POLE TO POLE,
ONE RELIABLE PARTNER IN HEAT TRACING

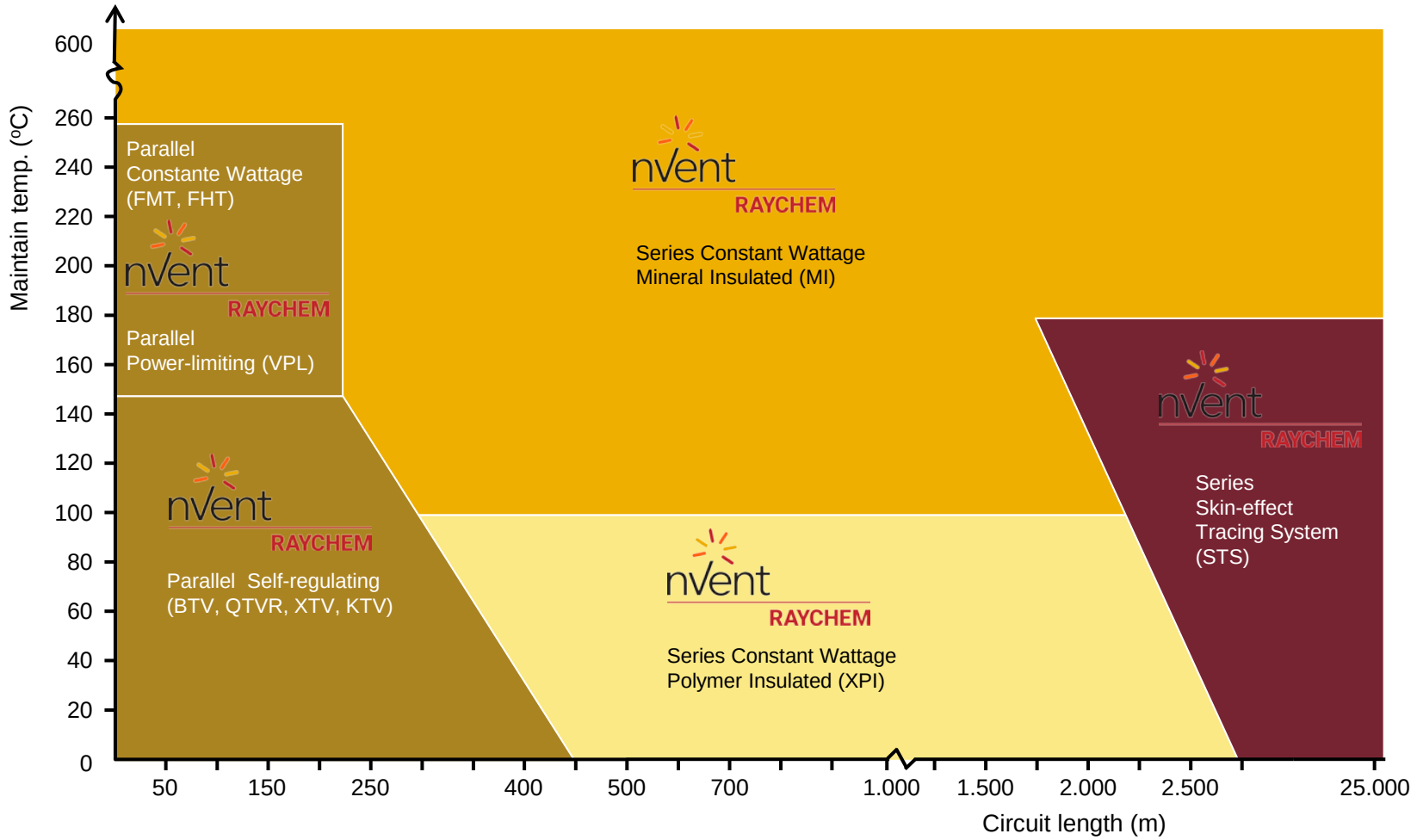
nVent

RAYCHEM

Why choose nVent RAYCHEM

1. As inventor of self-regulating heating technology, nVent RAYCHEM is the standard in heat-tracing, with +500.000 km heating cable installed in +100 countries
   - Widest range of high quality products, with 10 year product warranty
2. Complete heat tracing systems with most reliable system components & advanced control & monitoring offering
   - Easy installation, less maintenance, lower energy consumption
3. Excellent engineering & design capabilities
   - Best technical expertise, from small to mega projects
4. Biggest European distribution centre + local service centres
   - Outstanding product availability
5. Global company with local presence (2500 highly trained employees in 85 countries)
   - Excellent customer service support in your region

1. Widest range of high quality products



Parallel heating cables

Technology	Self-Regulating				Power-Limiting	Constant Wattage
						
Heating cable	BTV	QTVR	XTV	KTV	VPL	FMT/FHT
Max. maintain T	65°C	110°C	121°C	150°C	230°C*	230°C*
Max. exposure T	85°C	110°C	250°C	250°C	260°C	260°C
T-class	T6	T4	T3 (T2-20XTV)	T2	Auslegungs-abhängig	Auslegungs-abhängig
Max. circuit length	200m	115m	245m	230m	450m	330m
Max Power output @ 10°C	30W/m	64W/m	63W/m	65W/m	61W/m	40W/m
Nominal voltage	230Vac	230Vac	230Vac	230Vac	230V, 400Vac	230V, 400Vac
Applications	• Safety showers • Fire water lines • Process water • Chocolate production • Caustic lines	• Large bore water lines • Fuel oils • Acids • Fertilizers	• Large bore pipes • Steam-cleaned pipes • Oils • Polymers • Heavy fuels	• Heavy oils • High power output requirements • Steam-cleaned pipes	• Same + higher power output, higher maintain /exposure T, longer circuits • Medium size tanks • Vessels	• Same + higher maintain / exposure T, longer circuits • Economical cable, but more C&M required

Series Heating cables

Technology	Polymer Insulated (PI), Constant Wattage 			Mineral Insulated (MI), Constant Wattage 
Heizkabel	XPI-NH	XPI	XPI-S	Various metal sheath materials: HCCH / HCCH / HCC/ HCH / HCCP/ HCHP / HDC / HDF / HSQ / HIQ / Hax
Klassifizierung/ Schlagzähigkeit	Haz	Haz, 4J impact	Haz, 7J impact	Hazardous
Max. Dauernde Einsatztemperatur	260°C	260°C	260°C	1000°C*
Max. Interm. Einsatztemperatur	260°C	300°C	300°C	1000°C*
T-class	By design			By design
Max. Circuit length	Up to 5 km			Up to 5 km
Power output	35 W/m			Up to 300 W/m*
Nominal voltage	Up to 450/750 Vac (U_0/U)			Up to 600/600 Vac (U_0/U)*
Resistance ranges	0.8 Ω/km to 8000 Ω/km*			1 Ω/km up to 36000 Ω/km *

*For exact data, please refer to datasheet of each cable type

10 year product warranty

As an endorsement of our product quality & our commitment to providing customer value and peace of mind, we offer a 10 year product warranty program

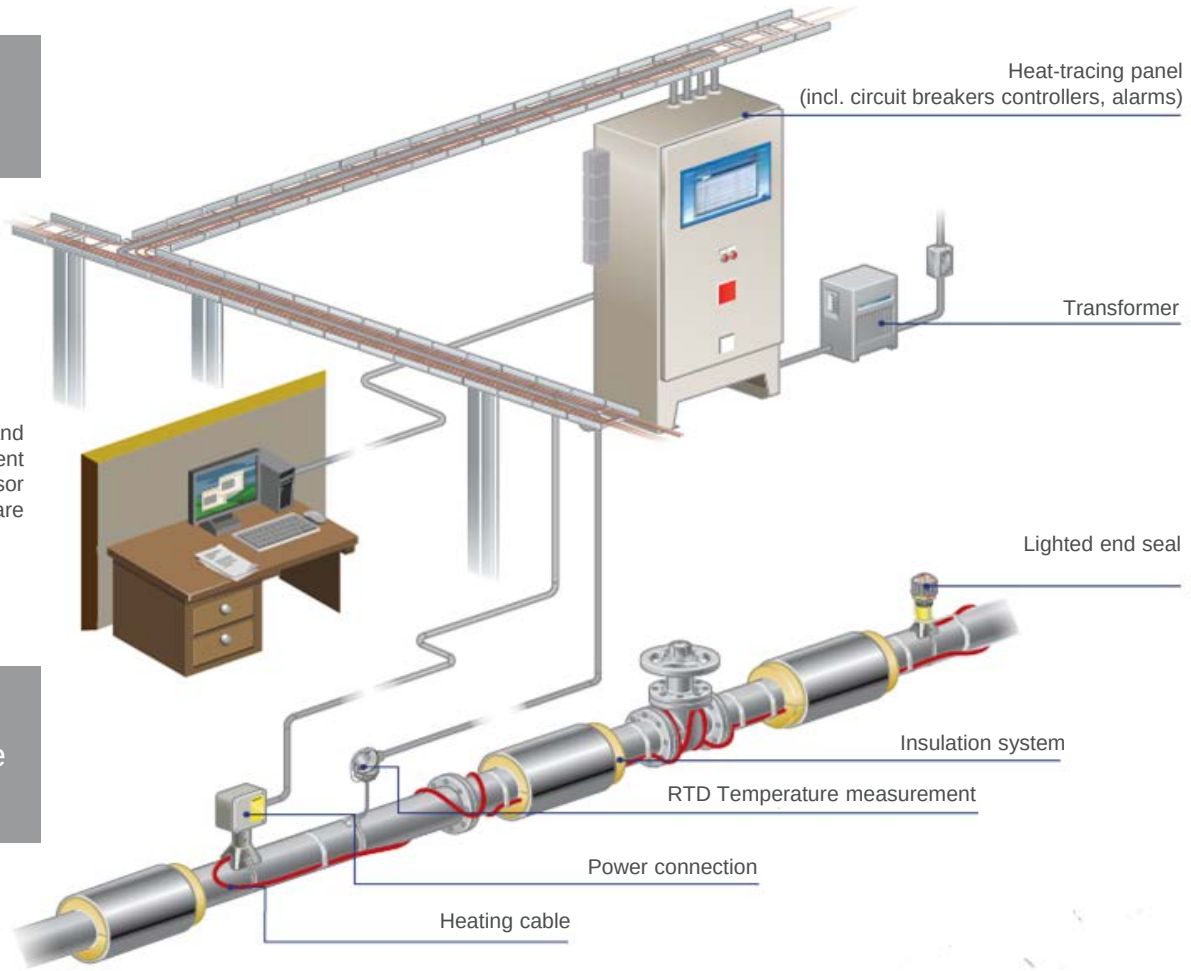
10 years warranty program available for following products:		
Brand	Type	Product
RAYCHEM	Heating cable	BTV, QTVR, XTV, KTV, VPL, FMT, FHT
	Component	Standard connection kits
RAYCHEM	Heating cable	XPI, XPI-S
	Component	Standard connection kits
RAYCHEM	Heating units	Factory pre-terminated MI heating units, using heating cable type HAx (Alloy 825)

- After online registration, and for installations inside Europe
- When installed, operated and maintained in line with our instructions
- For more information + registration: visit www.nVent.com

2. Complete solutions

Complete systems, with integral system approvals for hazardous area

From base line engineering to construction, commissioning and maintenance, we provide total care in heat-tracing

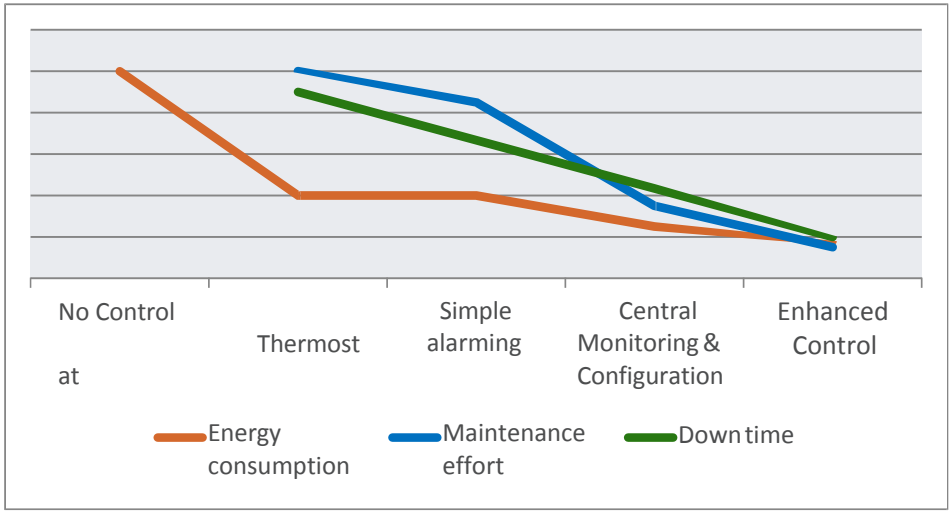


We manage the heat you need

Advanced control & monitoring systems

From the most proven and economical mechanical thermostats to the very latest innovations with online monitoring and integration in customer's DCS systems, we always provide a solution fit for purpose.

Maintenance categories	Actions
Central Monitoring	"Monitor its condition and replace it just before it fails"
Predictive	"Replace it one standard deviation before it statistically fails"
Preventive	"Oil it, and it will last longer"
Reactive	"If it breaks, fix it." (Mechanical thermostats)



Reduce downtime by smart monitoring

Advanced control & monitoring systems

Example of energy consumption on a 10 km traced pipe, as function of the selected control system

Average conditions										
Bergen, Norway										
Month	Average sunlight (hours)	Temperature				Discomfort from heat and humidity	Relative humidity		Average precipitation (mm)	Wet days (+0,25 mm)
		Average		Record						
		Min	Max	Min	Max		am	pm		
Jan	1	-1	3	-14	13	-	80	77	143	20
Feb	2	-1	3	-11	11	-	80	74	142	17
March	3	0	6	-10	20	-	79	67	109	16
April	5	3	9	-6	22	-	80	68	139	19
May	6	7	14	-2	27	-	78	64	83	15
June	6	10	16	1	32	-	83	71	126	17
July	6	12	19	5	31	-	86	73	142	20
Aug	6	12	19	4	30	-	87	73	168	20
Sep	3	10	15	1	26	-	87	74	228	21
Oct	2	6	11	-3	20	-	85	76	235	23
Nov	1	3	8	-6	15	-	81	77	211	21
Dec	0	1	5	-8	16	-	81	79	2014	22

Variable	Value
Pipe length	10.000 m
Maintain temp	5 °C
% of year below 5 °C	58 %
Process in flow condition	75 %
Energy cost	€ 0,10/kWh

Control system	Total energy/year [kWh]	Energy cost/year	% savings
Uncontrolled	1.321.735	€ 132.241,-	0 %
Ambient sensing	771.012	€ 77.084,-	42 %
PASC	215.904	€ 21.590,-	87 %
Line sensing	34.241	€ 3.373,-	97 %

Significant energy savings, by implementing advanced controls

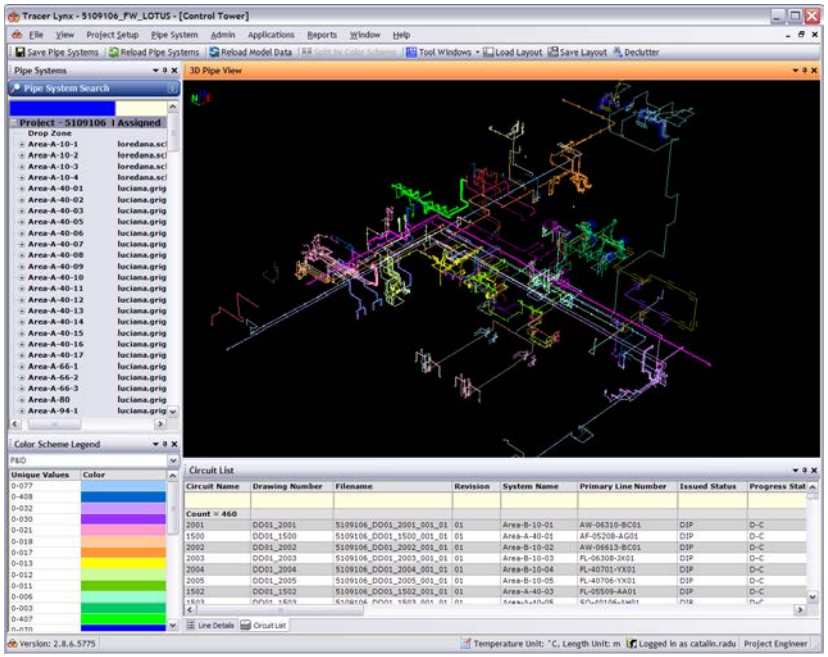
3. Excellent engineering & design capabilities

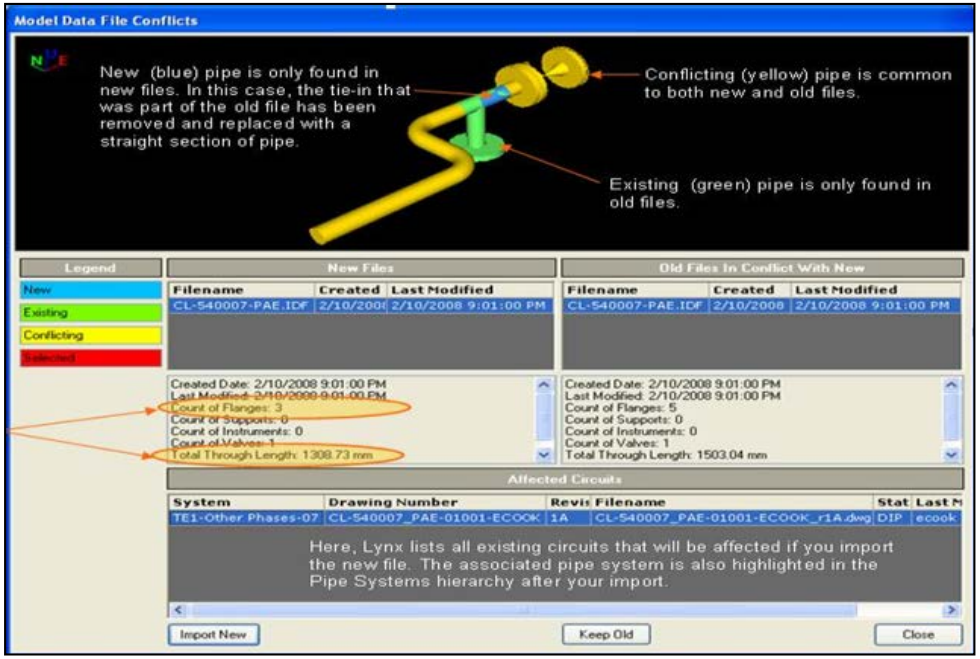
Best in class engineering heat-tracing design software based on decades of expertise, with thousands of active users

TraceCalc Net

TraceCalc Pro

TRACERLYNX





From small to mega projects, we manage the heat you need

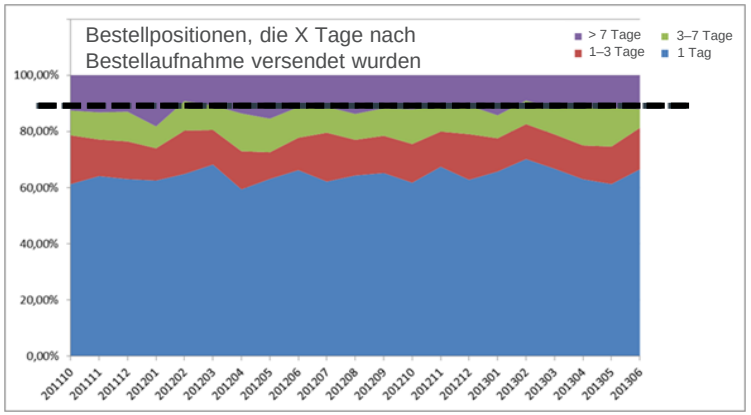
4. Outstanding product availability

- Biggest European distribution center for heat-tracing products (Leuven, Belgium)

- Most products available from stock:
  - 2000 different products, 10.000 locations, 5000 m² storage space
  - 2500 km of heating cables, 7500 industrial junction boxes, ..
  - Weekly replenishment from manufacturing plants & main suppliers

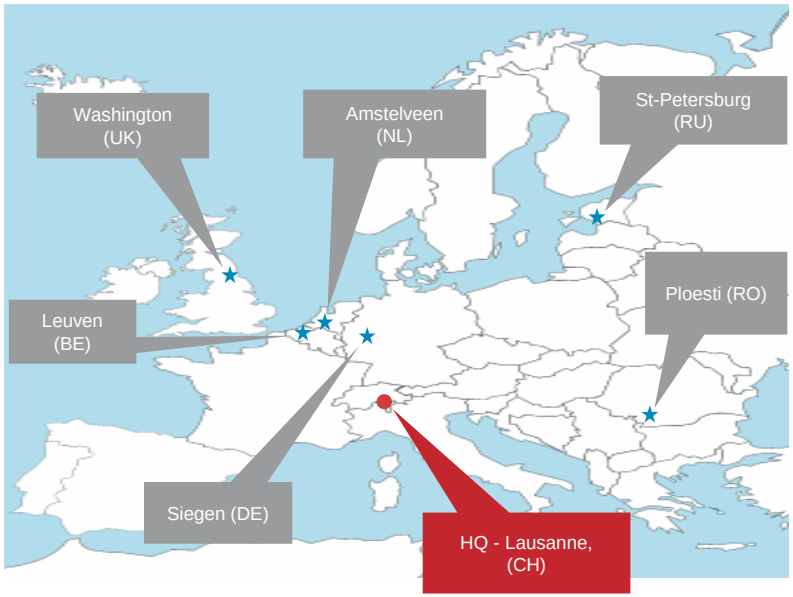
4. Outstanding product availability

- Best-in-class logistics and operational excellence, based on Pentair Integrated Management System (PIMS)
  - Production of 620.000 kits/year, 380.000 sub-kits/year
  - Handling of 160.000 order lines/year in 43.000 shipments
  - 95% on time delivery to promised date, 90% shipped within 7 days (includes non-standard items)



5. Excellent customer service support

- Local presence in most European countries + central customer service center in Belgium
  - handling >6000 customer calls/month
- ATEX and IECEx certified R&D lab
  - Rigorous testing at temperatures from -70°C to +600°C
- 6 regional design centers + highly trained field service engineers throughout Europe
  - We can handle complete projects.
  - This eliminates accountability of multiple contractors, or ineffective administrative issues



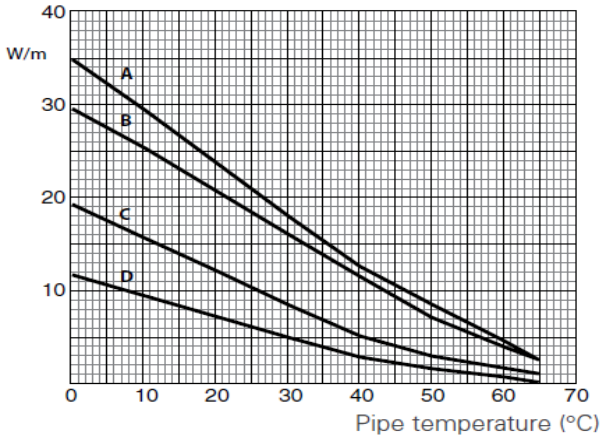
Parallel Self-Regulating heating systems

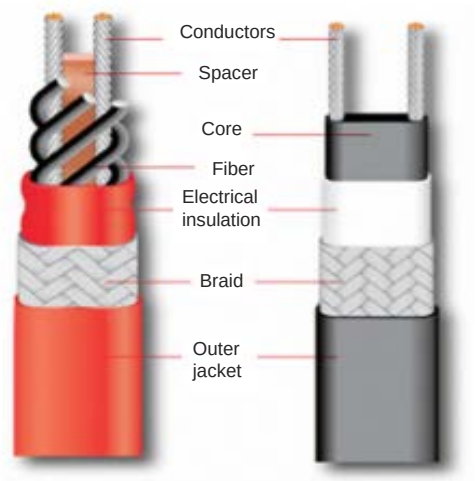
Parallel Self-Regulating heating systems

- What is it?
  - A polymer based parallel heat-tracing cable which inversely varies its power output, depending on the actual pipe/surface temperature

- What does it look like ?

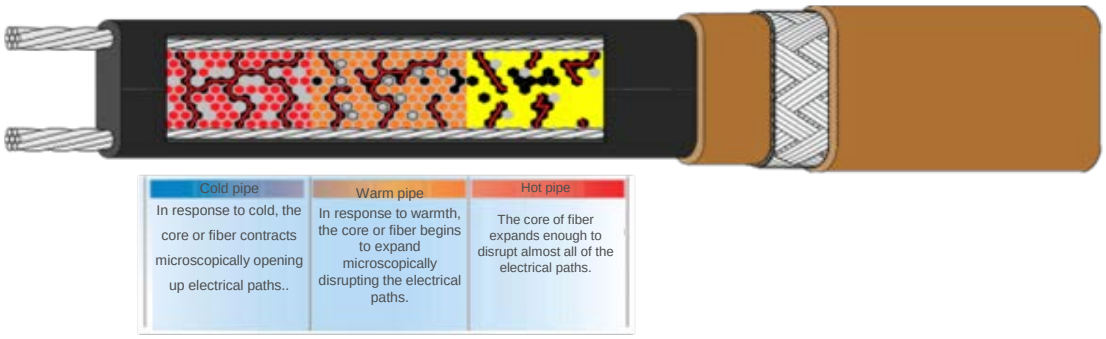
2 Conductors	Transport of electric current
Core (BTV, QTVR) or fiber (XTV, KTV)	Conductive polymer generates heat
Inner jacket	Electrical insulation
Metallic braid	Electrical ground path
Outer jacket	Protects cable and increases mechanical strength

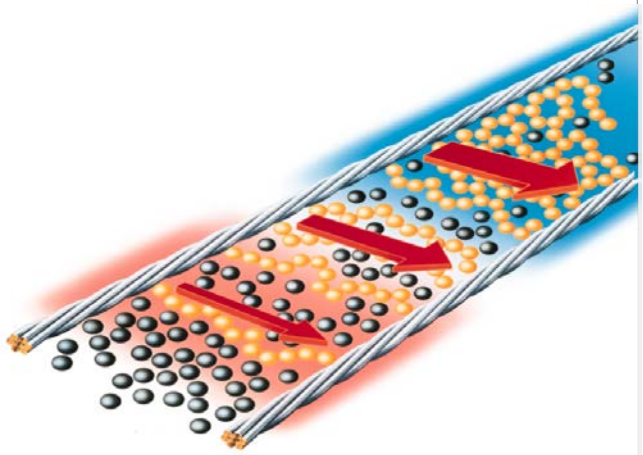




Parallel Self-Regulating heating systems

- How does it work?
  - The core is a mixture of polymer & conductive carbon black, creating electrical paths between the conductors
  - Lower pipe temperatures result in microscopic contraction of the core, more electrical paths between conductors, higher current, and higher power output of cable
  - Higher pipe temperatures result in microscopic expansion of the core, less electrical paths between conductors, lower current, and lower power output of the cable

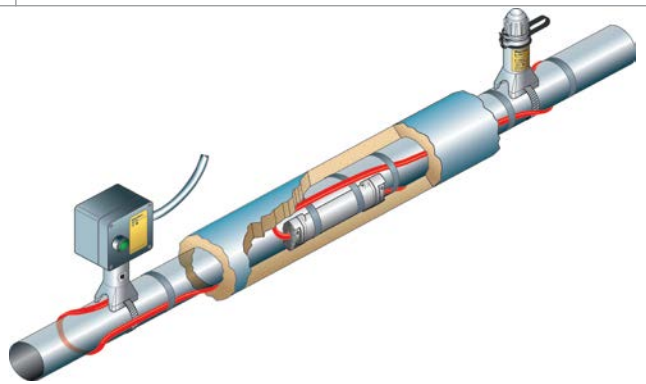




Parallel Self-Regulating heating systems

- Key benefits:

Parallel Construction	Cut-to-length, easy to install
Self-regulating	Uniform pipe temperature, lower energy costs, can be overlapped, suitable for complex pipework
Unconditional T-rating	Safe design (independent of length), cables don't overheat, complete system approval for hazardous areas
Cross-linking technology (pioneered by RAYCHEM)	Reliable, long life: successful in operation for decades
Parallel Construction	Cut-to-length, easy to install



Why choose nVent RAYCHEM?

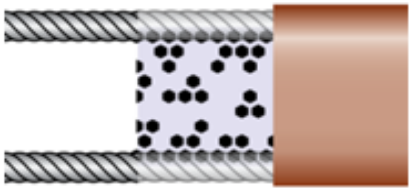
1. Uniform carbon dispersion in the conductive core
    1. Uniform heat distribution

- Excellent electrical contact between conductor and core
    - Durable contact, no cold or hot spots, no burnouts
- Tight insulating jackets
    - Efficient heat transfer
- Advanced connection kits
    - Fast and secure installation, simple product selection
- Reliable power output & long life
    - Supported by a 10 year product warranty

1. Uniform carbon dispersion

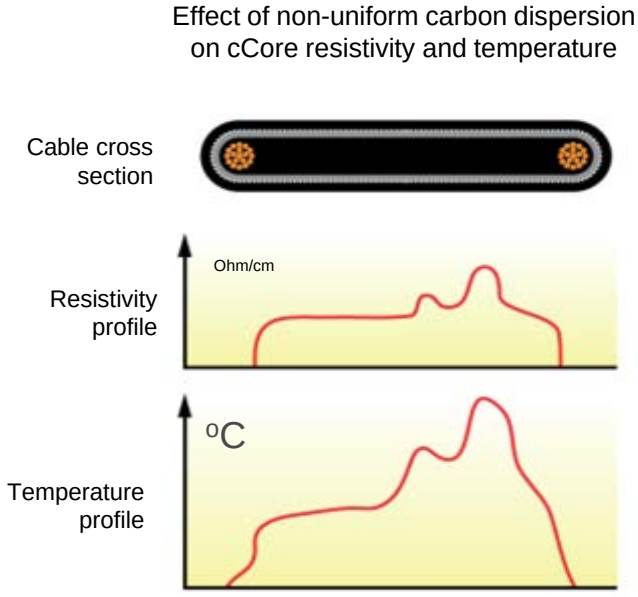
- The uniform distribution of carbon particles in all nVent RAYCHEM self-regulating heating cables prevents localized internal overheating and maximizes the life of the cable

Good dispersion



Poor dispersion

Effect of non-uniform carbon dispersion on cCore resistivity and temperature



Widerstandsspitzen führen zu lokalen Übertemperaturen und frühem Produktversagen

Poor particle dispersion is one cause of premature cable failure

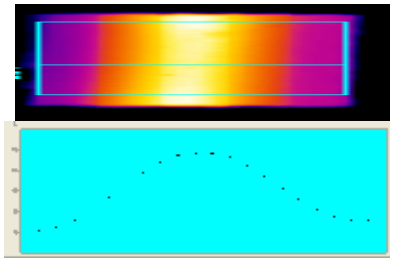
2. Excellent electrical contact

- All nVent RAYCHEM self-regulating heating cables have good contact between conductive core and the bus wires over its entire length, eliminating hot or cold spots and premature cable failure

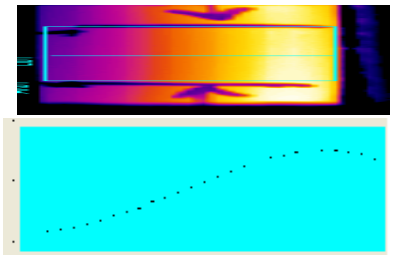
Good contact

Poor contact

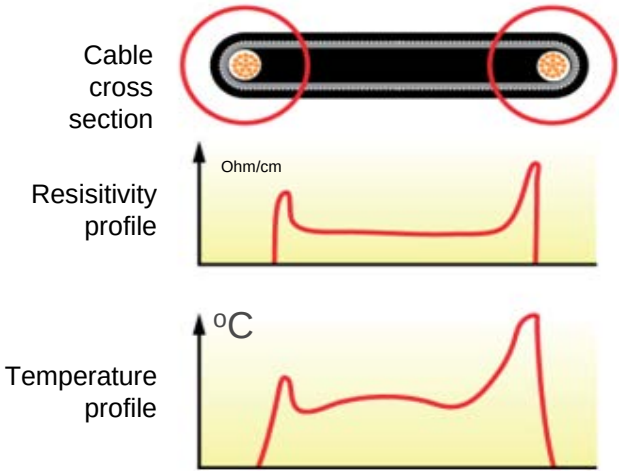
20QTVR



Competitor A



Effect of poor electrical contact on core resistivity and temperature



Poor electrical contact is another cause of premature cable failure

3. Tight insulating jackets

- The tight fit of the insulating jacket on all nVent RAYCHEM self-regulating heating cables maximizes the transfer of heat from cable to pipe, saving energy while eliminating premature aging of the cable.

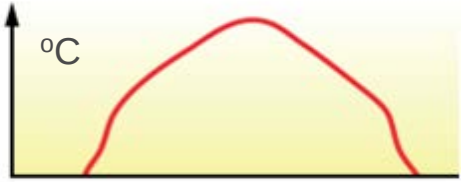
Tight jackets
(No air pockets)

Loose Jacket

Temperature profile –
Loose electrical insulating jacket

Cable cross section

Temperature profile



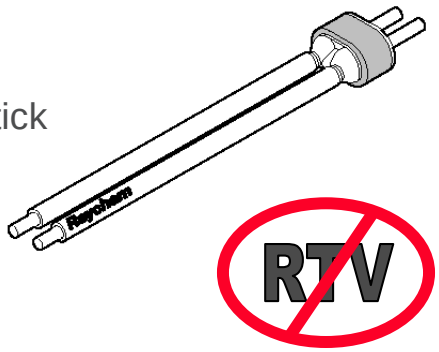
nVent RAYCHEM cable: Good control of core & jacket extrusion process

Competitive cable: poor control of core & jacket extrusion process

Loose insulating jackets can cause poor heat transfer from cable to pipe

4. Advanced connection kits

- One range for all nVent RAYCHEM industrial self-regulating cables
  - 10 year warranty available
  - Integral part of hazardous area system approval
  - Spacious boxes with front access & captive lid screws
  - Cold applied = no hot work permit needed
  - Patented nVent RAYCHEM core sealer without RTV (silicone RTV does not stick to fluoropolymer jackets)
  - Robust spring type terminals: fast & secure fixing
  - Fewer parts (only 7 parts per JBS-100) = less time to install
  - Visible monitoring the status of power and continuity (for lighted kits)
  - Anti-static and corrosion resistant

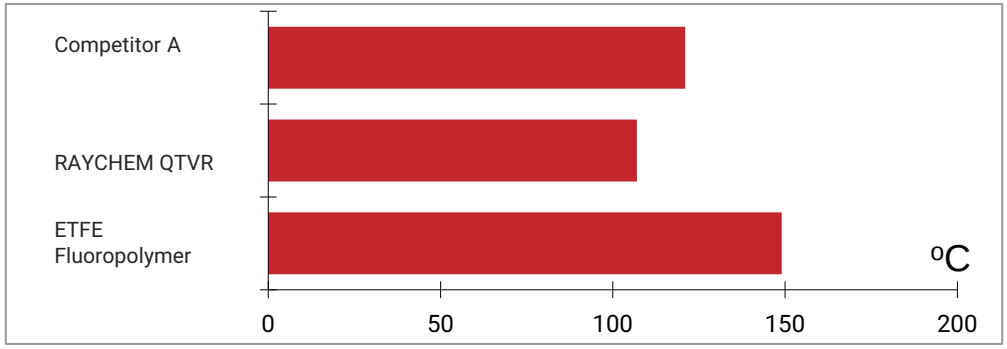


nVent RAYCHEM kits are simple to install, and extremely reliable

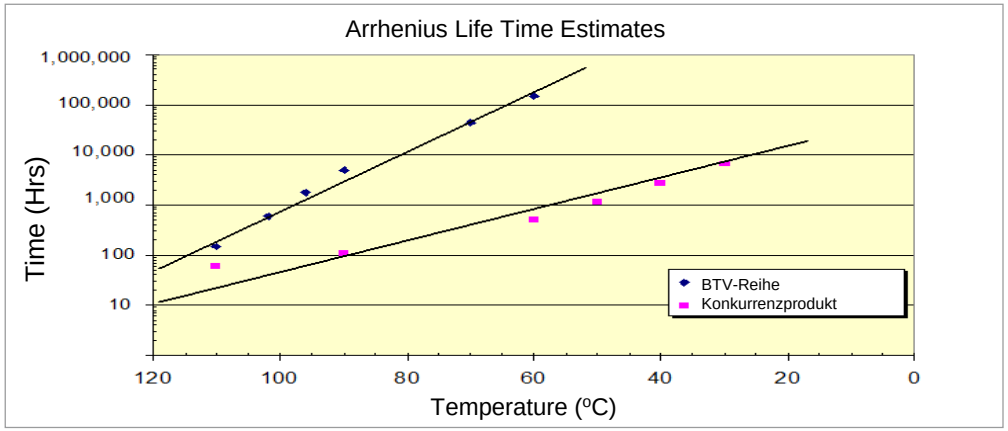
5. Reliable power output and long life

- As the inventor of self-regulating heating technology we have +40 years of experience in manufacturing best-in-class products, with over 500.000 km heating cable installed worldwide.

- Reliable product temperature ratings (in °C), Conservative approach fully backed up by polymer manufacturer's data



- Long product life by design and R&D expertise



5. Reliable power output & long life

- nVent RAYCHEM self-regulating heating cables are designed for a useful life of 20 years or more with „power on“ continuously, based on following criteria:

Retention of at least 75 % of nominal rated power after 20 years of operation at maximum published continuous exposure (maintain) temperature	Retention of at least 90 % of nominal rated power after 1000 hours of operation at maximum published intermittent exposure temperature

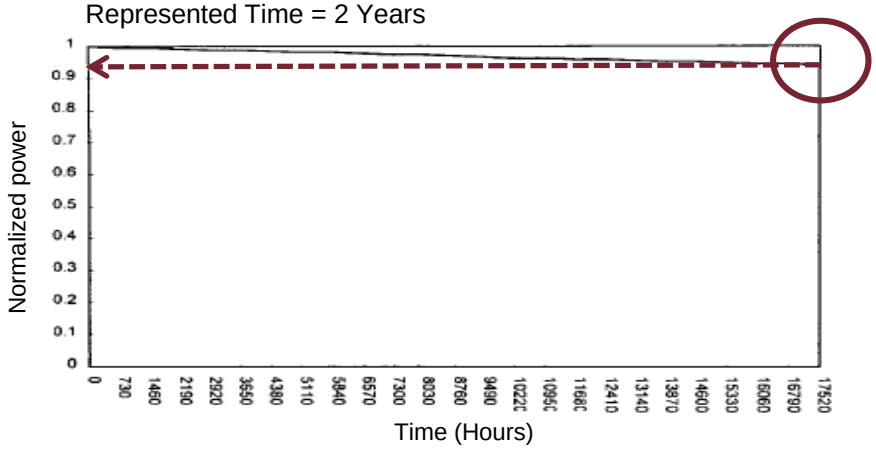
- Testing shall conform to UL 746B, IEC216-1 part 1
- In order to establish the life rating for self-regulating heating cables the Arrhenius model is being used

5. Reliable power output & long life

- nVent RAYCHEM self-regulating heating cables have a reliable power output throughout the entire product life. As the inventor of self-regulating cables we have gained over 40 years of experience and have delivered over 500.000km of cable around the world.

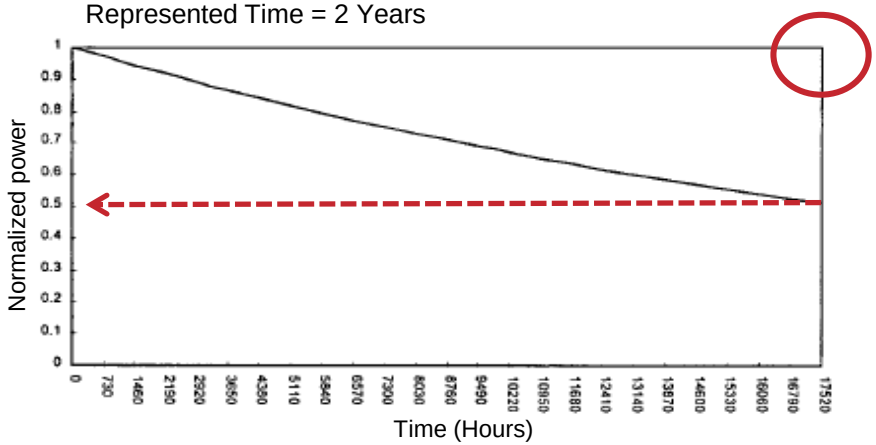
Accelerated aging tests - nVent RAYCHEM sample

Estimated Power Decay of XTV at 300 F
1 Year = 8 760 hours
Represented Time = 2 Years

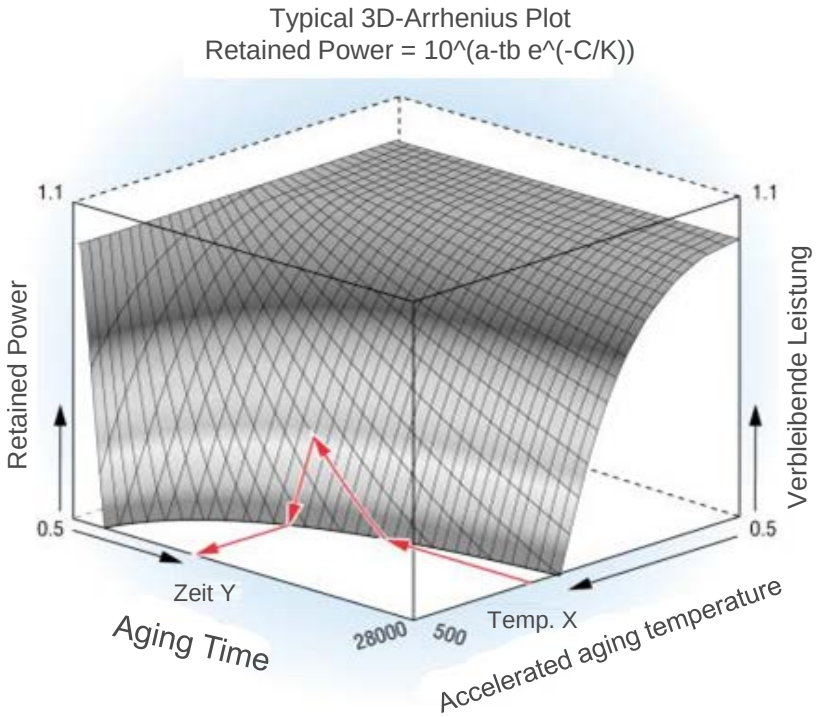


Accelerated aging tests - Competitor sample

Estimated Power Decay of 300 F
1 Year = 8 760 hours
Represented Time = 2 Years



Accelerated aging with Arrhenius model



- Accurate formula for temperature dependence of rate of a chemical reaction

$$k = Ae^{-E_a/RT}$$

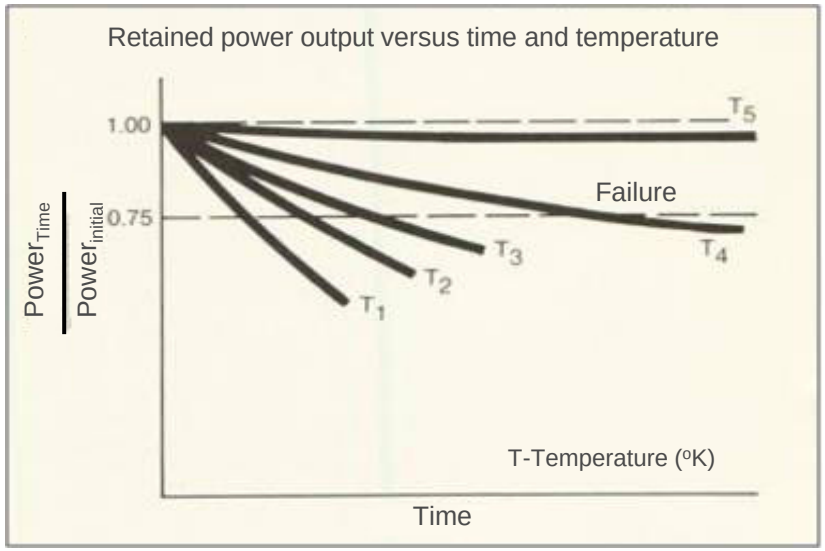
Where:
- k = Rate Constant
- A = Pre-exponential factor
- E_a = Activation energy
- R = Gas constant
- T = Absolute temperature, K

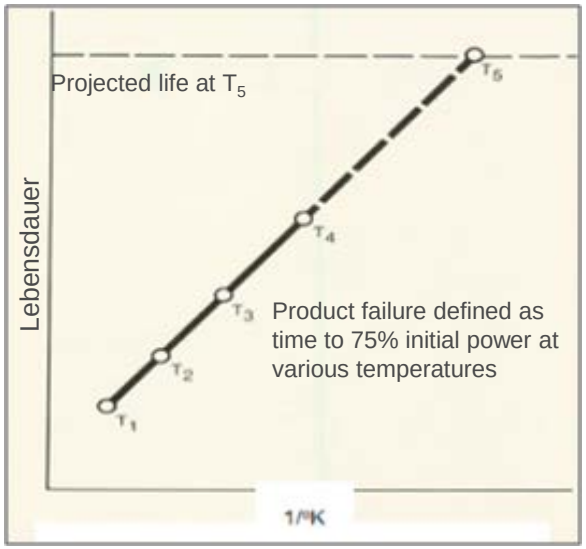
- A historically useful generalization supported by the Arrhenius equation is that, for many common chemical reactions at room temperature, the reaction rate doubles for every 10°C increase in temperature.

Accelerated aging with Arrhenius model

- Use aggravated conditions of heat, oxygen, sunlight, vibration, etc. to speed up the normal aging processes
- Help determine the long term effects of expected levels of stress within a shorter time, usually in a laboratory by controlled standard test methods
- Estimate the useful lifespan of a product when actual lifespan data is unavailable

Procedure: Test at high temperatures and extrapolate failure rate to lower temperatures



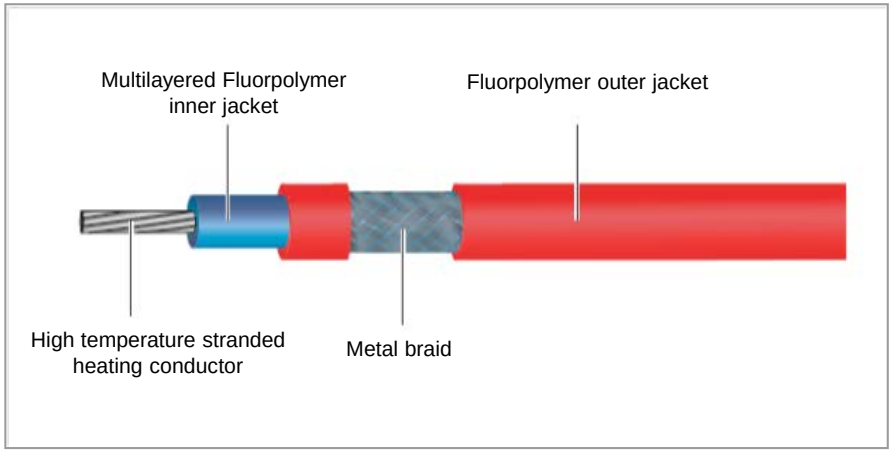


Polymer Insulated (PI) series heating systems

Polymer Insulated (PI) series heating systems

- What is it?
  - PI series heating cables are coaxial cables of which the central conductor produces heat and the inner and outer insulation jackets are all polymer based

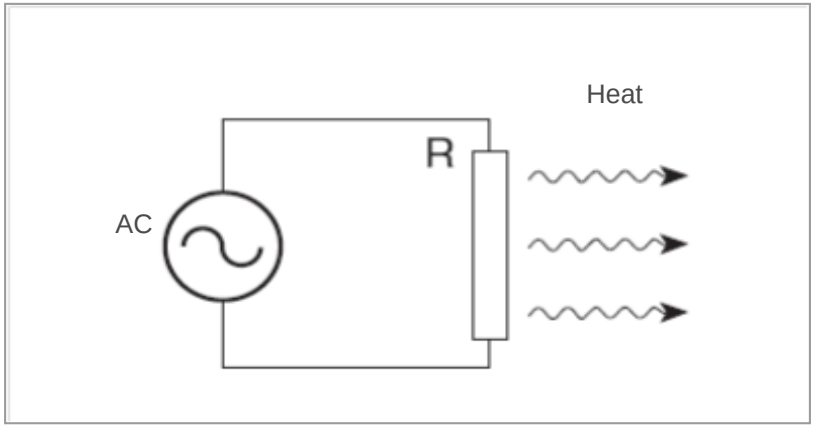
- What does it look like?



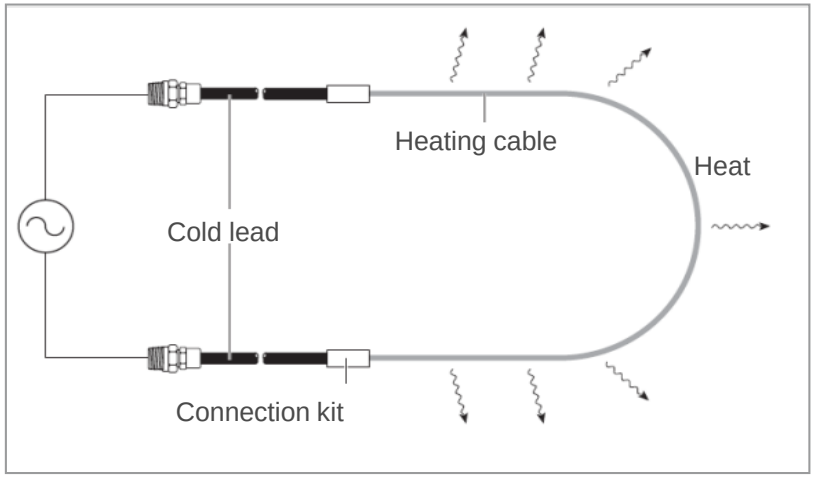
High temperature stranded central conductor	Generates heat
High temperature inner insulation jacket	Electrical insulation, stable across full temperature range
Metallic braid	Provides low ohmic ground path and mechanical strength
High temperature outer insulation jacket	Protection against the environment

Polymer Insulated (PI) series heating systems

- How does it work?
  - Heat is generated by the principle of ohmic resistance heating of the central conductor, which uses various materials to provide a specific resistance

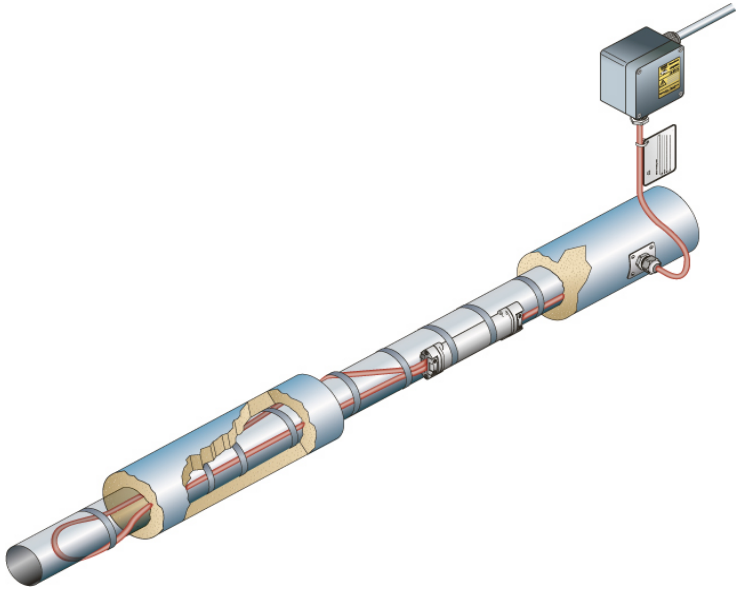


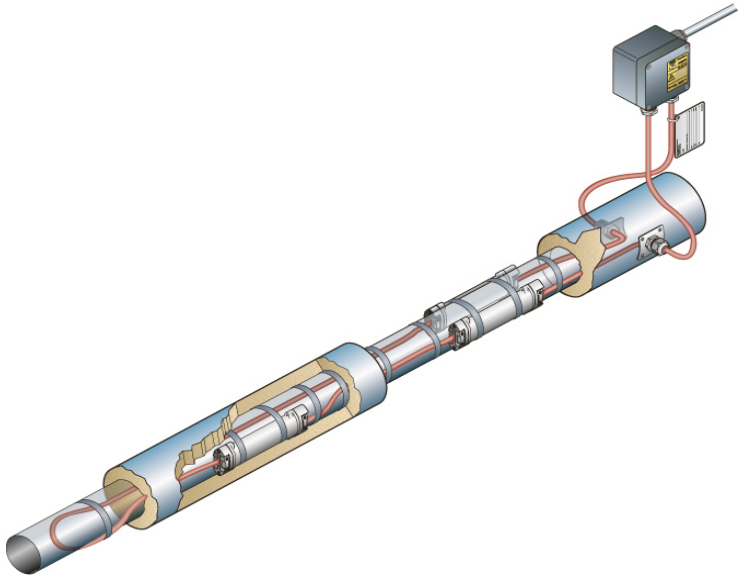
  - The heating cables are typically equipped at both extremities with non-heating sections, referred to as cold lead(s), to avoid a hot cable being exposed (safety purpose) and adding heat to the power connection



Polymer Insulated (PI) series heating systems

- PI series resistance heating cables allow for circuit lengths exceeding those of parallel heating cables (typically < 250 m).
  - This makes them particularly suitable for long pipelines and large tanks / vessels.
  - They offer an economical alternative to parallel heating systems.



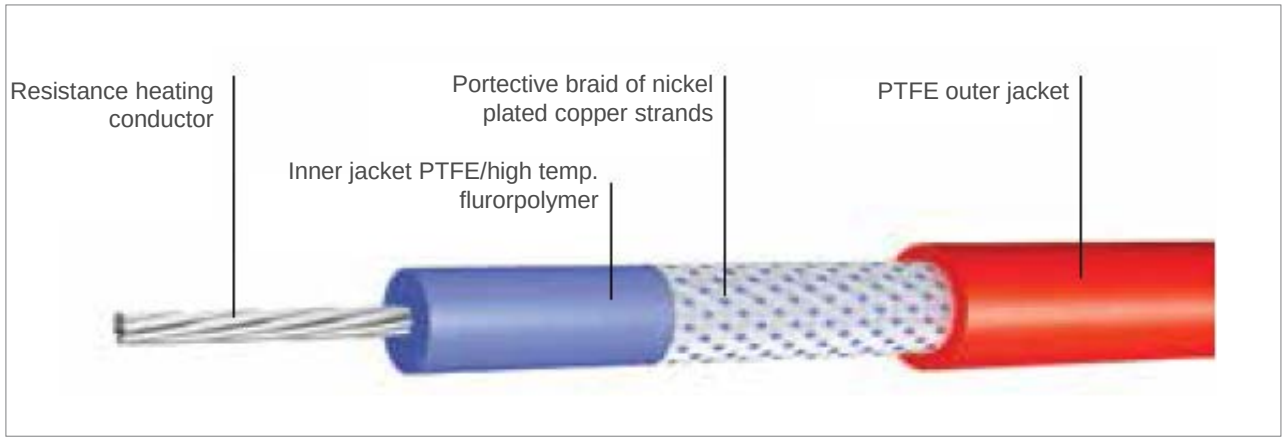


Why choose nVent RAYCHEM PI systems?

1. Nickel plated stranded conductor
   - Long life at elevated temperatures in corrosive
2. Seamless high temperature inner insulation jacket
   - No cold or hot spots, no burnouts
3. Excellent concentricity of insulation jacket
   - Reliable electrical insulation over product life, no conductor displacement, also when tightly bent
4. Use of PTFE in inner and outer jacket
   - Best thermal, electrical and chemical characteristics in the market
5. The most reliable connection kits
   - Secure and long-lasting installation at elevated currents & temperatures

1. Nickel plated stranded conductor

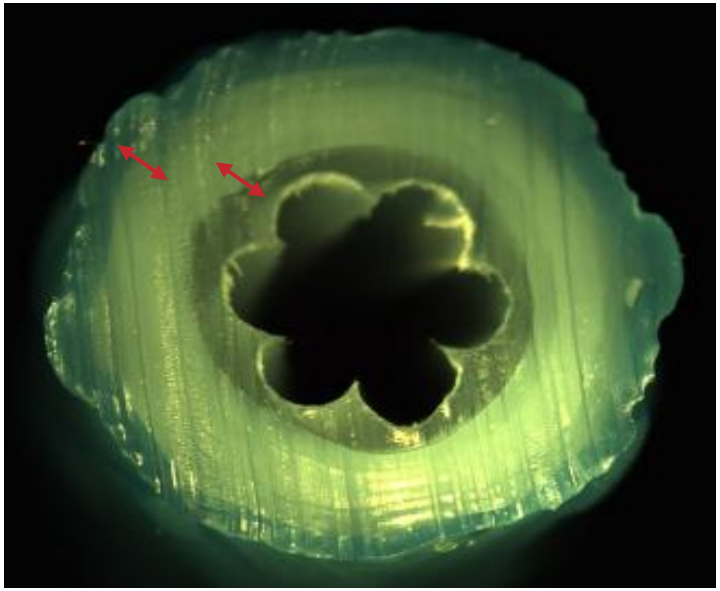
- nVent RAYCHEM XPI heating cables use high temperature stranded conductors which are either Nickel plated or corrosion resistant by use of conductor wire based on alloys with high nickel content (>20% Nickel).
  - This ensures a long life at elevated temperatures even in very aggressive corrosive environments.



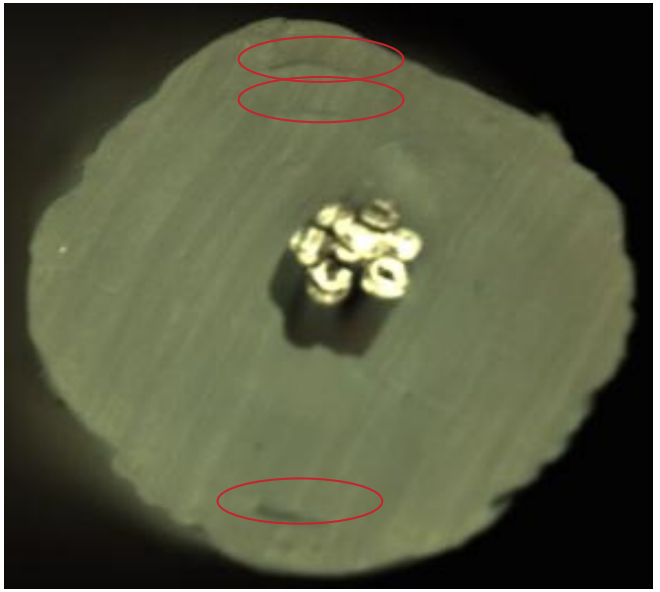
2. Seamless inner insulation jacket

- nVent RAYCHEM XPI heating cables use a seamless high temperature fluoropolymer sandwich inner insulation jacket. The sandwich construction of PTFE and high temperature fluoropolymer (for XPI and XPI-S) form one chemically bonded jacket without voids or gaps.

nVent RAYCHEM sample: One bonded jacket without voids or cracks



Competitor sample: gaps are found between the sintered layers

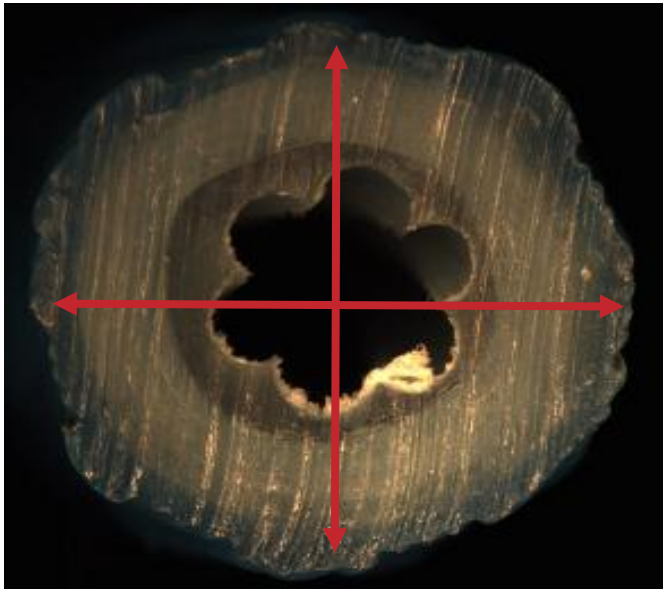


Air gaps in the insulation jackets are a reason of premature failure

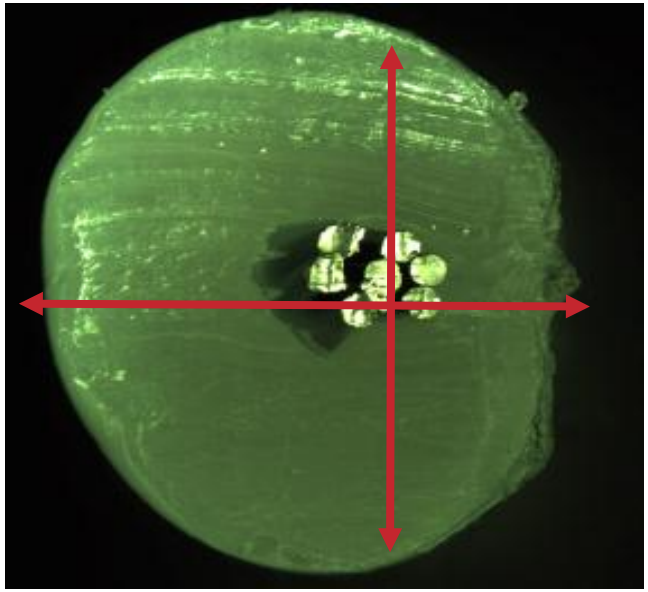
3. Excellent concentricity of insulation jacket

- XPI heating cable uses a consistent insulation thickness and well-centered conductors. This requires very good process control during production and results in an electrically very stable cable over its entire temperature range.

nVent RAYCHEM sample: Conductor well centered / consistent insulation thickness



Competitor sample: conductor not well centered / inconsistent insulation thickness



Inconsistent cable structure is a reason for premature failure

4. PTFE in inner and outer jackets

- Excellent material properties of PTFE:
  - High chemical resistance over its entire temperature range against the most aggressive chemical environments
  - Excellent mechanical and electrical properties over temperature range. The hardness and dielectric strength remain practically constant up to 300°C and don't decrease even after a prolonged temperature exposure (tested for 6 months at 300°C)
  - Excellent temperature withstand capabilities

Material	Max. continuous temperature	Melting temperature	Degradation temperature
PTFE	260 °C	327 °C (**)	400 °C
PFA	260 °C	304 °C	327 °C

** Above 327°C PTFE transforms from crystalline structure to an amorphous material but keeps its shape (unlike PFA which gets softer as it approaches its melting temp...)

5. The most reliable connection kits

- Connection kits are critical components in a series heating system
  - Developed for optimum performance and highest reliability with XPI heating cables
  - Off-the-shelf components for systems up to 100A, in all configurations
  - Compatible all across the 3 XPI heating cable families
  - An integral part of the system certification (no separate risk assessment required)
  - Complete range of tools for easy and most reliable installation

nVent RAYCHEM kits have proven their reliability in the most harsh environments

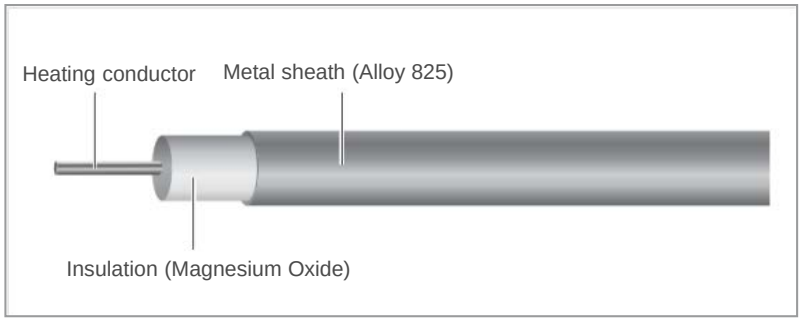
Mineral Insulated (MI) series heating systems

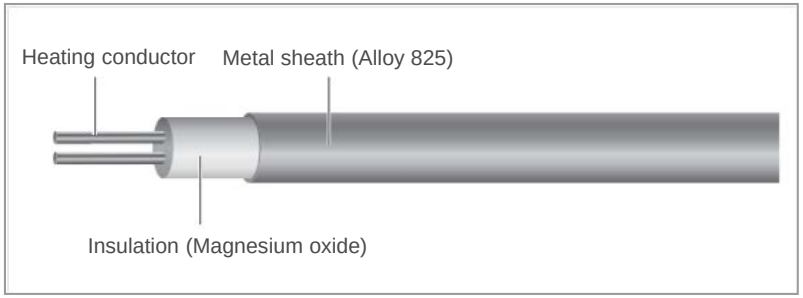
Mineral Insulated (MI) series heating systems

- What is it?
  - MI heating cables consist of one or two conductors embedded in a highly compacted magnesium oxide insulation surrounded by a metal sheath

- What does it look like?

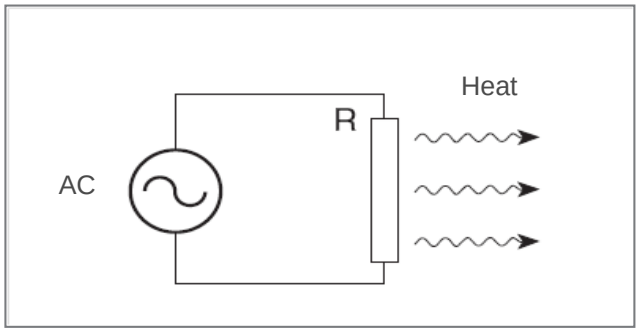
One or two solid central conductor(s)	Generate heat
Highly compacted dielectric Magnesium Oxide (MgO)	Electrical insulation
Metallic outer jacket	Low Ohmic ground path and protection against the environment



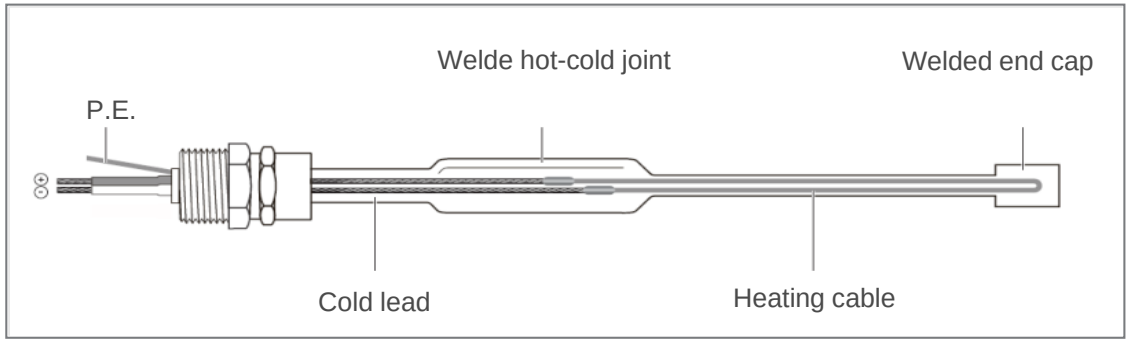


Mineral Insulated (MI) series heating systems

- Heat is generated by the principle of ohmic resistance heating of the central conductor, which uses various materials to provide a specific resistance

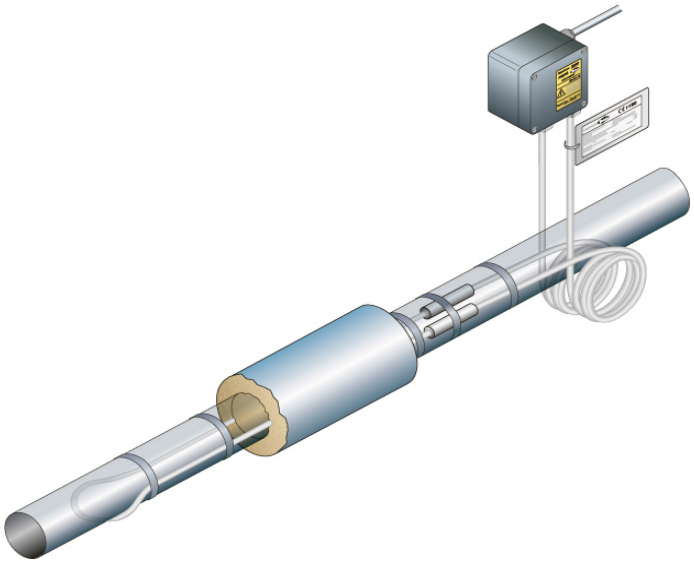


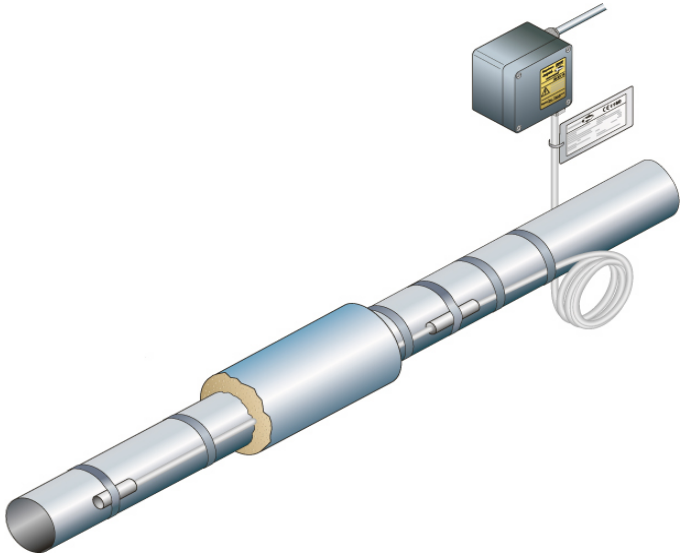
- The heating cables are typically equipped at both extremities with non-heating sections, referred to as cold lead(s), to avoid a hot cable being exposed (safety purpose) and adding heat to the power connection



Mineral Insulated (MI) series heating systems

- Maintain temperatures up to 600°C* and withstand exposure temperatures up to 1000°C
  - A wide resistance range makes them suitable from short instrument lines to very long transfer pipelines (up to 5 km from single power supply)
  - Maximum power output well exceeds range of any polymeric heating cable making them often the only alternative for high heat-loss and when fast heat-up is required





* Depending on the termination method & materials used, higher temperatures are possible

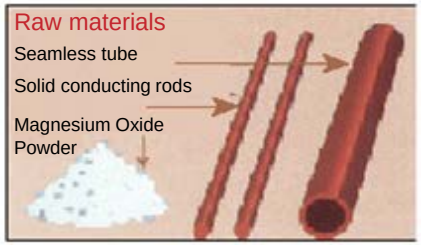
Why choose nVent RAYCHEM MI systems?

1. Seamless outer jacket
   - Superior strength and flexibility
2. Large variety of sheath materials and resistances
   - Suitable for all wide range of applications and environments
3. Dual conductor offering
   - Reduced installation time, lower installed cost for short lines
4. Factory-terminated with laser welded terminations
   - Superior quality and reliability
5. Superior engineering software (TraceCalc Pro)
   - Safe and easy design proving reliable performance

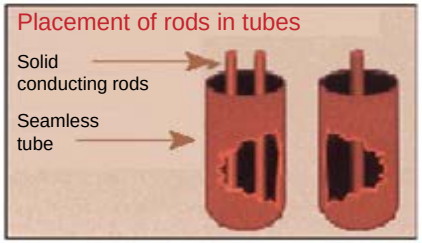
1. Seamless outer jacket

- nVent RAYCHEM MI cables are made of metallic tubes that are drawn to the required size. This construction provides a very rugged heating cable with superior strength in dynamic cut-through and crush tests. Special annealing processes maximize flexibility for ease of on-site handling.

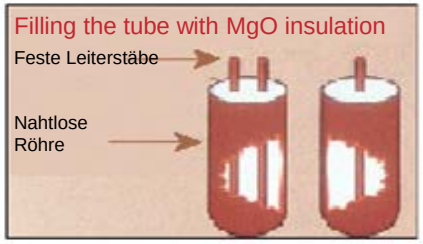
The nVent RAYCHEM manufacturing process and 100 % QC produces total reliability



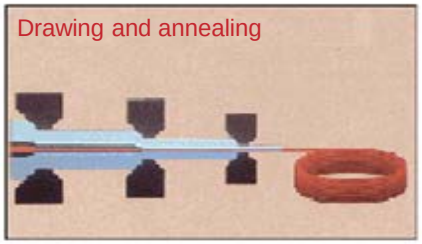
1.nVent RAYCHEM mineral insulated cable is manufactured from two raw materials: copper and magnesium oxide. The process begins with a 30‘ seamless copper tube, 21/2“in diameter, which ultimately becomes the cable‘s copper sheath.



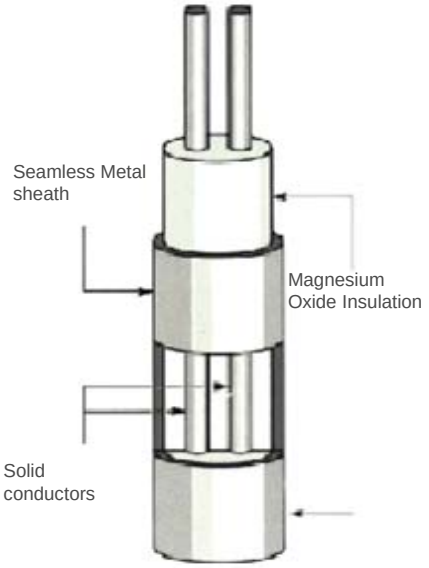
2. While in the vertical position, solid copper rod(s) which will become the cable‘s conductor(s) are positioned inside the tube, Magnesium oxide powder, the insulating componed, is poured into the tube.



3. As it is being poured, the magnesium oxide is solidly packed by powerful compression machinery. The filled 30'tube is then put through a series of drawing and annealing operations.



4. Once the cable diameter desired is reached, the cable receives a final anneal to produce ist exceptional flexibility.



Net rsult – a complete electrical cable system

2. Multiple sheath materials, wide resistance range

- nVent RAYCHEM MI cables are available in various sheath materials to match all kind of applications. Resistances from 2 Ω/km to 36000 Ω/km, covering applications from very short instrument lines to long transfer pipelines.

  The selection of sheath material is a balance between:

  - The required resistance to corrosion (dictated by industrial environment and associated products)
  - The required temperature resistance & power output

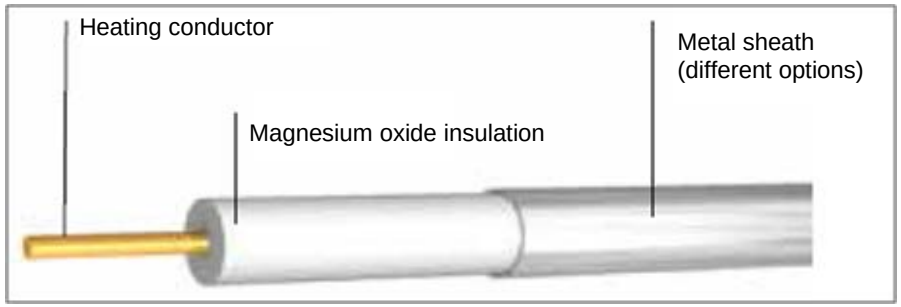
Cable reference	Sheath material	Max. sheath temperature	Max. typical* power output
HCCH / HCHH	Copper with HDPE over sheath	80°C	50W/m
HCC / HCH	Copper	200°C	
HCCP / HCHP	Copper with FEP over sheath		
HDC / HDF	Cupro-Nickel (70/30)	400°C	70W/m
HSQ	Stainless Steel 321	450°C with silver solder joint	150W/m
		750°C with laser welded joint	
HIQ	Inconel 600	450°C with silver solder joint	300W/m
		750°C with laser welded joint	
HAx	Alloy 825	550°C with silver solder joint	270W/m
		750 °C with laser welded joint	

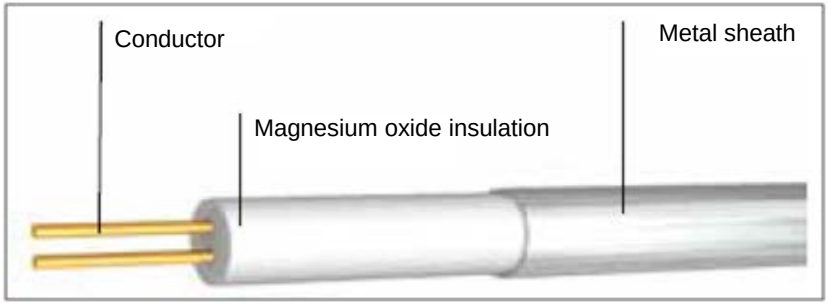
	Sulphuric acid	Hydrochloric acid	Hydrofluoric acid	Phosphoric acid	Nitric acid	Organic acids	Alkalis	Salts	Sea water	Chlorides
Copper – HDPE	GE	GE	A	A	A	NR	A	A	A	A
Copper	NR	NR	A	A	NR	A	A	X	NR	X
Copper – FEP	GE	GE	A	A	A	A	A	A	GE	GE
Cupro-Nickel	NR	X	X	X	X	X	X	X	GE	GE
Stainless steel	NR	NR	NR	NR	X	GE	A	A	NR	NR
Inconel 600	X	X	A	X	X	GE	GE	GE	A	GE
Alloy 825	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE

GE	Good to excellent
A	Acceptable
X	Check for specific data
NR	Not recommended

3. Single and dual core offering

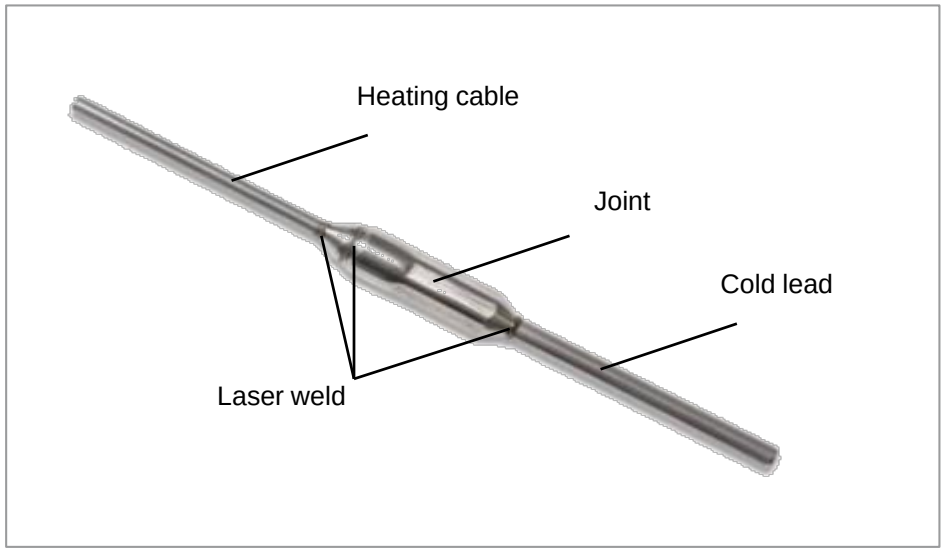
- nVent RAYCHEM MI cables are available with single and dual conductors. Advantages of dual conductors are:
  - Significant technical advantage when space is limited or when high resistances are required. (e.g. high temperature instrumentation lines, short branches)
  - Reduced installation time since only half of the cable length is required compared to an equivalent single conductor heating cable





4. Laser welded terminations

- Possibility to have the joints assembled by laser welding.
  - This technology, which is available for all Stainless Steel, Inconel 600 and Alloy 825 cables (single and dual core), allows maximum control of the welding process and optimization of the penetration depth of the energy beam.



5. Superior in-house technical expertise

- Manufacturing of nVent RAYCHEM MI heating cables since 1948 (originally branded PYROTENAX)
- Very wide installed base of products operating all over the world
- In house development of all products & continuous optimization of production processes for optimum reliability & consistent quality
- Designed for use in hazardous areas, supported by system approvals for global usage (without any need for risk assessment)
- Designs are supported by the most comprehensive design software in the market

Thank You