

# **Innovation in trenchless rehabilitation of potable water lines – SAERTEX-LINER® H<sub>2</sub>O**

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## **ABSTRACT**

In 2019, SAERTEX multiCom was awarded with the ISTT No-Dig Innovation award in the category of “UV curable GRP Liner for the trenchless rehabilitation of potable water lines” for their SAERTEX-LINER® H<sub>2</sub>O. This product, made in Germany, is produced by SAERTEX multiCom GmbH a manufacturer of UV-cured fiberglass-reinforced pipe liner for the trenchless rehabilitation of waste water and supply lines. SAERTEX-LINER® H<sub>2</sub>O was already used in more than 100 projects worldwide with more than 350 installations. This technical paper will create a common understanding of the construction of SAERTEX-LINER® in general. Additionally, the focus lies on the technical data, mechanical properties and pressure table of SAERTEX-LINER® H<sub>2</sub>O as well as the installation. This product is a class A liner according to DIN EN ISO 11295, which means that the liner is fully statically loadable and an independent pipe after installation. The rehabilitation with SAERTEX-LINER® H<sub>2</sub>O prevents a complete replacement of the original pipe, which is advantageous in areas where open trench methods are not useful due to ecological and economical reasons.

## **1. Introduction**

Trenchless UV-CIPP (Cured-in-place-pipe) has a long history of more than 50 years. The first cured-in-place-pipeline was installed in 1970 to make sure the above existing mushroom plant was not removed and digging was in that case no option [cf. Denise Sullivan, Trenchlesspedia, 2018, last access: 15.12.2022]. In municipalities and cities digging becomes more and more a problem, because the pipes, that needed to be rehabilitated are lying under streets, parks and buildings. The real-asset-loss is often not comparable to the costs of open construction methods. Additionally, cities and municipalities try to minimize the impacts on the environment, the households and resources, for example the protection of tree roots as well as reducing smell, dirt and emissions [cf. Prof. Dr.-Ing. Stein & Partner GmbH, Instandhaltung von Kanalisationen, 2001, last access: 15.02.2023].

UV-CIPP is another possibility to rehabilitate such pipes, which are not accessible on the whole length of the necessary rehabilitation. According to the ISO norm 11295 a cured-in-place-pipe is “lining with a flexible tube impregnated with a thermosetting resin, which produces a pipe after resin cure” [DIN EN ISO 11295:2018-6, 2018]. SAERTEX multiCom GmbH is a German manufacturer of UV-cured fiberglass-reinforced pipe liner, which is a close fit UV-CIPP product. These liners are used for the trenchless rehabilitation of wastewater and supply pipes and are proven in thousands of successful projects [SAERTEX multiCom GmbH].

Since 2016 SAERTEX multiCom GmbH is focused on the rehabilitation of potable water pipes by using their SAERTEX-LINER® H<sub>2</sub>O, which was the first sheer GRP (glass reinforced plastics) liner in the world [SAERTEX multiCom GmbH]. Water losses and a sustainable operation of water resources is an important task today and especially in the future. Problematic issues regarding water are the injustice in distribution and regard water as a matter of course [cf. UNESCO World Water Assessment Programm, The United Nations world water development report 2021: valuing water, 2021]. To reduce these losses and improve the existing pipe infrastructure, SAERTEX-LINER® H<sub>2</sub>O is used to rehabilitate potable water pipes without digging the complete rehabilitation section. It prevents a complete replacement of the original pipe by a rapid restoration of a functional pipeline system. [SAERTEX multiCom GmbH].

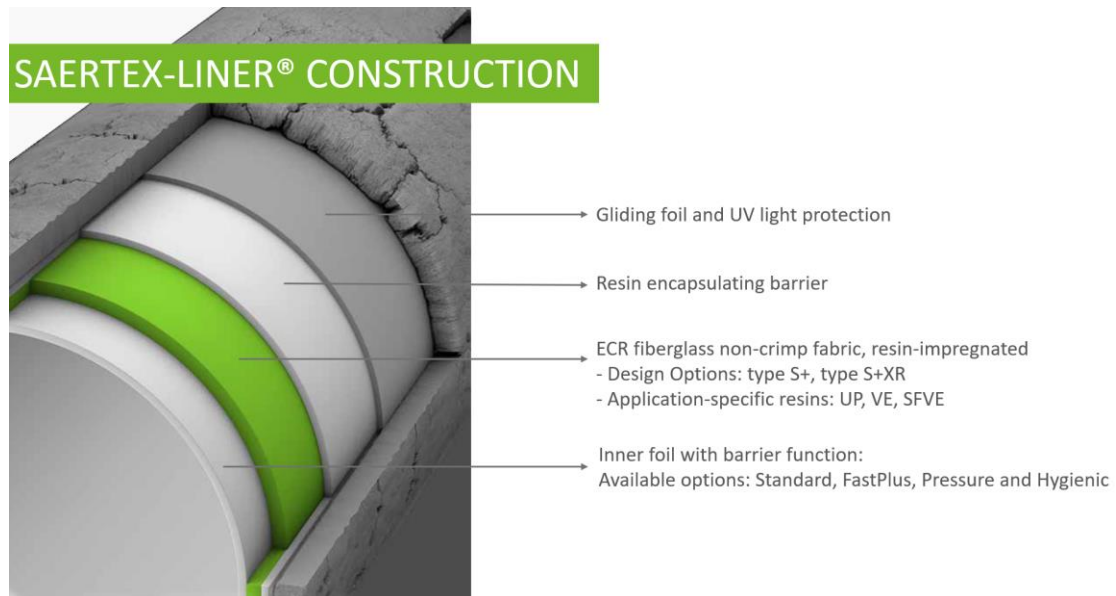
## **2. SAERTEX multiCom**

SAERTEX multiCom GmbH is a manufacturer of UV-cured fiberglass-reinforced pipe liners. SAERTEX multiCom was founded in 1996 as a subsidiary of SAERTEX GmbH & Co. KG and therefore belongs to the SAERTEX Group.

The complete process from the single glass fiber to the ready-to-be-installed liner is done in SAERTEX multiCom own facilities. It starts by creating a dry liner of multiaxial fabric, which is produced out of single glass fibers. This dry liner will be impregnated with a specific resin according to the product application and will be enclosed with foils. These liners will be delivered ready to be installed to the construction site. [SAERTEX multiCom GmbH].

### 3. Construction of SAERTEX-LINER®

SAERTEX-LINER® consists of four layers, having different purposes and resin according to the product application. Picture 1 represents the construction of SAERTEX-LINER® schematically.



**Picture 1.** Construction of SAERTEX-LINER®

The description of each layer will be done from the outside to the inside. The outside is showing the host pipe presented with classical damages such as cracks and holes.

The outside of the liner is protected with a gliding- and UV-light-protection foil. It prevents the unintentional curing of the liner by sunlight. Additionally, it is a robust layer which prevents the liner from mechanical damages while pulling the liner in the host pipe.

The resin encapsulating barrier lies under the gliding and UV-light protection foil. This layer ensures that no resin will differ in the environment and encapsulates the glass- and resin layer.

Then there is the glass fiber fabric, shown in green in Picture 1, as a durable corrosion and chemical resistant glass layer, which is impregnated with an application dependent resin. According to the conditions of each project the design option will be selected between type S+ or type S+ XR. The product application pretends the used resin – an unsaturated polyester resin (UP), a vinyl ester resin (VE) or a styrene-free vinyl ester resin (SFVE).

The inner surface of SAERTEX-LINER® is an inner foil with barrier function as the counter part to the protective outer foil. Depending on the options it is a temporary, a semi-permanent or permanent foil. The option Standard is a temporary foil, which is only used as an installation support, but will be removed after curing [SAERTEX multiCom GmbH]. FastPlus is a semi-permanent foil, which is according to DIN EN ISO 11296-4 a membrane that is used as an installation support, which will remain in the liner after curing, but is not expected to hold its integrity over the lifecycle of the product [cf. DIN EN ISO 11296-4:2018-9, 2018]. The pressure and hygienic option are permanent foils for rehabilitation of pressurized pipes. [SAERTEX multiCom GmbH]. According to the DIN EN ISO 11296-4 a permanent membrane is a foil which is needed as an installation support, it will remain in the liner after curing and provide a function over the operational life of the product [cf. DIN EN ISO 11296-4:2018-9, 2018].

#### 4. SAERTEX-LINER® H<sub>2</sub>O

This chapter will focus on the limitations of SAERTEX-LINER® H<sub>2</sub>O, the static classification, hygienic aspects and the installation [SAERTEX multiCom GmbH].

##### a. Product data and Pressure-Table

Table 1 shows an extract of the product program of SAERTEX multiCom focusing on SAERTEX-LINER® H<sub>2</sub>O. The chosen product series depends on the utilization of the product and determines the used resin. SAERTEX-LINER® H<sub>2</sub>O is used for the trenchless rehabilitation of potable water lines and will be impregnated with a styrene-free vinyl ester resin. Hygienic approvals, such as the AS/NZS 4020:2018 for Australia and New Zealand and different other ones from countries all over the world are applicable [SAERTEX multiCom GmbH].

PRODUCT SERIES	SAERTEX-LINER® H <sub>2</sub> O
Utilization	Potable water
Resin type	SFVE
Approvals	W 270, KTW, NSF, AS/NZS 4020:2018 and more
Styrene free?	Yes

**Table 1.** Product series SAERTEX-LINER® H<sub>2</sub>O

The applicable designs are type S+ and type S+ XR, depending on the operating pressure of the pipe. Table 2 shows that type S+ is used for operational pressures up to 1 bar in circular profiles. The dimension range is from 250 mm up to 1500 mm with wall thicknesses of 4 mm to 14 mm. Type S+ XR can withstand pressure up to 33 bar according to the diameter in circular profiles. The dimension range is from 250 mm to 1500 mm with wall thicknesses of 4.3 mm to 14.3 mm [SAERTEX multiCom GmbH].

DESIGN	Type S+	Type S+ XR
Host pipe profile	Circular	Circular
Application	Pressure	Pressure
Operating pressure [bar]	Up to 1	Up to 33
Fully structural Class A DIN EN ISO 11295	Yes	Yes
Diameter DN [mm]	250 – 1500	250 – 1500
Structural wall thicknesses [mm]	4 - 14	4.3 – 14.3

**Table 2.** Design options SAERTEX-LINER® H<sub>2</sub>O

Both design options are produced with the same foils on the inside and outside. All SAERTEX-LINER® are delivered standard with the gliding and UV-light-protection foil and the resin encapsulating barrier. To comply with hygiene SAERTEX-LINER® H<sub>2</sub>O has the permanent inner foil as option Hygienic [SAERTEX multiCom GmbH].

The mechanical properties of SAERTEX-LINER® H<sub>2</sub>O are strong. The long-term circumferential e-modulus is about 16.000 N/mm<sup>2</sup>, the short-term circumferential e-modulus is bigger than 20.500 N/mm<sup>2</sup>. Hence SAERTEX-LINER® H<sub>2</sub>O could care for highest static demands with low wall thicknesses. The long-term bending strength is about 210 N/mm<sup>2</sup>, the short-term bending strength is bigger than 270 N/mm<sup>2</sup>. [SAERTEX multiCom GmbH].

The maximum operating pressure for design option type S+ is for each diameter up to 1 bar. An extract of the pressure table of type S+ XR can be found in table 3. It shows the maximum operating pressure for each diameter. This data is based on the 10,000 h test and takes internal and external loads into account. For example, a liner DN 250 could resist an operating pressure of maximum 33 bar. This is decreasing by growing diameters. Table 3 shows additionally the design wall thickness and total wall

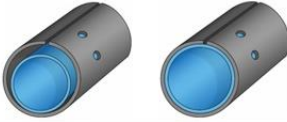

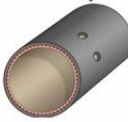
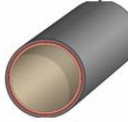
thickness. The design wall thickness concerns the thickness of the glass and resin layer, which is important for the statics. Here are the minimum design wall thicknesses presented. Sometimes a higher wall thickness is needed due to the conditions of the project and the related static. A higher design wall thickness does not relate to a higher maximum operating pressure. The total wall thickness instead includes all other foils and coatings of the liner [SAERTEX multiCom GmbH].

DIAMETER [mm]	DESIGN WALL THICKNESS [mm]	TOTAL WALL THICKNESS [mm]	MAX. OPERATING PRESSURE [bar]
250	4.3	6.5 ± 1	33.0
300	4.3	6.5 ± 1	27.3
400	4.3	6.5 ± 1	18.2
500	4.3	6.5 ± 1	14.4
600	5.3	7.5 ± 1	11.6
700	6.3	8.5 ± 1	10.7
800	7.3	9.5 ± 1	8.8
900	8.3	10.5 ± 1	7.9
1,000	9.3	11.5 ± 1	7.1
1,100	10.3	12.5 ± 1	6.5
1,200	11.3	13.5 ± 1	5.8
1,300	12.3	14.5 ± 1	5.3
1,400	13.3	15.5 ± 1	4.7
1,500	14.3	16.5 ± 1	4.6

**Table 3.** Pressure table SAERTEX-LINER® H<sub>2</sub>O Type S+ XR

**b. Static Classification in accordance with DIN EN ISO 11295**

There are a lot of different technologies to rehabilitate pressurized pipes, which can be classified in different categories according to DIN EN ISO 11295. This static classification is shown in picture 2 and considers internal and external loads of the pipe as well as loads during the installation. The first distinction in this classification is the independence or interaction of the product with the host pipe. A technology is considered as independent if it has its own longterm internal pressure strength. Instead, an interactive product needs radial support of the host pipe [cf. DIN EN ISO 11295:2018-6, 2018]. The classification as class C and D is not applicable to SAERTEX-LINER® H<sub>2</sub>O because this CIPP is a stand-alone-liner and does not stick to the host pipe. It does not need the host pipe itself. SAERTEX-LINER® H<sub>2</sub>O is a class A liner because the liner is close-fitted and an independent liner. It can withstand all internal loads during its design life. The liner is fully statically loadable and can be considered as a new pipe after installation [SAERTEX multiCom GmbH].

Class A		Class B		Class C		Class D	
							
Independent				Interactive			
Fully structural				Semi-structural		Non-structural	
Lining with continuous pipes	—			—		This document is not applicable	
Lining with discrete pipes	—			—			
—	Lining with close-fit pipes		—				
	Lining with cured-in-place pipes						
—	—		Lining with adhesive-backed hoses				
—	—	Lining with sprayed polymeric materials		—			

**Picture 2.** Static classification according to DIN EN ISO 11295 [cf. DIN EN ISO 11295:2018-6, 2018]

### c. Installation process and details

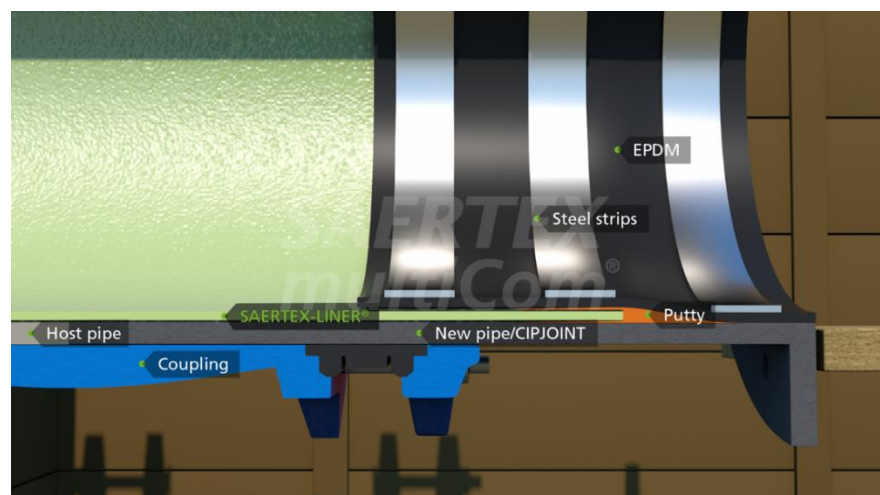
The installation itself does not differ to other installation methods of UV-cured fiberglass-reinforced pipe liner, but there are specific additional installation steps needed to ensure full connection to the network, withstanding of operational pressures and working safe during the installation. For potable water pipes it is necessary to use cleaned and disinfected installation equipment to ensure no contamination of the pipe or later the transportation medium [SAERTEX multiCom GmbH].

The installation of SAERTEX-LINER® H<sub>2</sub>O starts by creating excavation pits at the start- and endpoint of the rehabilitation section. It is important to create trenches wide and long enough to ensure the liner can be installed correctly and properly reconnect it to the network again. To have access to the host pipe it is necessary to cut out a piece of the host pipe. Additionally, a new piece of pipe or coupling must be mounted on the host pipe for preparation of the ends of the host pipe. Then it is necessary to do a visual inspection of the host pipe as preparation and cleaning of it [SAERTEX multiCom GmbH].

Decommissioned connections or large-scale defects and intermediate trenches must be secured with safety caps or closed or compressed in other ways before the liner is pulled in.

GRP liners will then be pulled through the rehabilitation section with protecting it against damages and contamination. The ends of the liner must each be positioned in the middle of the trench. The calibration of the liner will be done by closing the ends of the liner with cleaned packers and generating air pressure on the liner. This pressure will be increased until the liner is in a suitable position to the host pipe. Before inserting the UV-light chain in the trench, the lamps needed to be checked on their functionality. The UV light chain will be inserted in the liner and pulled from the final to the first excavation pit. The curing of the liner starts by the ignition of the lamps and the UV light chain is pulled backwards through the liner at a prescribed speed. A visual inspection and check of the technical parameters are possible on the UV truck and will continuously be documented. After the installation of the liner, it is necessary to install liner end seals for full connection to the network and to prevent groundwater from penetrating the cut edges of the composite material [SAERTEX multiCom GmbH].

Picture 4 shows the connection technology in detail. On the host pipe a new piece of pipe is welded or connected with a coupling. Another possibility is a CIPP JOINT of Nova Siria® which could be mounted on the host pipe and is a combination of a coupling and a new piece of pipe with flange. To ensure the connection of the liner and the new piece of pipe, the liner will be cut back approximately 10 cm from the end of the pipe. Then a layer of putty will be applied along the circumference of the cut edge. The putty will prevent the ground water from penetrating the cut edges of the liner. The liner end seal will be fitted after the putty is applied. These seals are consisting of a rubber often with 3 steel bands to fix it [SAERTEX multiCom GmbH].



**Picture 4.** Connection technology

Then the liner needs to be cleaned and disinfected, as well as a pressure test will be done. Finally, the network will be closed by installing a new piece of pipe in between and the excavation pits will be closed [SAERTEX multiCom GmbH].

## 5. Conclusion

Potable water lines worldwide are getting older and digging becomes more and more a problem, especially in municipalities and cities. The locations of the lines are often underneath roads and houses, where it is not economically and ecologically appropriate to rehabilitate in open trenches. Therefore, the need for trenchless rehabilitation is growing.

SAERTEX-LINER® H<sub>2</sub>O is an innovative and useful product to rehabilitate potable water lines trenchless in a short period of time. Additionally, the liner is fully statically loadable and is an independent pipe. Mechanical properties and the pressure table show that it has enormous advantages for rehabilitation projects. With support of SAERTEX multiCom GmbH installation teams will learn everything about the liner and the installation details in theoretical and practical trainings. Therefore, the liner was awarded with the innovation award of the international society for trenchless technology (ISTT) in 2019 and has proven in more than 350 installations all over the world.

## 6. References

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