The use of dewatering tubes Vs Typical tailings storage / discard / dewatering methods (white paper)

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Abstract:
This paper explores the utilization of geotextile dewatering tubes as an alternative to traditional approaches for dewatering and drying slime-laden slurries. Geotextile tubes, consisting of interwoven high-strength fabric, are employed as containers to separate solids from water. The objective is to assess the advantages of geotextile tube dewatering in terms of cost and time, in comparison to conventional methods such as drying pads and conventional filters. By presenting a comparative analysis, this study aims to provide a compelling case for the adoption of geotextile dewatering as a viable alternative in hydraulic construction projects.

Keywords: Dewatering, geotextile containers, hydraulic construction

1. Introduction

Dewatering tubes or containers are constructed using tightly woven materials known for their high-water filtration rates and fines control. These tubes offer an alternative to conventional dewatering methods like filter presses, drying ponds, tailing dams, and sludge ponds. The process involves assessing the compatibility of the sludge material with the geotextile, followed by pumping it into the tube to separate the solid content from the water. The resulting solids can be repurposed for various applications such as reprocessing, filling, or even sold as construction materials or fertilizers.

2. Types of geotextile materials used for dewatering

Geotextiles are classified based on the manufacturing process, mainly as woven and non-woven. Specialist fabrics, combining elements from both classes, serve specific purposes like coastal erosion protection. In the context of dewatering, woven geotextiles are widely considered the most effective for tube-based dewatering processes. Woven geotextiles possess high strength even under strain, making them suitable for this application. Additionally, variations of woven geotextiles, such as woven monofilament or combinations of woven and non-woven fabrics, offer enhanced filtration capabilities.

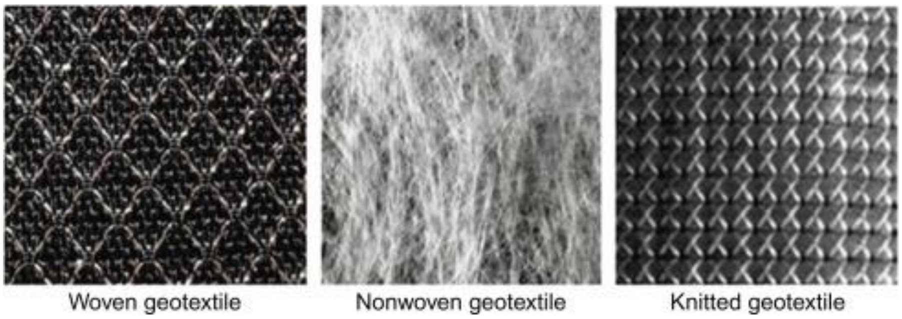

Fig 1. Woven vs non-woven fabrics

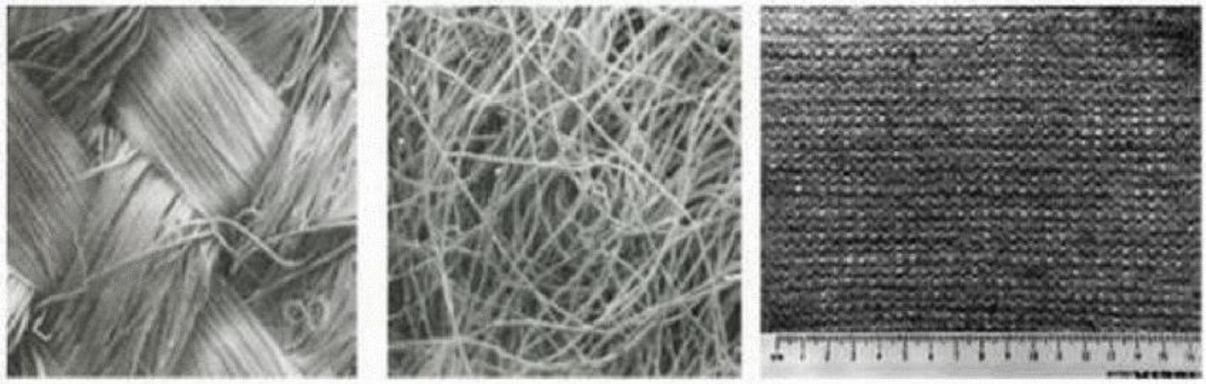

Fig 2. Microscopic view of woven and non-woven

Fig 3. Woven mono-filament fabric

3. Conventional methods vs Geotextile Dewatering methods

3.1 Conventional dewatering methods

Conventional methods for dewatering sludge can be classified into plate and frame filter presses, centrifuges, and belt presses. These techniques are commonly employed in waste and water treatment plants to reduce sludge volume for more efficient processing.

3.1.1 Plate and frame filter press

Plate and frame filter presses utilize recessed-chamber filter plates to separate liquids from solids. The filtrate is squeezed through the filter cloth in the chambers, and the resulting cake is collected and discharged onto a conveyor. This method is effective in achieving a solids content ranging from 40% to 70%. It is commonly employed in biological sludge, API separator sludge, or situations where a dry filter cake is desired, such as in specialized applications.

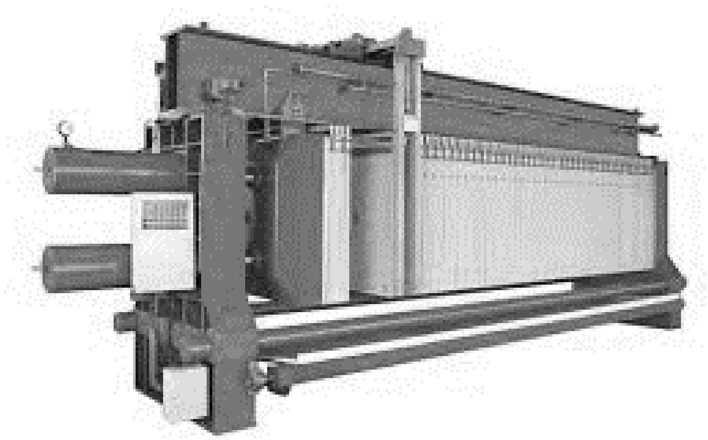

Fig. 4 Plate and frame filter press

3.1.2 Centrifuge

A centrifuge is a device that utilizes high rotational speed to separate solids with different densities. This method operates on the principle of buoyancy, where materials of higher density settle at the bottom of the mixture. Although centrifuges typically produce solids content in the range of 25% to 35%, their rapid processing speed is advantageous. Centrifuges are commonly used for applications such as oil sludge dewatering and municipal wastewater sludge treatment. They are particularly useful when size versatility, transportation, and disposal costs are considerations. However, centrifuges have certain drawbacks, including expensive replacement parts, susceptibility to internal wear, high noise and vibration levels, and high initial equipment capital costs.

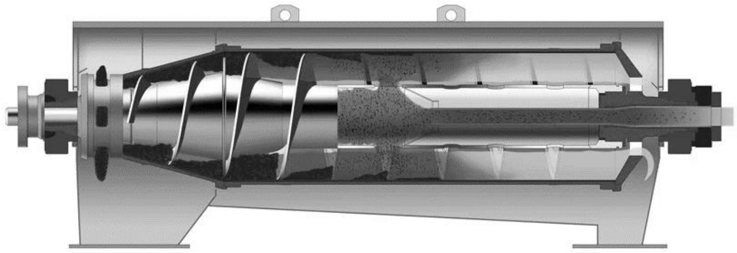

Fig. 4. Centrifuge for sludge dewatering

3.1.3 Belt presses

Belt presses are commonly used in situations where continuous operation is required and higher moisture content is acceptable in the filter cake. These presses separate freestanding water from sludge using gravity. The collected sludge is squeezed between two filter belts, extracting excess water from the sludge. The resulting filter cake typically contains 18% to 25% solids by weight. The dewatered sludge is collected in a bin, while the water is returned to the wastewater system. Belt presses are most effective for high-volume waste streams, such as those found in paper mills or river silt applications.

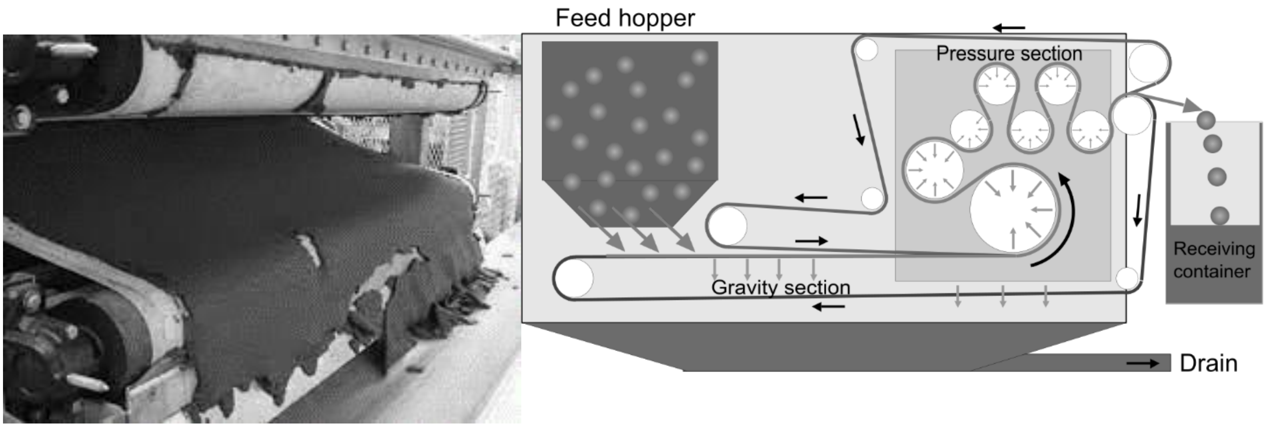

Fig 5. Belt press illustration

3.2 Alternative dewatering method, Geotextile tube or bag

Geotextile tubes are cost-effective containers made of interwoven high-strength fabrics used to separate solid-laden slurries. They allow water to pass through while retaining the solids, offering a non-mechanical and electricity-free dewatering solution. Slurries are pumped into the tubes, and flocculants may be added to enhance dewatering efficiency. The dewatering process occurs in stages, often requiring multiple pumps for complete filling. Geotextile tubes can be left in place for consolidation or appropriately disposed of. In some cases, dewatered sludge from processes like gold processing can undergo further refinement.

These tubes can be manufactured in various sizes, lengths, and fabrics to suit specific applications. They have a small footprint compared to larger machine-based dewatering systems and can handle different types of sediments, sludge, or sands. Geotextile tubes have demonstrated an impressive dewatered ratio, with up to 85% solids compared to the highest achievable ratio of 70% with conventional methods.

Overall, geotextile tubes offer a practical and efficient alternative for dewatering solid-laden slurries, providing higher solids retention, versatility, and cost-effectiveness compared to traditional approaches.

Fig 6. Geotextile dewatering tube

4. Selecting the Correct Geotextile tube size

As geotextile tubes are manufactured in different sizes and dimensions it is particularly important to select the correct sizes for a tube as this may impact the effectiveness of the dewatering process. Most manufacturers assist free of charge with the testing procedure to ease the selection process. Some factors to consider below:

4.1.1 Site Layout and Conditions

Assess the slope of the site to prevent tube rolling or movement. Proper anchoring and positioning are essential.
Determine the available space on the site. Geotextile tubes can be manufactured up to 100m in length, so ensure the site can accommodate the selected tube size to utilize its capacity effectively.

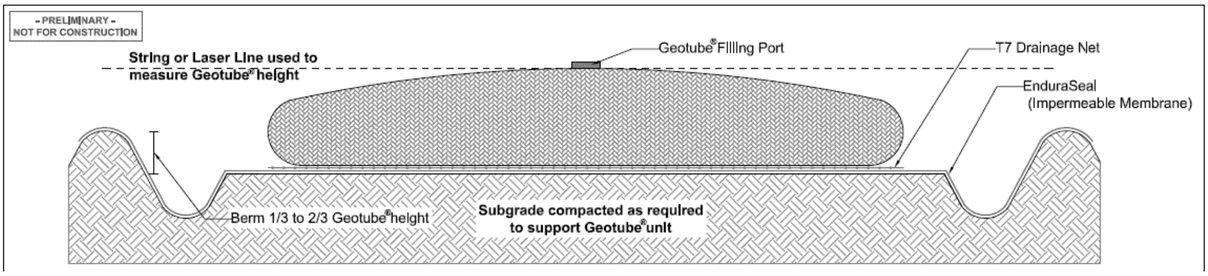

Fig 7. Illustration of a tube layout

4.1.2 Type of sludge to be dewatered and time required for the dewatering process

- Different fabrics and stitch types are available for geotextile tubes. To select the appropriate material, send a sludge sample to manufacturers who can assist in the testing process.
- Standardized tests, such as ASTM methods, are used to evaluate the performance of geotextile tubes. The following tests can be conducted to match the fabric to the dewatering requirements:
    - Falling-head test (ASTM D4491): Measures the permeability of the geotextile by evaluating flow rate and hydraulic head.
    - Pressure filtration test (ASTM D6830): Determines the comparative performance of filter media, aiding in design, manufacturing, and selection.
    - Standard cone testing (ASTM D4318): Characterizes fine-grained fractions of soils and construction materials, supporting engineering classification.

By considering the site layout, conditions, and the specific characteristics of the sludge, along with conducting appropriate testing, the correct geotextile tube size and fabric can be selected for optimal dewatering performance.

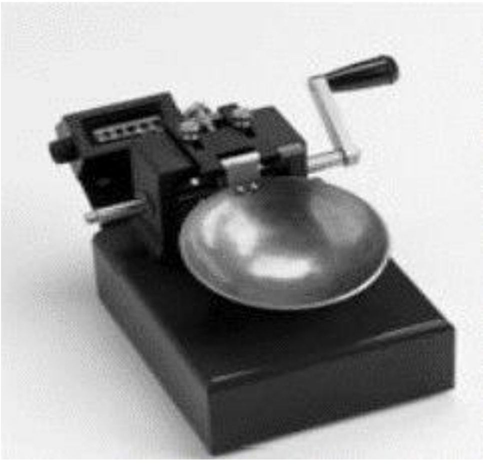

Fig 8. ASTM D4318 Atterberg limits

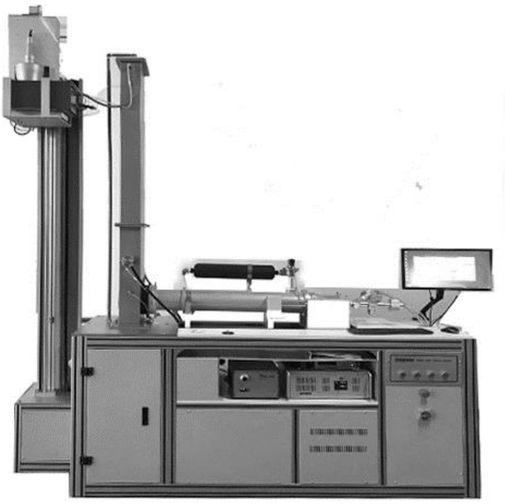

Fig 9. Duster filter efficiency test system ASTM D6830

Fig 10. ASTM D4491 Geotextile permeability test

Alternatively, field tests can be conducted to observe the performance of geotextile tubes:

- Hanging Bag Test (ASTM D7701): This test method assesses the flow rate of water and suspended solids through a geosynthetic permeable bag, typically used to contain high-water content slurry like dredged material. The test measures the volume of water passing through the geotextile bag over a specific time period, as well as the percentage of total suspended solids in the water (measured in milligrams per litre or parts per million).

- Geotextile Tube Dewatering Test (Based on Hanging Bag Test, ASTM D7701): This test specifically focuses on evaluating the dewatering performance of geotextile tubes. It utilizes the principles of the hanging bag test to measure the water flow rate and the concentration of suspended solids in the effluent water. By conducting this test, the effectiveness of the geotextile tube in separating solids from water can be assessed.

Field tests, such as the hanging bag test and the geotextile tube dewatering test, provide valuable insights into the performance and suitability of geotextile tubes for specific dewatering applications. These tests help validate the selection of the appropriate geotextile material and design for achieving desired dewatering results in real-world conditions.

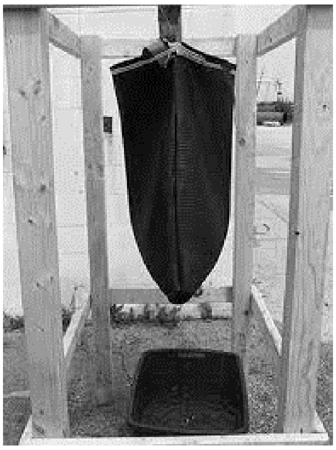

Fig 11. Hanging bag test ASTM D7701

5. Dewatering process in a geotextile tube

The dewatering process using geotextile tubes involves specific stages and phases to effectively remove water from the sludge and consolidate the material within the tube. These stages and phases are crucial to ensure optimal dewatering and avoid any potential issues. The process varies during the filling and draw-down phases, with changes in water movement and pressure. It's important to closely monitor the process to adhere to safety considerations determined during testing, as overfilling can lead to tube ruptures. The figures below illustrate the different stages and phases of dewatering:

These figures provide visual representations of the various stages and phases involved in the dewatering process using geotextile tubes. Understanding and following this process will help achieve efficient dewatering and successful consolidation of the material within the tubes.

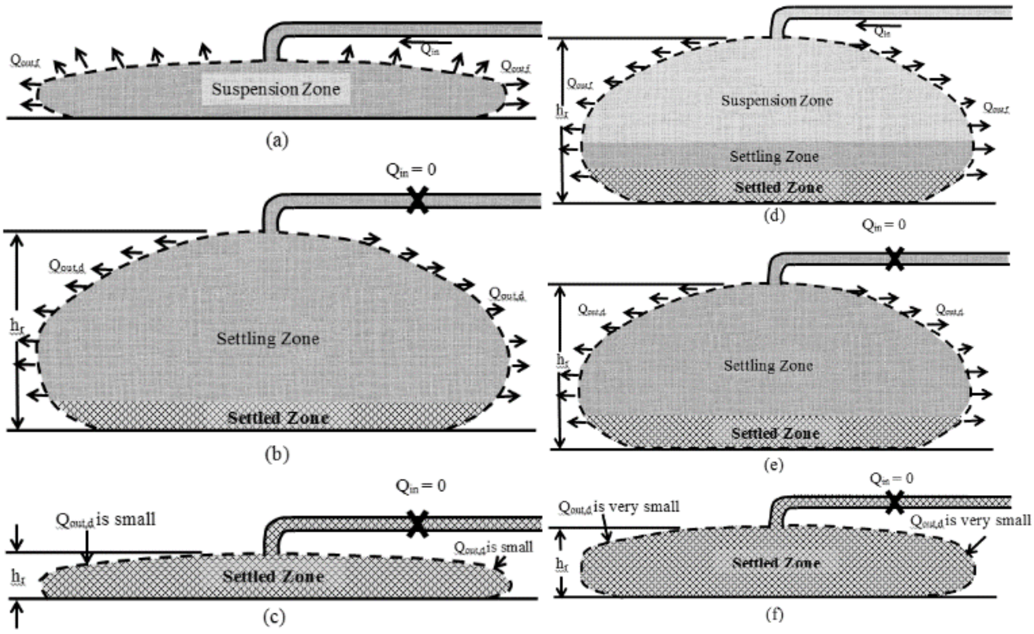

Fig 12. Conditions inside of the geotextile tube during different moments of filling and drawdown created after: (Yee 2012) (a) initial filling phase; (b) initial drawdown phase; (c) end of initial drawdown phase; (d) end of subsequent filling phase; (e) beginning of subsequent drawdown phase; (f) end of subsequent drawdown phase

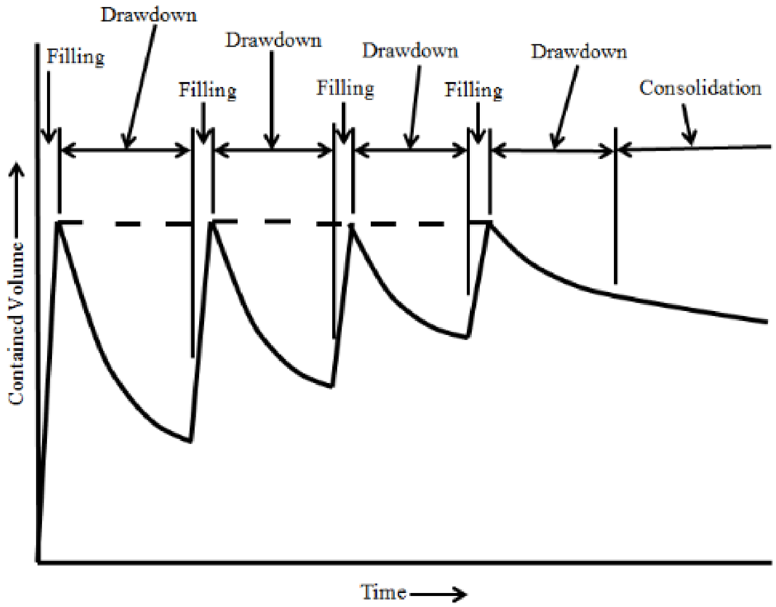

Fig 13. Filling, Drawdown and Consolidation Phases, created after: (Lawson 2008)

To enhance the effectiveness of the dewatering process and promote efficient water discharge through the geotextile filter, the use of flocculants can be considered. Flocculants are chemical additives that aid in the agglomeration of particles, facilitating either flotation or sedimentation. By adding flocculants to the sludge material, the agglomeration of fine particles can be promoted, allowing the free water to be released through the geotextile while controlling the retention of fine particles within the tube or bag. This improves the overall effectiveness of the geotextile tube for dewatering purposes. The appropriate selection and application of flocculants can optimize the dewatering process, leading to improved water separation and solids consolidation.

6. Comparing dewatering geotextile tubes to conventional methods.

When considering alternative methods of dewatering, several factors should be taken into account to guide decision-making. These factors can vary depending on the specific circumstances, but the following considerations are commonly debated:

6.1 Time: The impact on production schedules is a major concern, as it directly affects the overall efficiency and profitability of material processing. Geotextile tubes offer faster deployment and minimal capital outlay, enabling quick initiation and effective production of the required volumes. In contrast, conventional methods often involve extensive transportation, design, and construction efforts before the dewatering process can commence.

6.2 Financial implications: Geotextile tubes generally require lower capital investment for initialization compared to conventional methods. Their design and construction processes can be more streamlined, and they have a smaller footprint. Tubes only require a flat lay-down area for filling and dewatering, whereas other methods, such as belt presses, may necessitate the construction of larger facilities or filtration systems. Additionally, geotextile tubes can be stacked, maximizing the utilization of both surface and vertical space.

6.3 Storage area: Geotextile tubes require less space for storage compared to conventional plants or facilities. They can be delivered in roll format and easily stored on-site. Additionally, the stackability of tubes allows for efficient use of airspace. Unlike centrifugal or filter presses that need to be fully deployed, geotextile tubes can be paused or halted without disrupting other processes, providing flexibility and adaptability.

6.4 Regulatory compliance: Regulations regarding the disposal of sludge, waste, and the construction of new storage facilities such as sludge ponds, tailings dams, or drying pads can be stringent in many countries. Geotextile tubes offer a contained and controlled method for dewatering, mitigating the risk of environmental damage. This can simplify the process of obtaining licenses and approvals, potentially reducing the burden on operators or owners.

6.5 Location: Dewatering sites are often located in remote areas, far from urban centres. Conventional dewatering methods may face challenges in terms of transporting machinery and equipment to these locations, making them financially impractical in initial feasibility studies. Geotextile tubes, being supplied in a rolled format, can be easily transported by truck or other suitable vehicles, making them more feasible for remote applications.

6.6 Type of process required: The desired dry solids content after dewatering can vary depending on the specific application. Geotextile tubes have shown the ability to achieve higher percentages of solids compared to conventional methods, making them advantageous when the goal is to obtain a concentrated material that requires less transportation for reprocessing or disposal. However, if a higher fluid concentration is necessary, conventional methods may be more suitable.

6.7 Flexibility and scalability: Geotextile tubes offer flexibility in terms of scale. They can be manufactured in various sizes and lengths to accommodate different project requirements. This scalability allows for efficient dewatering operations, whether it's a small-scale project or a large-scale industrial application.

6.8 Operational simplicity: Geotextile tubes generally have a straightforward and non-mechanical setup. They do not require complex electrical processes, making them easier to operate and maintain compared to some conventional dewatering methods. This simplicity can lead to reduced operational complexities, training requirements, and potential operational risks.

6.9 Environmental impact: Geotextile tubes can offer environmental advantages in certain situations. By effectively separating solids from water, they can help reduce the volume of waste material, which can minimize the environmental footprint associated with disposal. Additionally, the contained nature of geotextile tubes can prevent the release of contaminants into the surrounding environment, promoting environmental stewardship.

6.10 Adaptability to varying sludge characteristics: Different types of sludge or sediment can present varying challenges for dewatering. Geotextile tubes can be tailored to specific applications by using different fabrics, stitch types, and additives. This adaptability allows for effective dewatering across a range of sludge characteristics, ensuring optimal performance and achieving desired results.

6.11 Maintenance and downtime: Geotextile tubes generally require minimal maintenance compared to conventional dewatering equipment. They have fewer mechanical components and are less prone to breakdowns or mechanical failures. This can result in reduced downtime and increased operational efficiency.

6.12 Project duration: The duration of the dewatering project can be a significant factor in selecting the most suitable method. Geotextile tubes offer quick deployment and can provide efficient dewatering over shorter project durations. In contrast, conventional methods may be more suitable for longer-term projects that require continuous operation and higher moisture content in the filter cake.

Considering these factors and evaluating the specific requirements of each dewatering project will enable decision-makers to determine the most appropriate method, whether it be geotextile tubes or conventional techniques, for achieving efficient and effective dewatering outcomes.

7. Comparison of Geotextile Tube Dewatering to Conventional Tailings Storage

As we have covered the general differences between conventional and tube dewatering, it would be of great interest to compare the possibility of using tubes for the containment of tailings instead of building tailings facilities.
Tailings facilities are regarded as some of the largest engineered structures on earth and are typically earth-filled embankment dams that store by-products of mining operations. One of the largest is the Syncrude Mildred Lake Tailings Dyke in Aberta Cananda.

Fig 14. Brazil, Hydro Alunorte Alumina Tailings dam

Methodology:
Geotextile Tube Dewatering: In this method, mine tailings are pumped into geotextile tubes made of interwoven high-strength fabric. The tubes allow water to pass through while retaining the solid particles. The dewatered tailings can be further processed or disposed of in a suitable manner.

Fig 15. Geotextile tubes watersolve

Conventional Tailings Storage: Conventional tailings storage typically involves constructing tailings ponds or dams where the slurry is deposited and allowed to settle. Water gradually drains from the pond, leaving behind the solid tailings. The stored tailings may require additional treatments or containment measures to ensure long-term stability.

Dewatering Efficiency:
Geotextile Tube Dewatering: Geotextile tubes have proven to be capable of achieving high dewatering efficiencies, with solid content retention rates of up to 85%. This results in a higher concentration of solids in the dewatered tailings.
Conventional Tailings Storage: Conventional methods generally achieve lower dewatering efficiencies, typically yielding solid content retention rates of around 70%. This means the resulting tailings have a lower concentration of solids.

Time and Cost:
Geotextile Tube Dewatering: The setup and deployment of geotextile tubes are relatively fast and require minimal capital investment. The non-mechanical nature of the process and the absence of large-scale infrastructure construction can reduce the time and cost involved in initiating dewatering operations.
Conventional Tailings Storage: Conventional tailings storage requires significant investment in the design, construction, and maintenance of tailings ponds or dams. The establishment of infrastructure and the time required for settling and consolidation can make this method more time-consuming and costly.

Footprint and Storage Area:
Geotextile Tube Dewatering: Geotextile tubes have a smaller footprint compared to conventional tailings storage facilities. They require a relatively small lay-down area for filling the tubes and can be

stacked to optimize space utilization. Geotextile tubes also offer flexibility in terms of storage capacity, as they can be partially filled and left in place for ongoing dewatering.
Conventional Tailings Storage: Conventional tailings storage facilities, such as ponds or dams, require a larger land area for construction and operation. The storage capacity is typically fixed and cannot be easily adjusted, which may limit the flexibility of the operation.

Environmental Considerations:
Geotextile Tube Dewatering: Geotextile tubes can be an environmentally friendly alternative to conventional tailings storage. The contained nature of the tubes reduces the risk of tailings leakage or seepage, minimizing the potential for environmental contamination. Geotextile tubes also offer the possibility of reprocessing the dewatered tailings for further refinement, reducing waste and environmental impact.
Conventional Tailings Storage: Conventional tailings storage facilities require careful design and management to prevent environmental risks. Liners and containment systems are often necessary to mitigate the potential for water contamination. The long-term stability and monitoring of these storage facilities are crucial to avoid environmental incidents.

In summary, geotextile tube dewatering provides a cost-effective, time-efficient, and environmentally friendly alternative to conventional tailings storage. It offers higher dewatering efficiencies, smaller footprints, and flexibility in storage capacity. However, the choice between these methods should consider site-specific conditions, regulatory requirements, and the specific objectives of tailings management.

8. Conclusion

In conclusion, the comparison between geotextile tube dewatering and conventional tailings storage reveals distinct advantages and considerations for each method. Geotextile tube dewatering offers higher dewatering efficiencies, quicker deployment, lower costs, smaller footprints, and greater flexibility in storage capacity. It also presents environmental benefits, such as reduced risk of contamination and the potential for tailings reprocessing. On the other hand, conventional tailings storage methods require significant infrastructure investment, have lower dewatering efficiencies, larger footprints, and fixed storage capacities. Environmental considerations include the need for careful design and management to prevent contamination.

The choice between geotextile tube dewatering and conventional tailings storage should be based on site-specific factors, regulatory requirements, and tailings management objectives. Geotextile tube dewatering may be a suitable option for operations seeking efficient, cost-effective, and environmentally friendly tailings management. However, it is essential to conduct a thorough assessment of the site, considering factors such as tailings characteristics, available space, local regulations, and long-term stability requirements.

Further research and case studies are needed to fully evaluate the performance, limitations, and long-term viability of geotextile tube dewatering in different mining contexts. Continuous advancements in technology and best practices can enhance both geotextile tube dewatering and conventional tailings storage methods, contributing to more sustainable and responsible management of mine tailings. Ultimately, the selection of the most appropriate method should prioritize safety, environmental protection, and the efficient utilization of resources throughout the lifecycle of mining operations.

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