

Control Your Speed

Uwe Thuenemann, ROSEN Europe, The Netherlands, and Judith Wegian-Kuipers, ROSEN Group, Germany, discuss the development of a new single section intelligent inspection tool designed to provide active speed control.

Until recently, the cost of running a magnetic flux leakage (MFL) intelligent inspection tool at high speed in gas pipelines, had been affected severely by the need to reduce flow rates in the pipeline. MFL inspection tools can operate in gas pipelines at a nominal flow rate of 0.8 – 3 m/s to their full specifications, and at up to 5 m/s to an acceptable level of performance. However, above this speed the laws of nature impair performance, if only due to the speed dependent build up of magnetic field in the pipe wall.

As a consequence, when an intelligent inspection tool run was scheduled, pipeline operators were faced with a significant loss of throughput (and in many cases a huge loss of earnings), even when it was possible to reduce the throughput given technical limitations or contractual commitments. Only in recent years have speed controlled MFL inspection tools allowed pipeline operators a much wider operating window for pipeline inspection runs.

When a pipeline operator recently commissioned ROSEN Europe to inspect a 48 inch gas pipeline network at high speed, the ROSEN Technology & Research Center (RTRC) implemented a novel approach. From the design to the complete inspection tool, RTRC provides technology to ROSEN Group companies around the world, including the development and manufacturing of sensors, mechanical and electronic components, and the necessary software.



Figure 2. View from the front of 46/48 inch dual diameter single section MFL inspection tool with active speed control.

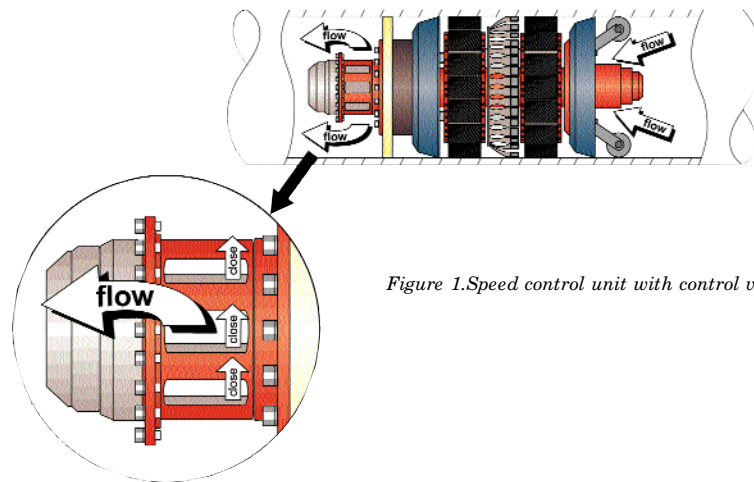


Figure 1. Speed control unit with control valve

Speed control principle

By creating a bypass within the inspection tool, it can be made to travel slower than the product transported in the pipeline. If the product (usually gas) is to pass through the inspection tool, a relatively large cross section of inspection tool will need to be completely open. Over the past few years, ROSEN has successfully inspected dozens of pipeline sections using an active speed control system. However, before the company developed the new 48 inch inspection tool, a secondary unit was required for electronics and batteries, as well as for the secondary sensor array. The necessary cross-sectional area of the bypass in the primary unit did not leave any room for these components.

Active speed control means that the travelling speed of the inspection tool in the pipeline is in fact controlled by its current speed, and is regulated accordingly. The reduction of speed is adjusted to the actual inspection tool speed, and is reduced proportionally whenever required. This ensures that the operating window of the inspection tool is maintained, even when the flow rate in the pipeline changes (due, for example, to a reduction of throughput at take off, or an increase at a tie in).

Based on speed information provided by the odometer system, a control valve opens the bypass as required, thereby regulating the speed of the inspection tool.

The speed regulation valve has naturally been designed as a fail safe system.

Single section tool development

The benefits of providing the MFL inspection tool in the form of a single section unit have been apparent since introduced by ROSEN 15 years ago. As a result, it is no longer necessary to extend pipeline tool traps built for ordinary cleaning tools; transport costs are lower; and onsite handling convenient, particularly offshore.

RTRC initiated a development program to benefit from these advantages. It required a new mechanical design, new sensor technology, and new hardware and software.

Mechanical design

The cross-sectional area required to allow a sufficient quantity of the gas flow through the inspection tool body to achieve the maximum possible speed reduction, means that the complete central body of the conventional intelligent MFL inspection tool must remain open. There is no space for components such as batteries and electronics inside the central body, and so they have been relocated in a streamlined tail section. This ensures that the highest possible speed reduction is achieved by providing an aerodynamic "wind tunnel" leading from the rear of the tool to the control valve at the front. As a

result, gas pipelines operating at speeds of up to 8 m/s can be inspected within specifications.

In spite of the demanding targets set to achieve a single section inspection tool with active speed control, other recent standard ROSEN design requirements have also been met. The inspection tool is capable of inspecting dual diameter pipelines (46 and 48 inch diameters in this case) and can pass 1.5 D radius bends and even 30° mitred bends.

Sensor technology

A secondary array of sensors has traditionally been used on MFL inspection tools (including ROSEN's single-section inspection tools) to allow for the important discrimination between internal and non-internal features.

However, the new speed control design of the inspection tool no longer leaves room for the secondary sensor array, and a major effort was therefore required to implement a new principle incorporating the internal/non-internal discrimination within the traditional primary sensors. As a result, each of the sensor carriers in the array now processes data from eight individual sensors, effectively

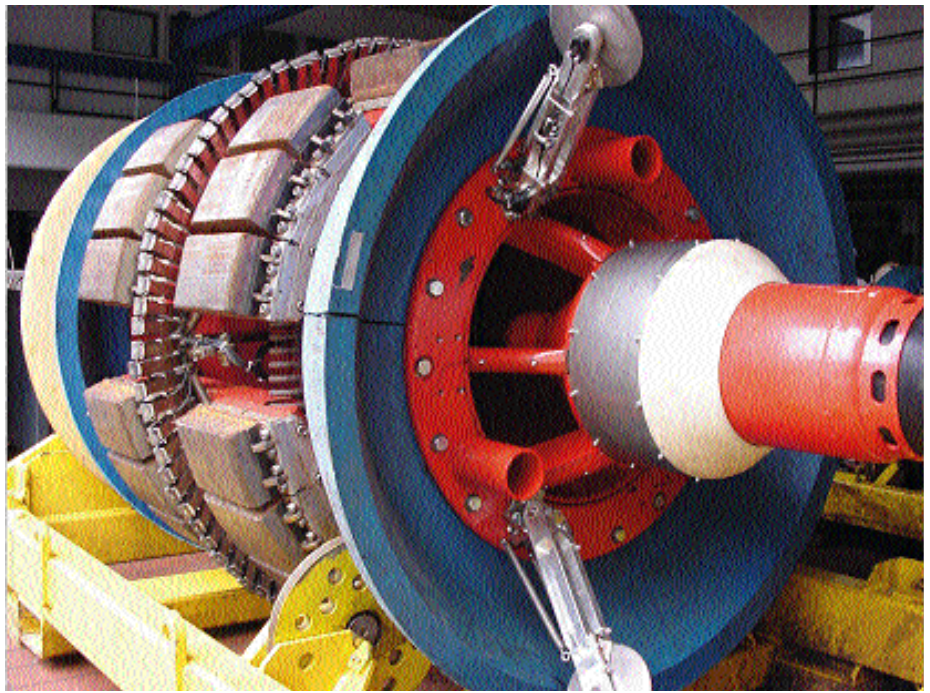


Figure 3. View from the back of 46/48 inch dual diameter single section MFL inspection tool with active speed control.

reducing the number of sensor arrays and cable connections by 50%. It goes without saying that this reduces the operating cost of the inspection tool in the interest of competitive survey cost.

Additional new technological details include the use of highly tensile materials

for the sensor housing and a ceramic wear surface to improve durability and reduce turnaround time between runs.

Electronic hardware

The simple idea of mounting the com-

plete measurement control, data acquisition, processing and storage unit in a small housing at the tail would never have materialised without access to recent advances in miniaturisation. The new electronic units designed to make the concept of a single section inspection tool possible at all, have now been implemented as a modular multi-purpose system that can be used for a variable number of channels, depending on required inspection tool size and sensor technology. Not only has this been a decisive factor in successfully building a 48 inch inspection tool with a large number of sensor channels, but the system components could also be used in a variety of inspection tools to be developed in the near future.

An extensive revision of the software that controls tool operation (comparable to the operating system of desktop computers) had to be written to accommodate the changes in parameters of the hardware being built at the time.

Conclusion

By combining the effort of its in-house research and manufacturing departments and its technology center (RTRC), ROSEN has designed and manufactured a new line of speed controlled MFL inspection tools in



Figure 4.46 48 inch dual diameter single section MFL inspection tool with active speed control at receiver

the space of four months, without the help of any external technology center. Less than two months after the inspection tool's completion, ROSEN Europe successfully inspected a 500 km gas pipeline system, demonstrating operational reliability under harsh site conditions.

In the near future, many of the newly developed technological achievements will be implemented in other of the company's

pipeline inspections tools, such as the MFL metal loss detection and Axial Flaw Detection (AFD) transverse flux intelligent inspection tools. In the meantime, pipeline operators are seeing significant cost savings thanks to a new concept in pipeline inspection technology: a single section MFL inspection tool with active speed control.