Introduction to heat shrinkable sleeves

J.Jumeau 20121030

ULTIMHEAT® UNIVERSITY

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Heat shrinkable sleeves were invented in 1960 by the company Raychem. The tubes are made by extrusion, and subjected to molecular modification by radiation of an electron gun. Their expansion can still be obtained or increased by mechanical stress (swelling hot). Then, when heated above a certain temperature, the molecular structure changes and the tubes return to their original shape. The double-walled sheaths are generally co-extruded with an inner wall fusing at a lower temperature than the outer wall. This inner fusible wall can be EVA, polypropylene, polyamide or FEP according to the material of the outer wall and applications.

The choice of a heat-shrinkable sleeve for insulating heating cables is the result of a multi-parameter equation. Firstly the sheath must withstand the temperature of the heating cable. It is the parameter *"Temperature resistance after heating"*. Secondly, it must be able to shrink on the cable, leads and connectors that will be connected and stay properly on without slipping, it is the parameter *"Shrink ratio"*. It must also be able to shrink without any damage on the heating cable due the requested shrinking temperature. It is the parameter *"Shrink temperature"*. It must be electrically insulating at the operating voltage value and not too thick for this insulation value: it is the parameter *"Insulation Voltage"*, which will determine the minimum sheath thickness.

It should not be a factor of flame spread. This is the parameter *"Flame Class rate"*. It must in some cases not only provide an electrical insulation, but also provide a sufficient protection level against liquid penetration. This parameter is the *"Double wall"*. And when all these major parameters are known and selected, the cheaper solution remains to be found.

Other minor criteria such as flexibility, color, UV resistance (important if the ducts are used outdoors), the corrosive action of the sheath on copper leads, Rohs and Reach Directives, are still to be taken into account.

The shrink temperature is an important criterion, and the ways to reach it are essential to the quality of the result. One must not exceed the temperature of destruction of the sheath or of the product on which it is put on. Do not burn it: the use of gas guns with direct flame may cause early carbonization. Ensure a proper distribution of heat over the entire surface and all around the sheath, for the duration of a proper shrinkage and, in the case of double-walled sheaths, for the required time to shrink the outer wall and merge the inner wall.

Comparative chart of the main characteristics of the heat shrinkable sleeves on the market place
Price levels are calculated with PVC as basis 1
Only self-extinguishing or UL94VO versions were selected

	PVC	Cross-link polyolefin	Double wall cross-link polyolefin	Neoprene	Poly Vinylidene Fluoride PVDF ***	FEP **	Silicone rubber	Fluor Elastomer Viton	PTFE	Double wall, PTFE+FEP
Temperature resistance after shrinkage (°C)	-30+105	-55+135	-55+125	-75+120	-55+175	-60+200	-60+250	-75+150	-60+260 (400: short time peaks)	-60+230 (400: short time peaks)
Shrink ratio	2 :1	3 :1 to 4 :1	2 :1 to 4 :1	2 :1	2 :1	1.3:1 to 2:1	1.4:1 to 1.9:1	2 :1	2 :1 to 4 :1	3 :1
Shrink temperature, °C*	70-100	80-125	80-125	135	175	190 (175 - 210 depending on quality)	150	150	325-340	320-360° depending on quality, 5 to 10 minutes
Insulation voltage Kv/mm	30 to 60	20 to 25	20 to 25	13	10 to 30	20 to 24	18 to 20	7,9	25	25
Miscellaneous	Numerous colors	Low UV resistance except black color	Low UV resistance except black color	The greatest flexibility	Low flexibility Very good resistance to chemicals and perforation	Good resistance to UV and radiations	Thick-walled, flexible	Very flexible	Difficult to shrink. Excellent chemical resistance	Very difficult to shrink. Excellent chemical resistance
Prix	1	3	8	15	22	30	50	60	75	100

* The lowest temperatures can shrink to 65 ° C with some crosslinked elastomers.
** EFF variants such as ETFE and PFA have similar characteristics.
*** Available in flexible version, with 150 ° maximum temperature. The low flexibility variant (175 ° C) is also known as Kynar.