

POLIDAN[®] TUX SYSTEM **THE CROSSLINKABLE SOLUTION** **FOR HIGH PERFORMANCE INDUSTRIAL** **APPLICATIONS**

Emmanuele Giacobbi (Solvay Padanaplast), Antonio Belforte (BP), Paul Rugraff (BP). Massimo Selle (BP)

In piping systems for hot water transport applications, like District Heating or Geothermy, the selected material must possess high pressure resistance together with excellent long-term performances at high temperatures, where traditional PE is limited.

As a strong commitment to deliver high value to its industrial customers and to promote clean and renewable energy sources, BP Solvay Polyethylene (now BP) and Solvay Padanaplast have developed a specially designed crosslinkable PEX-b compound, ELTEX[®] / POLIDAN[®] TUX100, which allows pipe and fittings produced thereof to meet safely such stringent requirements for these applications.

Alongside the outstanding mechanical properties, POLIDAN[®] TUX100 open the door to new remarkably easy installation procedures for the whole piping system. These include laying and welding operations prior to the curing stage, and smartly take advantage of the available hot water flowing through the system as to cure it *in-situ* during first stage of service life, even at normal operation conditions of high temperatures and pressures.

◆ What is POLIDAN[®] TUX100 ? ... Which properties and advantages ?

A **ready-to-use** thermoplastic PEX-b compound, which can be easily processed into pipes in standard HDPE extruders, in combination with a special crosslinking catalyst & stabilizing master-batch. The further stage is the curing process of the pipes, involving hot water.

The combination of both proprietary base resin, silane grafting process and catalyst/stabilizing MB allows POLIDAN[®] TUX100, once cured, to achieve **outstanding mechanical performances**.

POLIDAN[®] TUX100 also shows **excellent creep resistance even at high temperatures** up to 95°C, and thus offers a choice solution for hot water applications under pressure.

◆ Installing the network ... How connecting the pipes ?

POLIDAN[®] TUX100 offers good **flexibility**, allowing to the pipes made thereof to be coiled and installed cost-effectively on field. However, once cured with hot water, pipes/fittings can no more be jointed. Consequently, it is necessary to handle the pipes and fittings and to connect them together before they are crosslinked. Which solutions ?

- **butt-welding** : it is necessary to ensure pipes extremities to keep under a maximum critical degree of gel content, around 30 %, before installation. This can be achieved easily with a special technology developed and patented by BP Solvay Polyethylene, where pipe butts are protected from moisture by a sealed releasable aluminum foil.
- **electro-fusion** (installation or extensions) : a special crosslinkable coupler made-out from POLIDAN[®] TUX100, once cured, is able to sustain long-term service under temperatures as high as 95 °C. It allows to connect easily together POLIDAN[®] TUX100 pipes - whatever they are or are not yet crosslinked - using traditional EF welding machines.

◆ *In-situ* self-curing : just let the nature play !

Once laid and jointed all together, crosslinkable POLIDAN[®] TUX100 pipes & fittings components must still be cured. Easy and cost-saving solution: **just let the nature play**...

Indeed, in hot water transport applications, like District Heating or Geothermy, just operate the network and **take advantage of the readily available hot water/steam fluxing through**, as to spontaneously proceed *in situ* the crosslinking process from the inside-out.

Accurate SDR design of the network will finally depend on the service conditions in term of temperature and pressure.

◆ **Commissioning the network : dimensional stability ? ... Which operation conditions ?**

Once commissioned, the network will begin spontaneously its *in-situ* curing. At this early stage, could pipes undergo some undesired dimensional changes ?

During typical normal operations (e.g. 95 °C / 4.5 Bar), **all pipe dimensions will almost keep unchanged**, because several different complex contributions actually compensate each other.

However, some restraining systems (like concrete blocks) should be presumably designed to limit longitudinal retraction during further shutdowns.

The early stage of piping system operation will coincide with the *in-situ* self-curing process, where the material is not yet fully crosslinked and has yet to bear the network pressure besides high temperatures. Nevertheless, POLIDAN[®] TUX100 is able to successfully accommodate these stringent curing conditions and preserve its final mechanical properties. Thereby, **no reduction in temperature nor in pressure is needed during the commissioning**: just start and let run the network at its nominal service conditions.

| | | |
|--|--|--------------------------------------|
| | pressurized <i>in-situ</i> curing (4.5 bar – 95 °C) | Pressure-less bath curing (95 °C) |
| pipe failure time @ 6.1 MPa / 95 °C | 1100 hours | 1000 hours |

◆ **POLIDAN[®] TUX SYSTEM : other alternative applications ?**

Even if POLIDAN[®] TUX System is especially well suited to hot water transport applications like District Heating and Geothermy, it could be envisioned in other industrial markets, like chemical products conveying in chemical plants.

An interesting case study has been developed together with S.G.I.M. (Società Generali Industrie Magnesia), a Solvay company producing calcium and magnesium-based compounds in Angera (Italy).

BACKGROUND

A plant unit produces CaCO₃ (calcium carbonate) through a precipitation reaction that takes place with CO₂ and water.

Original pipes were carbon steel conduits, comprised of two vertical segments, one ascending and one descending, and a horizontal one, connected by elbows and attached to the reactor and to an external manifold. Each conduit is about 4.5 m long and weighs about 150 kg.

Product being conveyed is a gas made of aqueous vapor and CO₂ carrying highly fouling CaCO₃ powders, at an operating temperature of 65-70°C and pressure of 0.3 bar.

The persistent fouling action of the gas kept reducing the 12 conduits efficiency and required de-scaling operations every 25-30 days. The total weight of each exhaust conduit, with the addition of about 20-25 kg of deposits, made it necessary for a 5-man team which, with an hoist and supporting poles, removed the conduit, cleaned it and put it back in place. The whole operation took about two hours for each reactor. The effect of the maintenance cost on the overall productivity of the plant was not favorable, particularly considering that the frequency and the duration of this activity made it very difficult for all twelve reactors to function simultaneously at any given time.

TEST PERIOD

The installation of the TUX conduit prototype took 20 minutes and involved two of the five men who had previously disconnected the vertical steel element. The prototype weighed about 20 kg and required no hoist or any other tool except a wrench to tighten the flanges bolts onto both the reactor and the steel pipe. SGIM's technical personnel removed and re-installed the prototype conduit after 30, 60 and 160 days. In the course of the assessment operations no deposits or scaling were found on the pipe's internal walls, and each removal/installation was performed in a matter of minutes, with a truly negligible down time for the line.

THE FINAL PROJECT

In March 2000, SGIM decided to buy the TUX system. The final project features, for each conduit, are:

Raw material: POLIDAN[®] TUX, cross-linkable Sioplas HDPE compound

Pipe diameter: 140 mm, SDR17

Pipe length: 4.5 m

Total pipe weight: 50 kg

The internal surface of the fabricated bends was specially treated to make it perfectly smooth, in order not to interrupt the pipe's mirror-like internal surface. In fact, it is the smoothness that accounts for the absence of deposits, since the vapor droplets containing CaCO₃ cannot stick to the walls as they do on the much rougher steel surface (the values of superficial roughness for POLIDAN[®] TUX and carbon steel are respectively, 4x10⁻⁶ and 1x10⁻⁴ [m])

BENEFITS TO THE CUSTOMER

POLIDAN[®] TUX intrinsic features ensure that the conduits will maintain a high performance profile with no deterioration caused by the product's chemical aggression and temperature, by corrosion and scaling which, besides impairing the functionality of the line, foster bacterial aggression in the long term. From the maintenance point of view, it is interesting to note that the reduction of each operation's frequency (90 days) and duration, besides cutting costs, implies important personnel safety aspects. Each of the TUX conduit has an overall weight equaling 1/3 of its non-scaled steel equivalent, which cuts the risks involved in handling vertical

and aerial pipes to almost zero. Furthermore the personnel's exposure to vapors containing CO₂ is limited to a few minutes and to two workers per reactor.

TUX system's expected operating lifetime:

10 years as required by SGIM's design

Producer:

Nupi Spa has manufactured the TUX conduits (tradename: ChemPEX) at its Imola (Bologna) plant and the fabricated bends at its Busto Arsizio (Varese) plant.

◆ Conclusions

Crosslinkable POLIDAN® TUX100 together with *in-situ self-curing* technology constitute an eligible and attractive alternative to insulated steel in piping systems for hot water transport applications under pressure, like District Heating and Geothermy, and for transportation of non-oxidizing chemical products.

Due to the combination of proprietary know-how's, they offer outstanding long-term performances and provide a set of very cost-effective, time-sparing and fit-to-purpose advantages:

- pipes can easily be manufactured using conventional PE extruders ; material flexibility and lightness lead to nice pipe installation techniques
- traditional PE welding methods can be employed, either using butt-welding or specially designed POLIDAN® TUX100 electro-fusion couplers
- crosslinking process is carried out *in-situ* during early stage of service, just smartly using available flowing hot water ; network commissioning can be safely run under nominal operating conditions of pressure and temperature
- such *in-situ* crosslinked POLIDAN® TUX100 pipes & fittings, in a properly designed network, will offer outstanding resistance to creep and stress cracking, thus providing long-term service safety.