COMPLETE WATER RECOVERY WITH RESOURCE-EFFICIENT WEDOLIT® EASY-SPLITTING TECHNOLOGY

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Large-diameter pipes form the backbone of modern energy and raw material infrastructures. They are the central element of pipelines that transport oil, gas, water, or chemical products safely and economically over long distances. Their role in industry is therefore of strategic importance: without high-performance pipeline systems, the supply of energy and raw materials in globalized markets would be inconceivable.

However, the production of large-diameter pipes is a complex technological task. In addition to selecting suitable materials, precise manufacturing processes must be employed to ensure the required mechanical properties and corrosion resistance. Maintaining tight tolerances for diameter and roundness is particularly challenging. Furthermore, external factors such as increasing sustainability requirements, the processing of high-strength steels, and the integration of modern inspection methods complicate production. The combination of technical complexity, economic pressure, and safety-related aspects makes large-diameter pipe manufacturing a highly specialized field of industrial production.

Today, expansion represents a crucial step in the modern manufacturing process of longitudinally welded large-diameter pipes. After welding, this final forming step shapes the pipe into its final geometry through mechanical expansion. The objective is to improve dimensional accuracy and meet the strict tolerances for roundness and diameter that are essential for use in high-pressure pipelines.
In practice, various methods are used, with fully automated full-body expanders now representing the state of the art. They enable uniform expansion along the entire pipe length, ensuring high process stability. Processing high-strength steels is particularly demanding, as there is a risk of cracking or uneven deformation. Weld seams must also withstand the high stresses during the expansion process, requiring precise control of process parameters.

TRIBOLOGICAL CHALLENGE: EXPANDING LARGE-DIAMETER PIPES

Expanding large-diameter pipes is not only a geometric calibration step but also a complex tribological problem. During expansion, significant contact forces act between the cone and the outer segments of the expander head. These high surface pressures can cause wear, negatively affecting both service life and the quality of the pipe's inner surface.

To control these stresses, specialized expander lubricants are used. They form a stable lubricating film that reduces sliding friction while protecting the expander segments from wear. In addition, they help ensure a technically smooth internal pipe surface, which is crucial for media flow during operation. Uniform lubrication

also ensures reproducible expansion forces, reducing the risk of dimensional deviations and increasing overall process stability. Furthermore, expander oils must not leave residues that could impair subsequent inspections or pipeline operation. Their thermal stability is critical, as they must maintain a defined viscosity profile and lubrication performance even at high forming temperatures.

FIRST AND SECOND GENERATION EXPANDER LUBRICANTS

For a long time, ester-based expander oils were the industrial standard due to their excellent lubrication performance and natural raw material profile. As a result, they remain widely used in large-diameter pipe production, particularly from a sustainability perspective. Mineral oil-based expander oils are now equally state of the art and are considered a high-performance alternative, as ongoing development has specifically addressed properties of ester-based products that could lead to increased cleaning effort.

A fundamental issue with ester-based expander oils is their tendency to resinify. Natural triglycerides can undergo oxidative reactions under high temperatures and pressure loads, as encountered during forming processes. Under certain conditions, this can result in resin-like, sticky residues that accumulate on expander heads, machine components, and pipe inner surfaces, leading to contamination. The resulting increase in cleaning time and effort directly impacts plant availability and thus the

Fig. 1: Expanding large-diameter pipes is a tribological challenge in which the choice of a suitable lubricant influences both pipe quality and the wear protection of expander segments.

economic efficiency of the production process.

In contrast, mineral oil-based expander oils are significantly less prone to such polymerization and oxidation reactions due to their saturated hydrocarbon structure. In industrial practice, this results in cleaner equipment and consistent process stability.

Closely related to resin formation is the washability of oil residues from pipe surfaces. Oxidatively modified ester components tend to be less soluble and may require increased cleaning effort. Since a clean pipe surface is essential for subsequent process steps such as internal coatings, corrosion protection systems, or pipe welding, reduced washability can negatively affect the process flow. By comparison, mineral oil-based expander oils remain easily washable even after heavy use and extended storage. Their higher oxidation stability prevents thickening or stickiness, allowing easier rinsing and maintaining consistent surface quality.

In practice, cleaning is typically carried out through multi-stage rinsing cycles using water or low-concentration lubricant-water emulsions integrated directly into the production line. First, the pipe interior is flushed with high-pressure nozzles to remove lubricant residues and particles. This is followed by rinsing with temperature-controlled water, which promotes the formation of oil-water emulsions and facilitates the removal of lubricants from the metal surface. Emulsifiers are added to the expander lubricants to break the oil down into finely dispersed droplets enabling thorough cleaning. Spray systems are often used for the expander heads themselves to prevent deposits. Ester-based emulsions sometimes show a slightly increased tendency toward phase separation. As a result, free oil droplets may remain on the inner and outer pipe surfaces, which—if cleaning is inadequate—can increase the risk of adhesion issues in subsequent coating processes.

In contrast, mineral oil-based expander oils feature optimized emulsifier systems that ensure stable emulsions even under fluctuating process parameters, varying water qualities, and high temperatures. This ensures uniform wetting of the pipes, reduces oil separation, and increases process reliability in downstream manufacturing steps.

WATER RECOVERY THROUGH EMULSION SPLITTING

However, the resulting oil-water emulsions pose both ecological and economic challenges, as they must not be disposed of untreated.

In practice, separation plants are therefore used to treat these emulsions and enable the separate reuse of their phases. These systems operate on the principle of physico-chemical separation. By adding splitting agents—such as iron or aluminum salts and flocculants—the stability of the emulsion is disrupted. The oil phase coagulates and separates from the water. This is followed by sedimentation or flotation, resulting in two clearly distinguishable phases: purified water and oil flocs.

After treatment, the processed water shows

significantly reduced levels of organic and inorganic contaminants and can be reused as rinse water within the production cycle. This substantially reduces fresh water consumption, providing both ecological benefits through resource conservation and economic savings.

Comparable separation results can be achieved using organic splitting agents; however, the aqueous phase has an increased load of the splitting media used, making it unsuitable for reuse in the process.

The separated oil phase contains concentrated organic components with high calorific value. Instead of being disposed of as hazardous waste, it can be used for thermal recovery. In suitable incineration facilities, it serves as a substitute fuel, replacing fossil energy sources. This contributes to the overall energy efficiency of production and improves the carbon footprint.

THE THIRD GENERATION: EXPANDER LUBRICANTS WITH EASY-SPLITTING™ TECHNOLOGY

A newly developed formulation concept for expander lubricants by Master Fluid Solutions represents a significant advancement in the efficient splitting of expander oil emulsions. The core of Easy-Splitting™ Technology is the integration of a functional "predetermined breaking point" into the molecular structure of the emulsifier used. This minimizes the need for specially formulated splitting agents, whose mechanism of action is precisely tailored to the new lubricant concept. At the same time, it enables nearly complete separation of the oil and water phases, significantly exceeding the performance of conventional systems. The separated water exhibits exceptionally high optical clarity and is free of visible residues, allowing it to be directly returned to the process cycle.

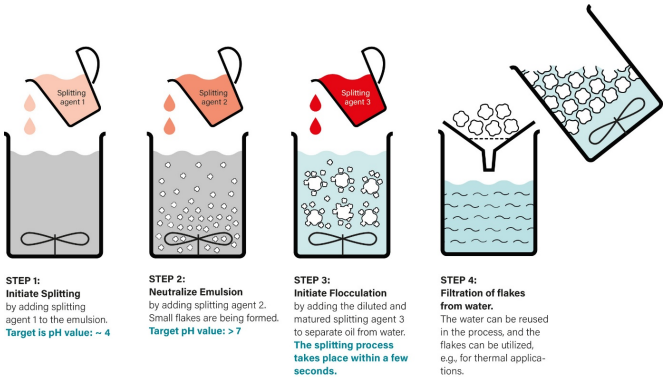

Fig. 2: Functional principle of WEDOLiT® Easy-Splitting Technology

CONCLUSION

Modern expander lubricants form a stable lubricating film that reduces sliding friction, protects expander segments from wear, and ensures technically smooth inner pipe surfaces. Reproducible expansion forces reduce the risk of dimensional deviations and improve overall process stability. Mineral oil-based expander lubricants can also be easily removed with water

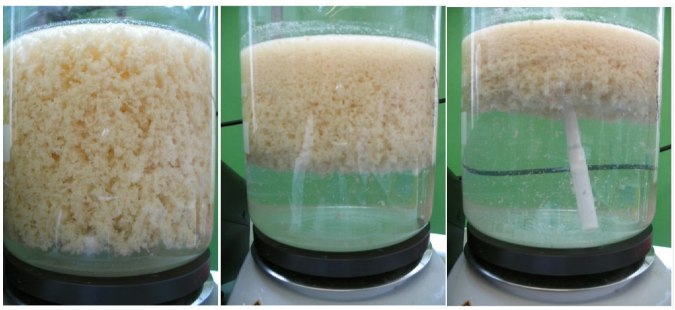

Fig. 3: Near-complete separation of oil and water phases with WEDOLiT® Easy-Splitting Technology

thanks to optimized emulsifier systems, and the water can be partially recovered in separation systems.

With WEDOLiT® Easy-Splitting™ Technology, a virtually complete separation of oil and water phases is achieved with minimal use of splitting agents, allowing the recovered water to be directly reused in the process cycle and significantly reducing fresh water consumption.

WEDOLiT® expander lubricants with Easy-Splitting™ Technology thus combine technical performance, process reliability, and resource efficiency into a forward-looking overall concept for large-diameter pipe manufacturing.

Find **more information** about the innovative WEDOLiT® Easy-splitting™ Technology