of hot thermal sparks is prevented and the air is not heated up to more than 45 °C (115 °F). Since the discharge length of one corona-GUN CKG is about 20 mm (0.8"), six electrodes are combined in one station for the treatment of cable. This station treats tubes and fibre cable of any diameter at a width of about 10 mm (0.4") at the bottom or at the top.



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TIGRES supplies corona stations for any cable application. For details about the advantages of our corona systems please contact our worldwide agents or us. We would like to discuss your problems concerning wetting and adhesion of your cable. Describe your application and we will suggest an appropriate TIGRES corona station for you.

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