



**Vallourec Tube-Alloy
THERMOCASE® VIT™ & AIT™**



How Vallourec Tube-Alloy THERMOCASE® VIT™/AIT™ Works

Vallourec Tube-Alloy’s Vacuum Insulated Tubing (VIT™) and Argon Insulated Tubing (AIT™) product line includes THERMOCASE® DeepWater, THERMOCASE® Steam and THERMOCASE® OnShore. These technical solutions are engineered for today’s and tomorrow’s well completion challenges. Each product line is comprised of specific models optimized for different applications as outlined in the chart below. The primary purpose of each VIT™ model is to dramatically reduce heat transfer via Convection, Conduction and Radiation between inner and outer tubes. AIT™ is a VIT™ alternative for applications that don’t require the ultimate level of insulation provided by the THERMOCASE® VIT™ product line (*k-value for AIT™ is 2-3 times higher than VIT™*).



Convective heat transfer is eliminated by either evacuating the annular space between the inner and outer tubes or utilizing an inert gas back-fill. Vacuum integrity is maintained during the service life of the well by incorporating a metal hydride getter to absorb deleterious gases inside the vacuum space.

Conduction heat transfer is minimized in the gap between inner and outer tubes with a vacuum. The insulation gap is maintained during operation by the incorporation of patented centralizer rings minimizing contact between tubes.

Radiation heat transfer is controlled by the inclusion of Multi-Layer Insulation (MLI) comprised of multiple alternating layers of reflective and non-conductive materials.

In addition, specialized insulation materials are available to minimize the above heat transfer modes in the critical region surrounding the coupling area. The combination of these insulation options make Vallourec Tube-Alloy’s VIT™ and AIT™ product line the highest performance, most reliable insulation solution available for a wide range of environments and applications on the market today.

Design Details

The THERMOCASE® product line consists of nine (9) models. Model nomenclature is comprised of three (3) numbers followed by an alpha character. The first number represents the predominant type of insulation utilized in the annular space separating inner and outer tube: 400 series uses an inert gas back-fill while 700 and 900 series use vacuum. The last two numbers represent the location of the fillet weld and thread: x50 is an internal fillet weld with a threaded outer tube for increased tensile strength and x70 is an external fillet weld with a threaded inner tube for improved annular clearance. Some model numbers are followed by an alpha character: “P” for preload and “U” for up-sized thread. The combination of these features represents a wide range of options available towards the design of an optimal thermal insulation solution, as summarized in the chart below.

Optimized THERMOCASE® Solutions by Application

Product Line	Application	THERMOCASE® MODEL								
		450	450-P	470	470-P	750	750-P	970	970-P	970-U
Deep Water	APB					x				x
	Heavy Oil Flow					x		x		
	Hydrate Preservation									x
	Hydrate Prevention					x				x
	Paraffin Prevention							x		
Steam	CSS		x		x		x		x	
	SAGD		x		x		x		x	
Onshore	Geothermal	x		x				x		
	Paraffin Prevention							x		
	Permafrost	x		x				x		

Vallourec Tube-Alloy THERMOCASE® VIT™/AIT™ is ideal for the following applications:

Deepwater Challenges:

Annular Pressure Buildup (APB) Mitigation

- Production hydrocarbons from a subsea well heats up the surrounding casings and annular spaces. This heat transfer can dramatically increase contained pressure within enclosed annular spaces, leading to catastrophic collapse of intermediate casings.

-THERMOCASE® Advantage:
Prevents APB Concerns.

Heavy Oil Flow Enhancement

- Many shallow offshore wells produce highly viscous heavy crude oil (API Gravity below 20°). As oil from moderate temperature and pressure formations travel up the production tubing, heat is lost to surrounding annular spaces, which greatly increases oil viscosity and effectively reduces daily production.

-THERMOCASE® Advantage:
Maintains oil viscosity without any additional heat input, leading to enhanced production and accelerated revenue.

Methane Hydrate Preservation

- Deep water well completions occasionally pass through gas hydrate zones. Heating of these hydrate zones during production can lead to dramatic releases of methane gas, creating a structural destabilization in the region around well completions, particularly near the mudline.

-THERMOCASE® Advantage:
Stabilizes well completions near the mudline by preventing the heating of unstable hydrate zones during production.

Methane Hydrate Prevention

- During well shut-in, stationary hydrocarbons cool to the same ambient temperature as the surrounding mudline, just above freezing. This can result in the formation of methane hydrate plugs along the inner wall of the tubing, preventing hydrocarbon flow when the well is brought back online. In the absence of any insulated

tubing solution, this may lead to expensive and time consuming remediation measures.

-THERMOCASE® Advantage:
Significantly increases the critical time window following shut-in before methane hydrate plugs develop.

Paraffin/Wax Formation Prevention

- In heavy oil reservoirs, power loss to a downhole Electric Submersible Pump (ESP) can lead to dramatic temperature drop, resulting in paraffin wax accumulation inside production tubing near the mudline. In the absence of any insulated tubing solution, this may lead to expensive remediation measures.

-THERMOCASE® Advantage:
Increases the time to restore ESP power before paraffin wax accumulation begins.

Typical VIT™ and AIT™ Sizes

Inner Pipe	Outer Pipe
1.900	2.875
2.375	3.500
2.875	4.500
3.500	4.500
4.500	5.500
4.500	6.000*
4.500	6.625
5.500	7.000
5.500	7.063**
7.000	9.625

*Special Order

**Not standard OCTG

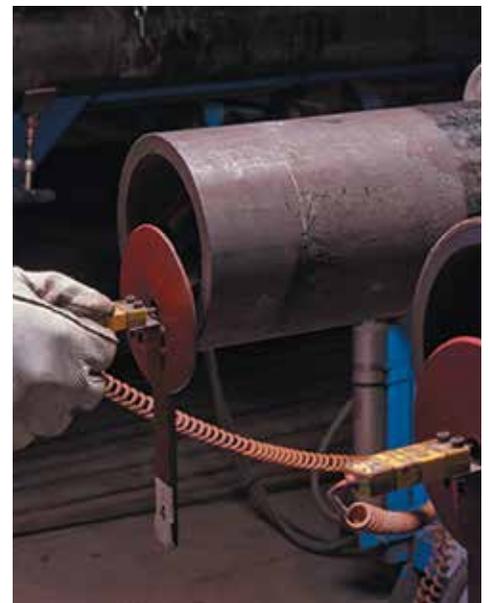
Typical Pipe Materials Welded Together to Produce VIT™* and AIT™

Inner Pipe	Outer Pipe
L80	L80
L80 13Cr	L80 13Cr
13Cr 85	13Cr 85
13Cr 95	13Cr 95
13Cr 110	13Cr 110
13Cr 110	L80**
Hyper 13Cr 110	Hyper 13Cr 110
Hyper 13Cr 110	L80
Hyper 13Cr 115	Hyper 13Cr 115

Note:

*Other combinations and higher alloys available on request or under development.

**VIT™ Model 970™ only.



Steam Challenges:

Cyclic Steam (CSS)

- CSS, an in-situ Enhanced Oil Recovery (EOR) process, relies on a single well used as both injector and producer. As steam is pumped downhole, casing and cement are subjected to numerous fatigue cycles induced by the alternating heating and cooling during production. These fatigue cycles can result in steam leaking to well surface due to connection, casing and cement failures.

-THERMOCASE® Advantage:

Improves cement, casing and connection integrity and overall wellbore stability while improving steam delivery performance.

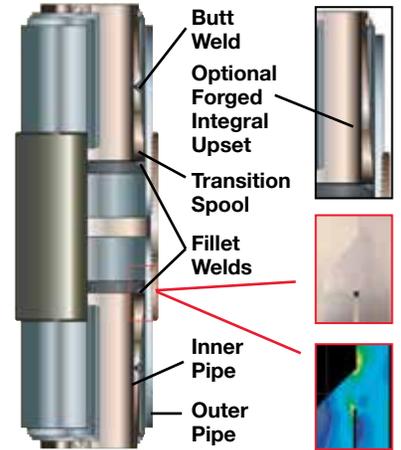
Steam Assisted Gravity Drainage (SAGD)

- SAGD, an in-situ Enhanced Oil Recovery (EOR) process, relies on a dual well design which includes injector and producer. As steam is pumped down to the toe and heel of the injector well, heat is lost to a colder environment, leading to higher Steam to Oil Ratios (SORs) and lower oil production.

-THERMOCASE® Advantage:

Improves deliverable steam quality while decreasing Steam to Oil Ratio (SOR) and increasing oil production. Also reduces production start-up time through accelerated wellbore and reservoir heating, providing critical steam savings.

THERMOCASE® Model 750™
Outer Tube Threaded, Inner Tube Welded Inside of the Outer Tube



Onshore Challenges:

Paraffin/Wax Formation Prevention

- As produced hydrocarbons from moderate temperature reservoirs travel up the production tubing, heat is lost to surrounding annular spaces. If enough heat is lost, flowing temperatures decrease and paraffin wax settles out of solution, accumulating on the tubing wall, and leading to blockage, significantly reducing production flow.

-THERMOCASE® Advantage:

Prevents oil temperature from falling below the wax appearance temperature, thus assuring maximum flow.

to the ground and short-circuited through shallow water aquifers, significantly reducing production heat reaching the steam generator. This lost heat reduces the power output and overall efficiency of the entire geothermal power generation system.

-THERMOCASE® Advantage:

Ensures lower cost and optimum steam generator performance.

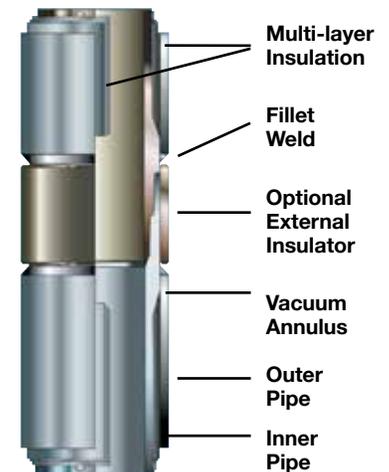
Permafrost Preservation

- In arctic regions, produced hydrocarbons melt the surrounding permafrost. This can destabilize the well pad, leading to structural and environmental damage.

-THERMOCASE® Advantage:

Stabilizes the well pad in arctic regions during production.

THERMOCASE® Model 970™
Inner Tube Threaded, Outer Tube Welded Outside of the Inner Tube



Geothermal

- As superheated steam and water is produced from high temperature geothermal formations, heat can be lost

Thermal Efficiency and Performance Capabilities

Vallourec Tube-Alloy Advantages:

- Original *Pioneer* of THERMOCASE® VIT™.
- Preferred VIT™ deepwater supplier since 1999.
- Proven minimum 12 year service life.
- Worldwide installations in the most severe environments.
- Over 1.6 Million feet installed to date.
- More than 20 customers trust THERMOCASE® to solve their thermal issues.
- Multiple insulated tubing options available to optimize solutions.
- Manufactured in both Range 2 (RG2) and Range 3 (RG3) lengths.
- Coupling insulation customized for each application.
- Proven weld qualification procedures for a wide range of custom steel chemistries.
- Thermal modeling expertise, including the ability to calculate k-values and optimize the VIT™ design for each well.
- Access to VAM® premium threads and local Vallourec service centers plus a wide range of threading options.

Insulated tubing performance is stated as a “k” value, which is expressed as BTUs/hour-foot-°F. Currently, the product is capable of joint-averaged k-value relative to the insulation gap of 0.004 to 0.006 in deepwater applications, and 0.006 to 0.02 in higher temperature applications such as CSS/SAGD. In addition to a high performance insulation solution, Vallourec Tube-Alloy offers several other strategic advantages.



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