

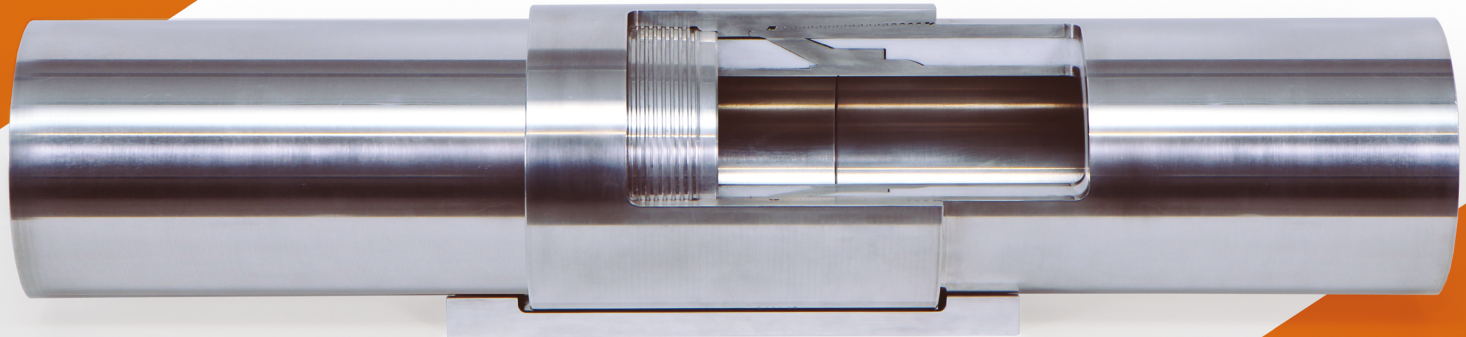


VACUUM INSULATED TUBING

VACUUM INSULATED TUBING



Vacuum Insulated Tubing (VIT) is designed to develop oil and gas fields located in the most challenging oil and gas production conditions in the permafrost and/or in zones characterized by gas hydrate / paraffin deposition, high viscosity of extracted hydrocarbons.



TIMELINE OF VIT DEVELOPMENT IN TMK

Type of thermal insulation	Design features	Performance specifications
Since 2010		
<p>Vacuum Insulated Tubing</p> <p>Vacuum shield thermal insulation</p>	<p>In accordance with the design, a shield of foil and basalt fiber fabric (together with gas absorbers) is installed in the annular space.</p> <p>Vacuum is created in the annular space. A fluoroplastic coupling insert is placed inside the coupling.</p> <p>"Pre-stressing" of the internal pipe is performed in the VIT designed for operation at high temperatures.</p>	<p>Operating temperature: up to +350°C Operating pressure: up to 16MPa Thermal conductivity (K-factor) along the pipe body, W/(m*K): up to 0.012 (+220°C), up to 0.02 (+350°C) Thermal conductivity (K-factor) of the fluoroplastic coupling insert, W/(m*K): up to 0.25</p> <p>The pipes are used for the following:</p> <ul style="list-style-type: none"> • Prevention of wellbore thawing in permafrost zones • Prevention of formation of gas hydrate, asphalt, resin, and paraffin depositions • Injection of superheated fluids into the reservoir in order to heat up high-viscosity oils during development by cyclic steam heating methods (including such as CSS and SAGD)
Since 2015		
<p>Non-Vacuum Insulated Tubing</p> <p>Insulation with inorganic thermal insulation materials</p>	<p>In accordance with the design, a shield of foil and basalt fiber fabric is installed in the annular space. A fluoroplastic coupling insert is placed inside the coupling.</p> <p>The design was developed with account of additional requirements of our customers – oil companies.</p>	<p>Operating temperature: up to +180°C Operating pressure: up to 16MPa Thermal conductivity (K-factor) along the pipe body, W/(m*K): up to 0.03 (+50°C), up to 0.06 (+180°C) Thermal conductivity (K-factor) of the fluoroplastic coupling insert, W/(m*K): up to 0.25</p> <p>The pipes are used for the following:</p> <ul style="list-style-type: none"> • Prevention of wellbore thawing in permafrost zones • Prevention of formation of gas hydrate, asphalt, resin, and paraffin depositions • Injection of superheated fluids into the reservoir in order to heat up high-viscosity oils during development by cyclic steam heating methods (including such as CSS and SAGD)

KEY PERFORMANCE AND TECHNICAL PARAMETERS OF VIT

Performance parameters	Limit value
Operating temperature, °C	up to +350
String length, max	determined by calculation and depends on the type of threaded connection
Thermal conductivity coefficient (k-factor) along the pipe body, max	see table below
Thermal conductivity coefficient (k-factor) of coupling insert, max, W/(m*K)	0.25

Indicator	Non-Vacuum		Vacuum	
	VIT operating temperature, °C	up to +50	up to +180	up to +220
K-factor, W/(m*K)	0.03	0.06	0.012	0.02

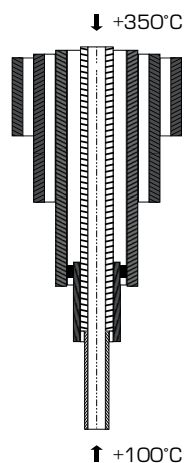
Technical parameters	Limit value
Residual air pressure in the annular space, max, mm Hg	$8 \cdot 10^{-2}$ Pa ($6 \cdot 10^{-4}$)
Pipe length, m	10–11.7*
Weld seam requirements	The seams should be heat treated
Hydrotesting	VIT with made up couplings is subjected to hydrotesting at $R = 0.8 \sigma_T$
Grades	Carbon (55–95 ksi); 13Cr (80 ksi)
Charpy test	Not less than 50 J/cm ² at –60°C

*based on customer requirements we can produce pipe with the length of 6–10 m

APPLICATION OF VACUUM INSULATED TUBING

↑ +100°C

- Prevention of wellbore thawing in permafrost zones
- Prevention of formation of gas hydrate, asphalt, resin, and paraffin depositions



↓ +350°C

- Injection of superheated fluids into the reservoir in order to heat up high-viscosity oils during development by cyclic steam heating methods (including such as CSS and SAGD)

VIT PRODUCTION PROCESS

Rolling,
heat treatment,
testing, measure
cutting, surface
cleaning



Assembly of
the external
and the
internal
pipe



Welding of the
external and
the internal
pipe with
vacuum-tight
seams



Inspection
of the
weld
joints



Creation of vac-
uum in the VIT at
the exhaust cart
and tightness
testing of the
weld joints



Thermal
conductivity
testing and
finishing
of VIT

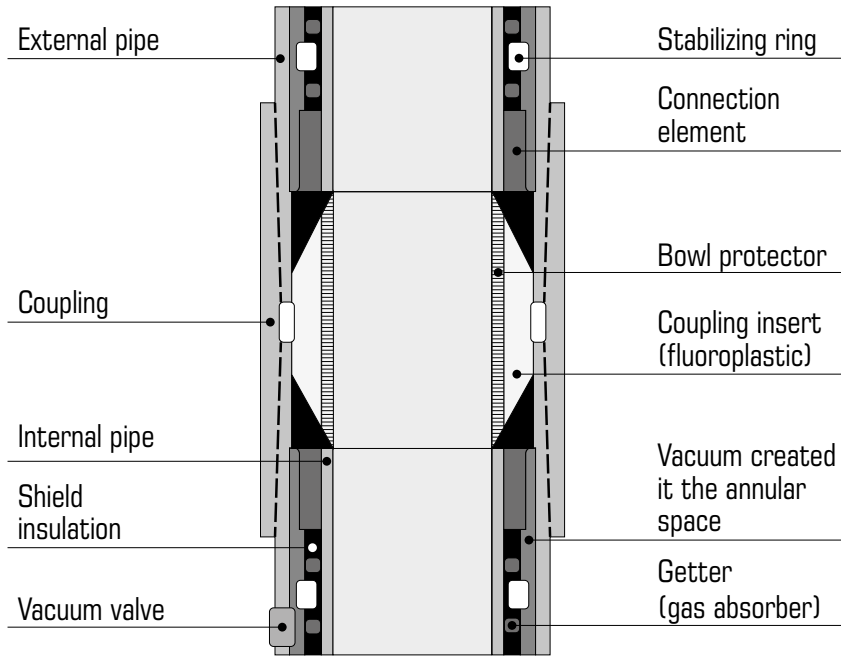
PRODUCT MIX

VIT size	External supporting pipe		Internal pipe	
	OD, mm	WT, mm	OD, mm	WT, mm
9 5/8 x 0.395 – 6 5/8 x 0.352	9 5/8	0.395	6 5/8	0.352
7 x 0.317 – 5 1/2 x 0.304	7	0.317	5 1/2	0.304
7 x 0.408 – 5 x 0.296	7	0.408	5	0.296
7 x 0.362 – 5 x 0.296	7	0.362	5	0.296
6 5/8 x 0.352 – 5 x 0.296	6 5/8	0.352	5	0.296
6 5/8 x 0.352 – 4 1/2 x 0.290	6 5/8	0.352	4 1/2	0.290
6 5/8 x 0.352 – 4 1/2 x 0.271	6 5/8	0.352	4 1/2	0.271
6 5/8 x 0.352 – 4 x 0.262	6 5/8	0.352	4	0.262
6 5/8 x 0.352 – 4 x 0.226	6 5/8	0.352	4	0.226
5 3/4 x 0.374 – 4 x 0.262	5 3/4	0.374	4	0.262
5 3/4 x 0.374 – 4 x 0.226	5 3/4	0.374	4	0.226
5 1/2 x 0.361 – 4 x 0.262	5 1/2	0.361	4	0.262
5 1/2 x 0.361 – 4 x 0.226	5 1/2	0.361	4	0.226
5 1/2 x 0.361 – 3 1/2 x 0.254	5 1/2	0.361	3 1/2	0.254
5 x 0.362 – 3 1/2 x 0.254	5	0.362	3 1/2	0.254
5 x 0.296 – 3 1/2 x 0.254	5	0.296	3 1/2	0.254
4 1/2 x 0.271 – 3 1/2 x 0.254	4 1/2	0.271	3 1/2	0.254
4 1/2 x 0.271 – 2 7/8 x 0.217	4 1/2	0.271	2 7/8	0.217
4 1/2 x 0.250 – 3 1/2 x 0.254	4 1/2	0.250	3 1/2	0.254
4 1/2 x 0.250 – 3.268 x 0.197	4 1/2	0.250	3.268	0.197
4 1/2 x 0.250 – 2 7/8 x 0.217	4 1/2	0.250	2 7/8	0.217
4 x 0.262 – 2 7/8 x 0.217	4	0.262	2 7/8	0.217
4 x 0.226 – 2 7/8 x 0.217	4	0.226	2 7/8	0.217
3 1/2 x 0.256 – 2 3/8 x 0.197	3 1/2	0.256	2 3/8	0.197
3 1/2 x 0.254 – 2 3/8 x 0.190	3 1/2	0.254	2 3/8	0.190
3 1/2 x 0.256 – 1.900 x 0.157	3 1/2	0.256	1.900	0.157

Developed product mix

Product mix that is currently being developed

BASIC VIT DESIGN (VACUUM SHIELD THERMAL INSULATION)



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