RENEWAL OF THE FREE-RUNNING SPRINGWATER PIPELINE BETWEEN GAICHEL AND KOERICH (G.-D. LUXEMBOURG)

EVALUATION OF THE CONDITION AND RENOVATION MEASURES

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The 'Syndicat des Eaux du Sud'

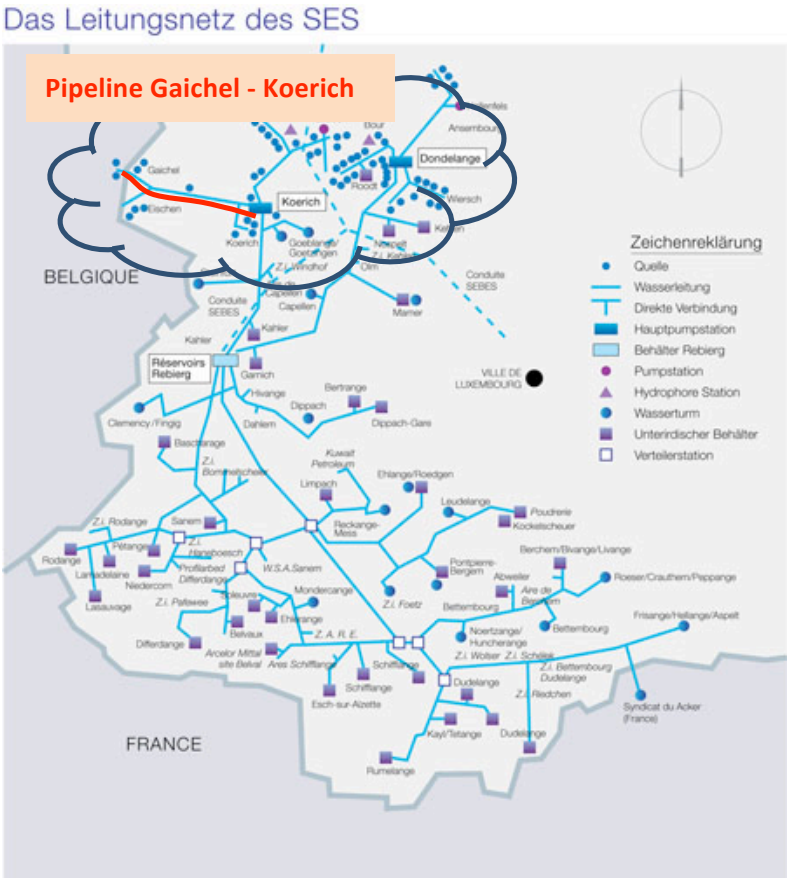
On 8 June 1908, the municipalities in the south of Luxembourg decided to join forces as an inter-municipal syndicate, which was to supply drinking water to the affiliated municipalities. The task of the SES was, and still is, to provide its affiliated municipalities and industries with clean drinking water.

Sixty-five spring catchments in all, which draw their water from the Luxembourg Sandstone geological formation, supply spring water to the two pumping stations in Koerich and Dondelingen, from where it is pumped to the main reservoir on the "Rebierg", the highest point in the area supplied by the SES.

23 municipalities are affiliated to the SES.

Since then, the SES has been supplying around 40% of the population of Luxembourg with drinking water. The 23 municipalities that get their drinking water from the SES need more than 15,000,000 m^3 of water a year. 20% of this water goes to industry.

The SES has a water distribution network 220 km long in total. A 27 km long springwater pipeline network located in the Eisch valley transports the water from the 65 sources to the individual pumping stations



Catchment area and pipe network

Evaluation of the Gaichel-Koerich pipeline

The 7.5 km long springwater pipeline that runs between the town of Gaichel and the Koerich pumping station is made of grey cast iron and was constructed between 1909 and 1911.

There are a number of problems with this free-running pipe, one of which is that there is not a guaranteed rate of flow.

The flow has to be restricted in the Koerich pumping station in order to ensure the highest possible delivery rate, since, if the valves are opened fully at the Koerich pumping station, after a short while no more water will flow through.

Since no accurate topographical documents were available for the pipeline, it had to be measured topographically.

In the topographical survey, the pipeline was examined by means of depth sounding. The result of the elevation profile obtained from this data is that the pipeline runs with only a minimal gradient in many places – an average of 0.36%.

The couplings of the pipeline are sealed with liquid lead, as was customary at the beginning of the 20th century.

In order to assess the condition of the pipeline, it was also subjected to a more detailed inspection.

TV cameras were put through several times (2009 + 2011), and this gave us a good insight into the current state of the pipeline.

Foreign bodies, such as timber, stones and sand, were found inside the pipeline. These had most probably been there since it was constructed over 100 years ago and have since then impaired the network's performance.

Furthermore, incrustations were found, caused by the deposition of iron.

Incrustations of iron in the pipes

In several places we identified cross-section constrictions which reduce the diameter of the pipeline by up to 30%.

Stones

Stalactites and leaky connections

The camera inspection revealed that the Kindel source pipeline was a steel pipe with joints sealed with lead.

Both the cast iron pipelines between Gaichel and Koerich and this steel pipeline were coated externally with bitumen to inhibit the corrosion process.

Steel pipeline Gaichel DN 150 – connections sealed with lead

During the inspection, lead deposits were also found at various places in the pipeline. Evidently the lead had flowed into the pipeline during the sealing operation.

On the basis of these findings, the inspected sections of the pipeline were flushed through with the jet washer in order to remove deposits and foreign bodies from the pipeline.

The various camera inspections of the pipeline also show how difficult the conditions were under which the pipeline was built back in 1908, and the time pressure under which the work was carried out with the resources that were available at that time.

In 2009, only 1.5 km out of the approximately 7.5 km of the pipeline system were inspected with the camera. No statement can be made about the section not inspected. The condition of the remaining 6 km cannot, however, be assumed to be any better.

As part of the study, it was recommended that the pipeline should be replaced in the medium term. This is necessary in order to make sure that this important feeder remains reliable in the long term.

Rehabilitation of the Muller and Kindel catchments (2011 and 2012)

In addition to the renovation of the pipeline, the complete reconstruction of a number of springs was also under consideration. The preliminary geological studies in the vicinity of the springs in Gaichel suggested that the method of catchment should be redesigned. On the basis of the geological findings obtained, it was recommended that the spring water should in future be captured by means of horizontal bore holes.

For the horizontal boring, a new shaft was sunk in front of the old catchment structure. The shaft has a diameter of 3.20 m and is up to 10 m deep, depending on the geological conditions. From the shaft, 3 to 4 bore holes, about 60 m long and having a diameter of 20 cm, were drilled into the aquifer in a fan formation. The bore holes were fitted with stainless steel full-wall pipes and winding wire filter pipes.

The horizontal bore holes are made in such a way that the filter sections are located in the rear section of the horizontal strand. The protected catchment zone for the springs was therefore moved into the mountain. Thus there is a much greater depth of ground above the horizontal strands, with the result that during heavy downpours and in the event of flooding, no surface water can be tapped unfiltered. This tapping method practically eliminates any deterioration in the bacteriology of the spring water during heavy rainfall.

The pumping trials carried out since then at the Kindel and Müller springs, showed that the spring discharge rates has almost doubled. The increase in spring discharge rates has to be taken into account when determining the sizing of the pipeline intended for renewal.

Installing automatic ventilation valves

The topographical survey of the pipeline showed that various high points in the old pipeline were not equipped with ventilation devices. Ventilators had to be installed at these high points, and at other points old ventilators had to be replaced with new ones.

Since the headwater pipeline is only exposed to very low operating pressures, ventilation fittings specifically designed for drinking water pipelines with very low operating pressures were chosen. The advantage of these is that they are suitable for low-pressures operating from 0.1 bar.


Ventilation devices

Replacement MID Flow meter in the Koerich pumping station

In the Koerich pumping station, the shut-off valve on the pipeline was also replaced with a ring piston valve in 2010. This valve enables flow rates to be set more accurately in the pipeline in question.
In addition, a magnetic inductive flow meter (MID) was installed in Koerich near the pumping station; by this means, flow rates can be measured more accurately.

Magnetic inductive flow meter (MID) at the pumping station in Koerich

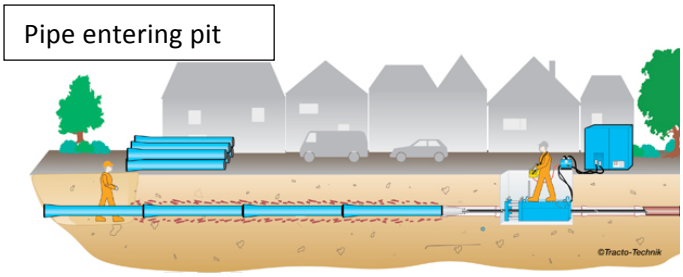
Renovation of the pipeline using <u>burst lining</u>

Various sections of the pipeline – total length: 1,300 m – were renovated between 2010 and 2012. Since the pipeline lies beneath a golf course and some heavily frequented road sections, the pipeline was replaced using the environmentally-friendly burst-lining process.

The bends in the pipeline were detected during the camera inspection and subsequently measured topographically. They are the pass-through points, and define the places where machine pits or pipe-laying trenches need to be dug.

Bend in the pipeline

With this method, the new pipeline is drawn through the old one, in the process of which the old pipeline is split open using a bursting head and pushed into the ground. To prevent any fragments of the old grey cast iron pipeline nicking the new pipeline, we used pipes made of ductile cast iron with a reinforced cement mortar shell in a longitudinally force-locked design.



Since the couplings are exposed to particular mechanical strains and stresses, they are protected with sheet metal cones to prevent, for example, any nicks caused by old fragments. Protective rubber sleeves are also inserted between the couplings and the sheet metal cones.

By this method it is possible to renovate a 300 mm diameter pipeline over a maximum length of 250 m in one pass. With a smaller diameter pipe it is even possible to lay in lengths of up to 450 m.

When introducing the pipe, the traction forces are measured continuously to ensure that the maximum permissible traction forces are never exceeded.

Berst-lining traction unit

When the Kindel springwater pipeline was laid, the traction force of the traction unit, coupled with the fact that the skin friction of the piping located in the ground was too low, meant that the piping was removed completely by the traction unit.

During the laying process, the old Kindel line therefore had to be flame cut into two half-shells.


Flame work on the old pipeline

The future

The pipeline between Gaichel and Koerich will be renovated in sections over the coming years. In so doing, the diameter of the pipeline will be increased from 325mm to 400mm.

In order to prevent incrustations, the pipeline will in future be cleaned regularly. For this purpose, pipe cleaning boxes are now being incorporated at 500 m intervals to provide access to the pipeline for future cleaning operations.

As part of the renovation work, preliminary investigations into alternative routes for the pipeline are to be carried out in order to eliminate or reduce existing high and low points.

For the renovation of the existing pipeline the burst lining method will continue to be used, although in a modified form. In order to enable longer lengths to be laid at a time, a special technique will be employed by means of which individual sections of pipeline can be pulled in and burst simultaneously.

In addition, the Wyckerslooth source will be rehabilitated. In the future and – as with the Müller and Kindel sources – the spring water will be captured by means of four horizontal bore holes.

Overall, our experience with the methods used has been positive, and we have found excellent solutions to the problems, so that the preservation of the free-running pipeline between Gaichel and Koerich is safeguarded for the future.