BECHTEL

Lowering the Carbon Footprint in Pipeline Construction

A Greener more sustainable future for Pipeline Construction

Lowering Carbon Footprint in Pipeline Construction

Standard pipeline design and installation has changed significantly over the last two decades, with greater emphasis on efficiency, safety, environmental protection, and a reduction of the carbon footprint.

Fundamentally, the higher the level of energy expended for installation of a pipeline, the larger the carbon footprint, and the main changes and trends have been around the processes and techniques for installation which allows for construction to be performed safer, with improved productivity and lower energy consumption, resulting in a greater efficiency in reducing the carbon footprint.

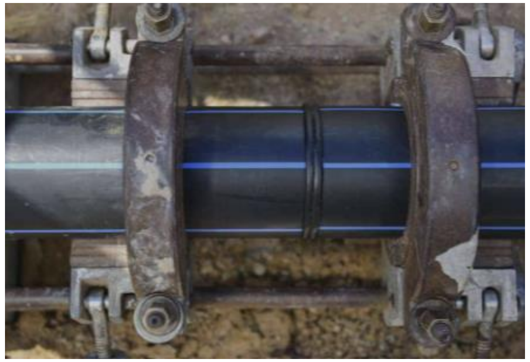
These changes are primarily in:

- Use of drones and Lidar for route survey and initial planning in dense jungle and remote locations
- Materials
- Internal & External Coatings
- Welding Processes
- Installation techniques such as Trenchless Construction and Teleferics
- Transportation & Construction Equipment

Materials

- The use of higher grade/ higher strength steel materials allows for lighter wall thickness, resulting in a lower carbon footprint for pipe production in the mill and lower energy expenditure during installation
- For selected services, plastics in the form of HDPE and ceramic composites materials are a viable alternative to steel and offer excellent corrosion resistance, ease of installation and extended service life.

API 5L Pipe Grade	Min. Yield Strength (ksi) Min.	Min. Tensile Strength (ksi) Min.
X52	52.2	66.7
X60	60.2	75.4
X65	65.3	77.6
X70	70.3	82.7
X80	80.5	90.65
X100	100.1	110.2

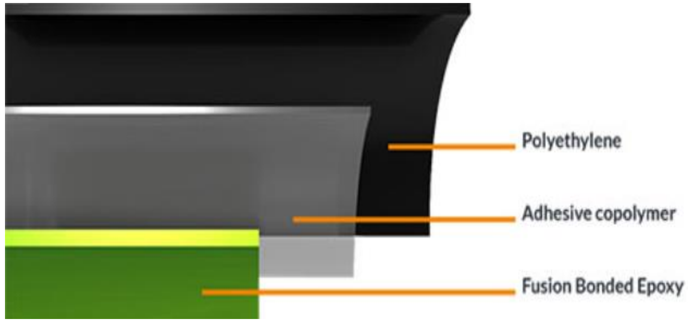


Internal Coatings

- Multiple benefits
  - Improve pipeline performance and service life
  - Corrosion protection
  - Improved flow characteristics & efficiency
  - Reduced maintenance costs
  - Improved product quality
  - Environmental protection (reduces the chances of pipeline degradation & leaks)
  - Minimizes deposit formation.
- The limitation on internal coating is that it requires application by either robotic means, which can be unreliable, or coating application of single or double joints as welding construction progress, however this significantly impacts production or can require personnel to enter the pipeline for manual application/ repair, which is both slow and introduces safety implications and concerns.

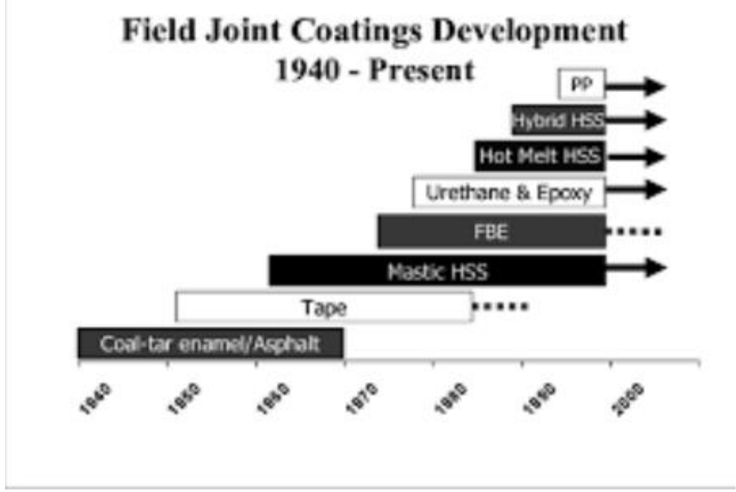
External Coatings

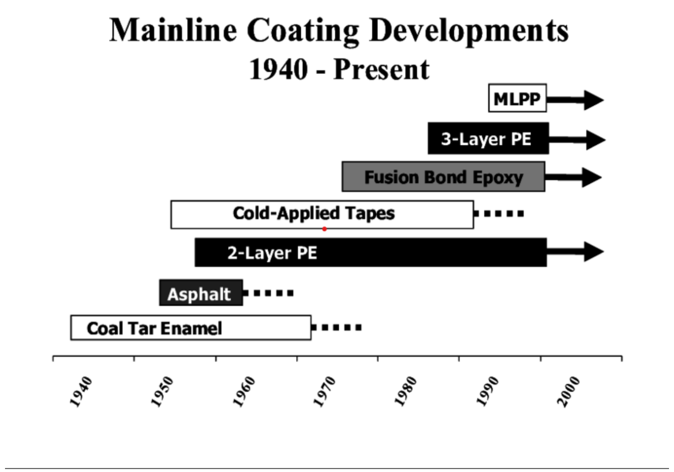
- Older pipelines were protected using a cold applied tape wrap systems, which were often prone spiral corrosion.
- The development of FBE has been the primary pipeline coating material for over 30 years, and offers excellent corrosion resistance, however this coating is highly susceptible to mechanical damage and today, most pipelines are coated with either a 3LPE or Polyurethane coating, both which offer excellent mechanical and corrosion protection, with 3LPE also offering a greater degree of thermal insulation over other coatings
- With improved corrosion protection, comes increased life expectancy of the pipeline



External Coatings *(cont'd)*

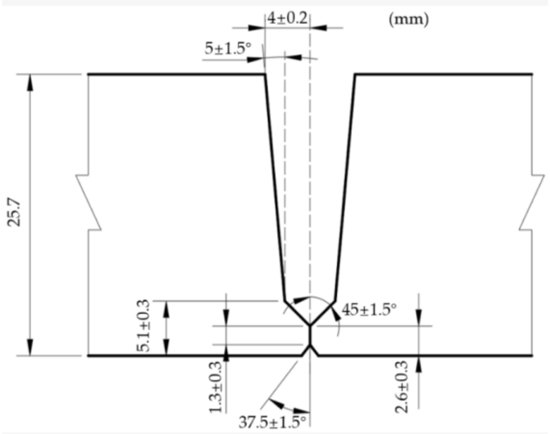
- 3LPE coating is composed of epoxy resin layer, adhesive layer deposited during the gel stage of the FBE application to bond with the FBE, and polyethylene layer
- Whereas 3LPP coating uses polypropylene
- Coating thickness of 3LPE coating is usually 1.8mm - 4.0mm
- Coating thickness of 3LPP coating is usually 1.0mm - 4.5mm
- The more robust external PE OR PP coating provide excellent mechanical protection for the FBE





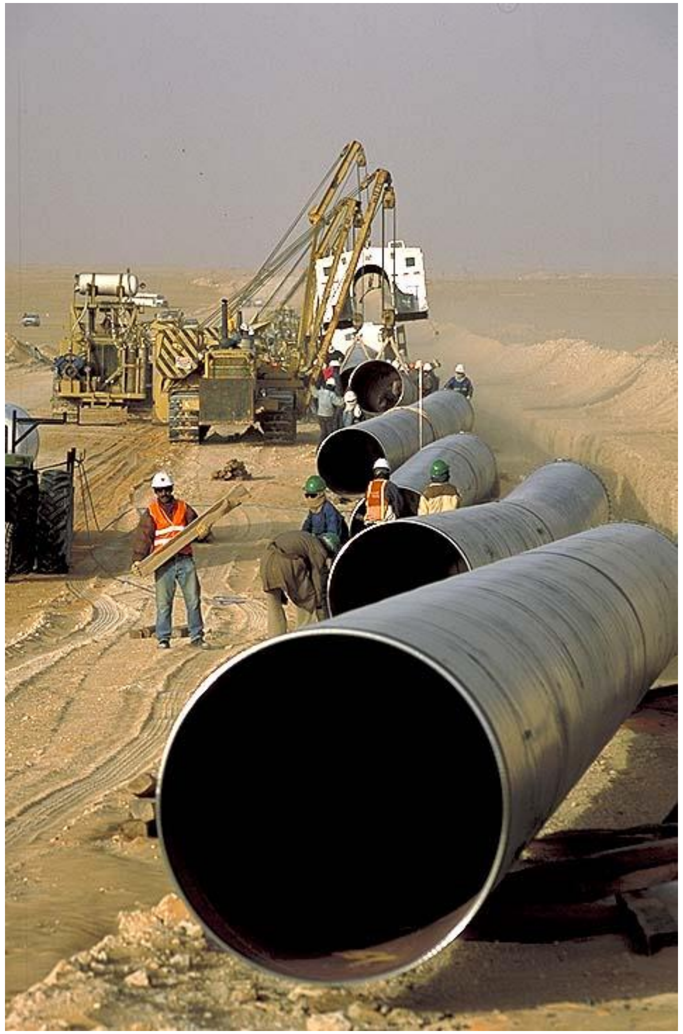
Welding Processes & NDE

- Processes have trended away from SMAW (Manual) towards GMAW (Automatic welding)
- GMAW process is much faster as electrode (filler wire) is continuously fed by mechanized system
- The reduction in weld joint geometry (from 30O to 5O) allows for faster welding times (~ X10 faster), less filler material and lower energy consumption
- This allows for a greater productivity and efficiency, significant reduction in materials, time and carbon footprint through lower energy requirements and shorter welding times



Welding Processes & NDE *(cont'd)*

- Advantages of GMAW
  - High-quality welds with good appearance and low spatter.
  - Better control over the welding process with less clean up required.
  - Higher welding speeds and efficiency.
  - Superior deposition rates to SMAW, increasing productivity (~ X10)
  - Good for welding thin materials.
  - Easiest type of welding to learn.
  - Process is more forgiving for the robot.
- Disadvantage
  - GMAW equipment is costlier upfront
- NDE
  - Mainline NDE on pipelines has shifted away from X-ray towards AUT / PAUT / PAToft
  - Improves safety and eliminates radiation hazards
  - Does not require barriered off exclusion zones
  - Instant results provides real time immediate feedback for welding supervisors



Teleferics Installation

Increases safety and efficiency for installation on steep slope sections.

- Eliminates the need to tie off or winch installation for construction on steep slopes
- Allows for several joints to be welded on level ground and then moved into position, reducing the work required on steep sections, improved productivity and safety
- Does require a specialized subcontractor and set up
- Requires frequent inspections and maintenance

Trenchless Construction

- Trenchless Construction can consist of HDD, Direct pipe thrust boring and micro tunneling
- Reduced the environmental impact and need to a large RoW
- HDD - Significant benefits for river crossings, congested ROW with multiple assets and tunnelling under hill ranges to reduce execution risks
- The use of inert drilling fluids such as Bentonite, has significantly reduced environmental impact.
- By using little or no chemical additives in the drilling fluid, the drilling fluids can be mixed with soils and spread during reinstatement with no adverse effects.
- Can significantly reduce safety risks where pipeline installation requires deep open cut sections of trench
- Eliminates the traditional drill/blast & excavate cycle and associated environmental issues and has applications for both onshore and offshore (Beach approach)
- Can significantly aid with EIA requirements in environmentally sensitive areas

Transportation & Construction Equipment

- Use of electric vehicles and heavy equipment significantly reduces the carbon footprint (but does require significant up-front investment of infrastructure support)
- Many clients are now looking at this as an option to reduce carbon footprint
- Several equipment manufacturers are now offering fully electric or hybrid machines as an option
- Electric prime movers are now in use by several companies throughout Europe and the goal in the UK is that all new vehicles will be Electric by 2035
- The use of buses for mass transportation to the RoW and limitation of personal vehicles along the RoW reduces the carbon footprint and Man-machine interface safety issues.
- Walking over short to medium distances on the RoW provides a zero-carbon footprint for personnel during construction

CAT 320 medium excavator

CAT 950 GC medium wheel loader

CAT 906 compact wheel loader.

CAT 301.9 mini excavator

Offshore Pipelay

- Use of DP for pipelay barges vs Conventional ‘S’ pipelay Barges
- Full DP replaces a minimum of two anchor handling tugs (often 3 or 4 for a large pipelay vessel in deep water and rough weather regions).
- Fuel usage for DP thrusters is less than fuel required for tugs and winch generators (usually min. of 8 winches on dumb lay barge can be up to 12)
- Eliminates the requirement for manufacturing 8-12 large anchor winches & 25-35 KM of large diameter wire rope (anchor lines, pennant wires, pennant buoys and 8-12 large anchors).
- Reel lay including Pipe-in Pipe system; -offers fast track pipeline installation for some DP vessels
- The use of field joint high-density foam to replace hot mastic which was traditionally used to fill offshore field joints. (Eliminates need for gas fired boiler to melt mastic and emission fumes from molten mastic)
- These factors all further reduce the carbon footprint

Conclusion

Lowering Carbon Footprint in Pipeline Construction

Expenditure of lower energy during material manufacture and installation of pipeline design and construction will **significantly lower** the **carbon footprint**.

However, for welding processes like **GMAW** and the use of **electric RoW construction equipment**, there are economical consideration that must be considered for the **upfront costs** for materials, equipment and infrastructure to support this option…

Which must be factored into any potential project bid and agreed with clients.

These options are **only economically viable** on larger projects with longer pipelines, as the higher production and efficiency that comes with **higher upfront costs**, needs to be recouped and **cannot be done on shorter, smaller projects**

The importance of internal coatings cannot be underestimated.

A high-grade coating of both line pipe and field joints, **will provide significant benefits** during pipeline operational life for productivity, quality and maintenance.

The future of pipeline construction, is **trending increasingly to greener,** more **sustainable** methods of construction, and these options need to be offered to clients as an **option to keep the carbon footprint to a minimum** during project design and execution…

The real question is whether potential clients will **recognize** and **accept the additional costs** and **benefits** that **come from the additional upfront costs on a project.**

Questions ?

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