

# The Reliability of Sewer Robots

## Faulhaber Provides Motor Technology for Pipe Renovation Projects

Faulhaber Austria GmbH

To the average driver waiting for the green light, the busy intersection in the heart of the city looks no different from any other morning. They have no idea that they are in the middle of a building site—or on top of one to be more precise.

Just a few meters below a dazzling beam of light cuts through the darkness and startles the underground “inhabitants.” A camera lens is transmitting images of wet, cracked walls to the surface where the operator watches his monitor while he controls the robot. Not a scene from a science-fiction or horror film, but modern everyday life in sewer renovation. Motors from Faulhaber are used for camera control, tool functions and the wheel drive.

The days when conventional construction teams went to work on the sewer system, digging up roads and crippling the traffic for weeks are a thing of the past. It is much more pleasant if the inspection and renovation of the pipes take place below ground. To-



day, sewer robots can perform many tasks from the inside. They play an increasingly important role in the maintenance of urban infrastructure—ideally without disturbing the life that transpires just a few meters above them.

### Robots Replace Excavators

It was previously necessary to expose underground pipelines over long stretches just to localize damage. Today, sewer robots perform the assessment with no construction work at all. They are guided into a pipe at a gully or house connection. A built-in camera inspects the inner wall of the pipe to localize the damage. If robots are equipped with so-called working heads, they can also perform many repairs immediately.

“There are different kinds of sewer robots,” said Regina Kilb, who analysed this growing market segment at Faulhaber. “The devices for pipes with small diameters, usually shorter house connections, are attached to a cable harness. They are moved by rolling this harness in or out. They are equipped only with a swivelling camera for damage analysis. For large pipe diameters, on the other hand, machines mounted on carriages and equipped with multifunctional working heads can be used. Such robots have long been available for horizontal and, more recently, vertical pipes. The trend is towards smaller sewer robots, by means of which smaller diameter pipes can also be examined. In general, the field of application for sewer robots can be defined according to the pipe diameter: too large for push cameras, but too small for people.”

The most commonly used type of robot is designed for straight, horizontal travel in sewers with only a slight gradi-



Figure 1 In the past, it was necessary to expose underground pipelines over long stretches just to localize damage. Today, sewer robots perform the assessment with no construction work at all (courtesy of Regelmann).

ent. These self-propelled robots consist of a chassis—usually a flat cart with at least two axes—and a working head with integrated camera. Another version is able to navigate bends in the pipe. Lastly, there are robots that can even move in vertical pipes because their wheels or crawler tracks press against the pipe wall from the inside. A moveable suspension on the frame centers the device in the middle of the pipe; the spring system compensates for irregularities as well as small cross section changes and ensures the necessary traction.

These and other sewer robots are used not only in sewer systems, but also in industrial pipeline systems, such as in the chemical, petrochemical or oil and gas industries. “The requirements on the motors in the chassis are very high,” said Kilb. “They must pull the weight of the cables that supply them with power and transmit the camera images. For this purpose, the robots require motors that deliver very high power with minimal dimensions.”

### Working in the Pipe

Sewer robots can be equipped with very versatile working heads for automated repairs. They are able to eliminate obstacles, incrustations and deposits or protruding sleeve misalignments through, e.g., milling and grinding. They fill small holes in the pipe wall with a sealing compound carried on-board or bring a sealing plug into the pipe. On robots for smaller-diameter pipes, the working head is located directly



Figure 2 Regina Kilb, process engineer with Faulhaber (courtesy of Faulhaber).

at the end of the carriage; on machines for larger pipes, this is located at the end of a moveable arm.

In such a sewer robot, up to four different drive tasks are therefore handled: for the wheels or the crawler tracks, for the movement of the camera, for the drive of the tools and for the moveable arm that moves them into position. With some models, a fifth drive is used to adjust the camera zoom.

The camera itself must be swivelled and rotated so that it can always supply the desired viewing angle. The camera bracket does not provide much space, which is why particularly small, yet very precise, motors are needed here.

Options include the flat and, measuring just 12mm, extremely short gearmotors of the 1512...SR series or even larger models of the 2619...SR series.

Faulhaber’s wide range of products also includes stepper motors or brushless drives with diameters from 3mm as well as the corresponding gearheads. “With respect to their size, these drives achieve the highest efficiency and energy density that is available,” Kilb said.

### Heavy Cable-Drag

This ratio plays an important role on the chassis as well, particularly as the trend is towards miniaturization to enable the devices to be sent into even smaller pipes. The design of the drive varies: the entire carriage, each axis or each individual wheel can be moved by a separate motor. Not only must the motor or motors move the chassis and attachments to the

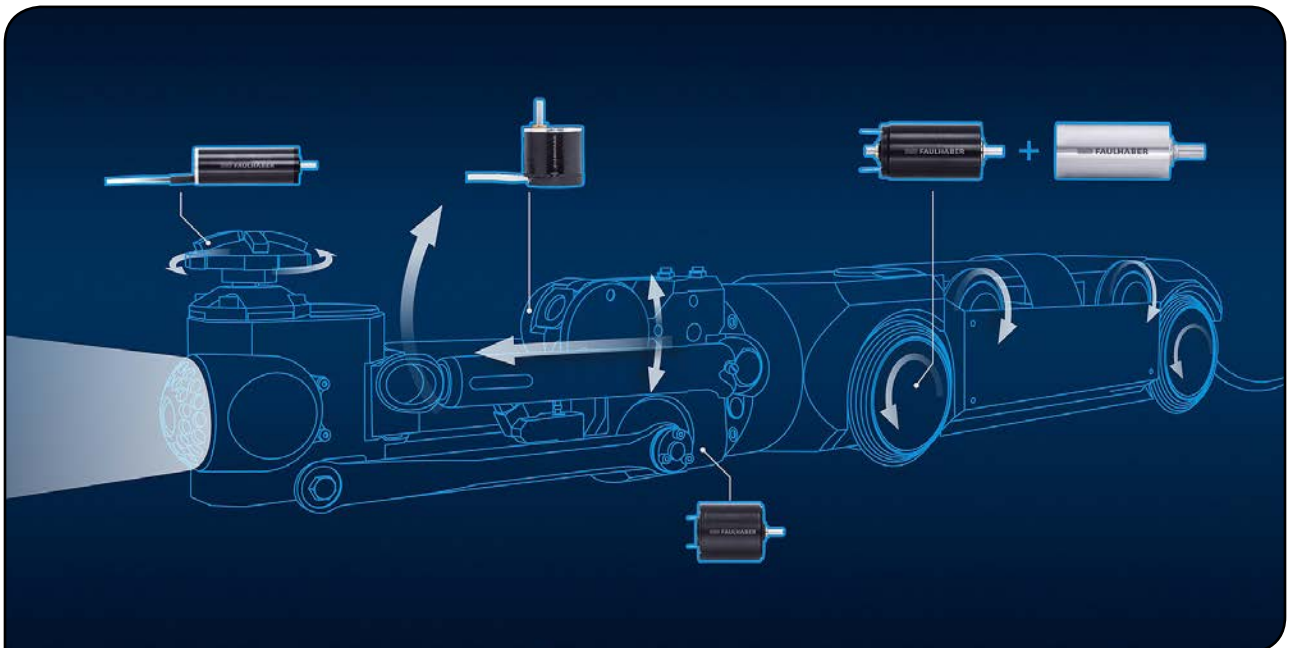


Figure 3 In a sewer robot, up to four different drive tasks are handled for the wheels or the crawler tracks, for the movement of the camera, for powering the tools and for the moveable arm that moves them into position. With some models, a fifth drive is used to adjust the camera zoom (courtesy of Faulhaber).

point of use, they must also pull along heavy pneumatic or hydraulic lines in addition to the electric cable.

With a range of up to 2,000 meters, the result is a cable drag of considerable weight. Thus, the drive must produce a very high torque, according to Kilb.

“At the same time, movement is time and again impeded by an obstacle. Overload at full speed occurs regularly. This is something that only very robust motors and gearheads can withstand. For this type of use, we recommend the proven graphite-commutated 3257 of the CR series or the 2224 of the SR series with precious-metal commutation and the new gearheads of the 20/1 R and 26/1 R types. The motor can be equipped with radial pins to secure the suspension and to absorb the forces that arise during overload,” Kilb said.

The motor for the robot arm requires less force than the radial drive and has more space than the camera version. The requirements on this powertrain are not as high as on the others in the sewer robot. “For this task, we have a very wide range of standard motors available,” Kilb added. “Among them is the optimum solution for every variant.”

### Compact Power Pack

The drives for the tools, on the other hand, must consistently deliver maximum performance — with small dimensions, since space is always limited in the function head. At the same time, motors that offer a particularly large amount of force and can operate trouble-free for a long time are needed for powerful gripping or for hours of milling.

They must also hold their ground against the competition posed by pneumatic and hydraulic drives. Due to the design, these produce higher torques than are possible using electrical drives in sewer conditions.

However, the electric motor needs neither the additional hydraulic or pneumatic drive unit nor the heavy and expensive lines and instead requires only the power cable, which is present in any case. The performance of the motors is increasing constantly, thanks not least of all to the knowhow and the ongoing development work of the engineers at Faulhaber.

“Motor type 2057...BHS, for example, is developed for such milling heads and achieves speeds in excess of 30,000 rpm,” Kilb said. “This tool plays a very important role in pipe-in-pipe renovations, as it ensures the free flow between the side and main pipe.”



Figure 4 The graphite-commutated motor 3257 of the CR series or the 2224 of the SR series with precious-metal commutation can be equipped with radial pins to secure the suspension and to absorb the forces that arise during overload (courtesy of Faulhaber).

### Pipe in Pipe

Today, damaged sewage pipes are often not replaced, but rather lined on the inside with plastic. For this purpose, a plastic tube is pressed into the pipe with air or water pressure. To harden the soft plastic, it is subsequently irradiated with UV light. There are, in turn, specialized robots equipped with high-power lamps that move through the pipes for this purpose. After they perform their work, the multi-purpose robots with working head must move in to cut out the lateral branches of the pipe. This is because the hose initially sealed all inlets and outlets of the pipe. During such applications, one opening after the next is milled into the hard plastic, often over the course of hours. The service life and reliability of the motors are of decisive importance here to allow work to be performed uninterrupted.

“With us, the manufacturers of sewer robots find a wide range of products that offers a suitable motor for all of the different tasks in this sector,” said Kilb. “This applies both with respect to power and efficiency as well as to robustness. Furthermore, we are available to our customers as a development partner if, for example, parallel positioning of the motor and gearhead is required for the camera movement. Together with our customers, we develop specific solutions for special requirements. These products do their part in increasing the amount of sewage work that is performed underground without construction crews.” **PTE**

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