Deepwater Reference Book - Pipeline Systems - Synopsis

Flexible Pipeline	Wet Insulated Pipeline	Pipe-In-Pipe (PiP)	Concrete Coated Pipeline	Steel Pipeline

Flexible Pipeline

Assembly of unbounded layers of steel and plastic providing:
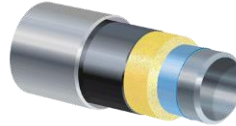- -high axial and torsional stiffness
- -Low bending stiffness

Wet Insulated Pipeline

Insulation coating made of:
- FBE
- Adhesive
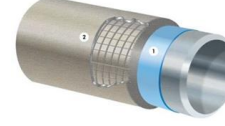- Insulation U value >2 W/m2.K

Pipe-In-Pipe (PiP)

Pipe within a pipe with gap filled with
- Foam U value ~1.2-1.5 W/m2.K
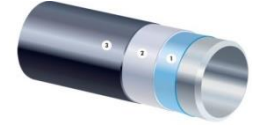- Air/specific insulation U value ~0.5-0.8 W/m2.K

Concrete Coated Pipeline

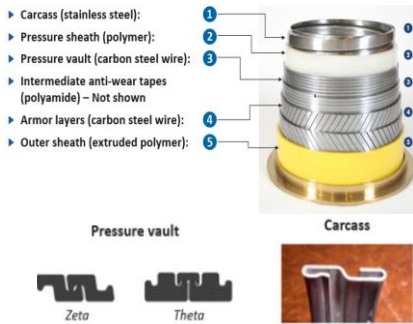Pipe covered with a concrete layer.
- Maximum thickness : 150 mm
- Maximum density : 3.4 t/m3

Steel Pipeline

Steel pipe covered with.
- FBE (0.5 mm thick) or
- FBE+ Adhesive + PP or PE (~3mm thick)

- Carcass (stainless steel):
- Pressure sheath (polymer):
- Pressure vault (carbon steel wire):
- Intermediate anti-wear tapes (polyamide) – Not shown
- Armor layers (carbon steel wire):
- Outer sheath (extruded polymer):

Pressure vault — Zeta, Theta — Carcass

Main Flexible Pipeline Manufacturers:
- TechnipFMC (France)
- GE Wellstream (USA-UK)
- NOV (Danemark)

Installation methods :
- S-lay
- Reel-lay
- J-lay
- Towing
- Flex lay (vertical and horizontal

IPB incorporating:
- Insulation (7)
- Gas Lift Tubes (6)
- Heat Tracing System
- Optical Fiber

Allowable Strength Design (ASD) Codes :
- ISO 13623 : Pipeline Transportation Systems (PTS)
- ASME B31.4 : PTS for hydrocarbons & other liquids
- ASME B31.8 : Gas Transportation

Load and Resistance Factor Design (LRFD) Codes :
- DNVGL-ST-F101 : Submarine Pipeline Systems
- API –RP-1111 : Design, Construct°, Operation and Maint. of Offshore Hydrocarbons Pipelines.
- ISO 16708 : PTS: Reliability based limit state methods.

ASD codes hoop stress formula and criteria

Design code	Hoop stress calculation formula	Maximum allowable hoop stress
ASME B31.4	$\sigma_{hoop} = \dfrac{(Pi - Po) \cdot OD}{2 \cdot t_{nom}}$	72% SMYS for Pipeline, 60% SMYS for Riser
ASME B31.8	$\sigma_{hoop} = \dfrac{(Pi - Po) \cdot OD}{2 \cdot t_{nom}}$	72% SMYS for Pipeline, 50% SMYS for Riser
ISO 13623	$\sigma_{hoop} = \dfrac{(Pi - Po) \cdot (OD - t_{min})}{2 \cdot t_{min}}$	77% SMYS for General Route, 67% SMYS for Landfall&Riser

API 5L Steel Grade characteristics

API 5L Grade	SMYS (MPa)	UTS (MPa)	Corresponding ISO 3183-3 grade
B	241	413	L245
X42	289	413	L290
X52	358	455	L360
X60	413	517	L415
X65	448	530	L450
X70	482	565	L485
X80	551	620	L555

Pipeline Interfaces/tie-ins

Pipeline End Termination
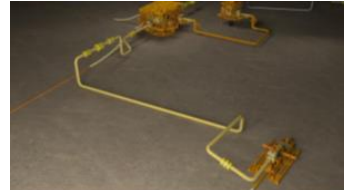
Deepwater Spool

Shallow Water Spool

Pipeline corrosion protection

External coating
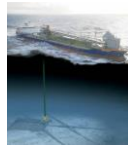

Internal coating

Claded pipe

Lined pipe

Sacrificial anode

Pipeline mechanical Protection (shallow water mainly)

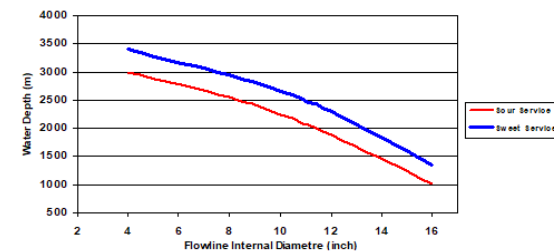**Rockdumping**   **Jetting Machine**   **Mechanical Cutter**   **Mattresses**   **GRP cover**
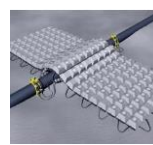
Flexible Pipe Depth Limitation

Water Depth (m) vs Flowline Internal Diametre (inch)
- Sour Service
- Sweet Service

Note: Maximum water depth based on the following basis,
- Flowline laid empty
- Max. laying tension of 425T
- DAF = 1.25

Main Steel Pipeline Manufacturers:
- Vallourec (Europe)
- Tenaris (Italia)
- US Steel (USA)
- Nippon Steel and Sumitomo (Japan)
- JFE Steel Corporation (Japan
- TATA Steel (India)