# Unique and sustainable system for producing garments without water discharges

LIFEanhidra

Jeanologia aitex PIZARRO

Co-funded by the European Union

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# Main goal of Life Anhidra and challenge

The main objective of LIFE ANHIDRA is the development and validation of an innovative, efficient and effective solution to regenerate and reuse water in-situ in the textile washing and finishing process. This will allow:

**Up to 60 days**

Of water reuse in processes involving industrial washing machines.

**21.000 $m^3$/cycle**

Water reuse in processes involving industrial washing machines during 60 days.

**123.408 $m^3$/year**

Water reuse in processes involving industrial washing machines during a year.

The design and construction of the ANHIDRA technology has been carried out through a scaling process, as the base technology has been previously developed and tested on a smaller scale. This system will be patented internationally, with a high potential for replicability worldwide. Detailed replication and development of commercial plans to reach European textile companies in the short term is also part of the project.

Savings in terms of fresh water used, wastewater generated, energy consumptions and other waste streams generated during the project has been continuously monitored, and a Life Cycle Analysis has been carried out in the final stages of the project.

In addition, the valorisation of fibrous waste has been explored, with a basic circular economy approach. The textile waste generated by the system has been collected, conditioned and characterised before investigating its potential processability for different uses.

# Main goal of Life Anhidra and challenge

## Expected impacts of Life Anhidra

### 92% reduction in water consumption

Dehydrating the garment finishing industry

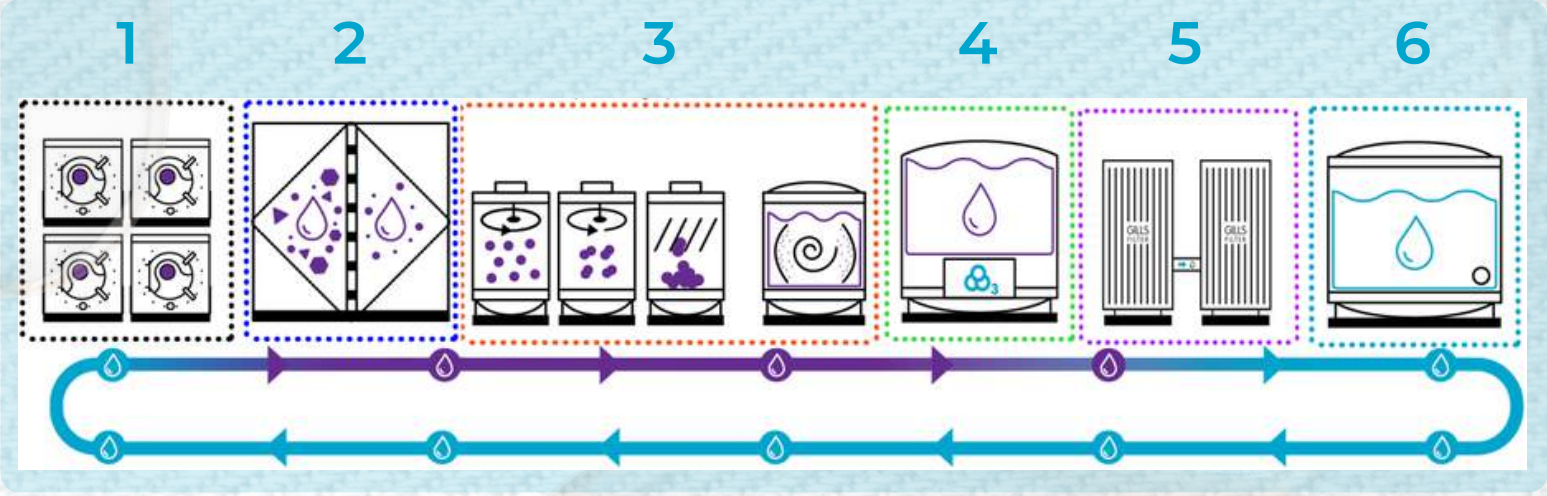
### 98% reuse of water from industrial processes

Maximisation of annual reclaimed water of rejected flows

### Avoid discharge of emerging pollutants

### Reuse and valorization of recovered fibers

# Structure of the Anhidra system




**1** **Washing machines:** The set of industrial washing machines is connected through a common piping network that collects the used water from each washing machine and directs it to the ANHIDRA system for treatment.

**2** **Mechanical filtration:** This filtration system separates the solids and suspended particles present in the wash water through filters that retain mainly textile fibers from the garments.

**3** **Cyclone system:** Suspended solid particles are removed from water using a centrifugal process, which separates impurities through centrifugal force, resulting in cleaner water.

**4** **Ozone treatment:** Ozone is generated in situ and is put in contact with the water to be treated, taking advantage of its high oxidizing capacity to eliminate organic contaminants such as detergents, oils and dyes. This process significantly improves water quality without generating toxic waste, since ozone decomposes naturally into oxygen, achieving an efficient, safe and environmentally friendly treatment.

**5** **Ultrafiltration system:** By means of a membrane filtration system, the smallest particles present in the water are removed and water of sufficient quality for washing processes is obtained.

**6** **Clear water storage tank:** The treated clean water is stored, ready for reuse in the washing process.

# Structure of the Anhidra system

## Prototype


# Project partners

Jeanologia®

JEANOLOGÍA, founded in 1994, is an R&D SME whose main activity is based on the textile industry and new technologies applied to this sector. JEANOLOGIA MISSION is to transform the textile industry, making it ecological, ethical and eco-efficient thought its technologies.
JEANOLOGÍA acts as project coordinator to launch the technology developed in Europe on the global market. ANHIDRA allows to reach its objective “minimizing water consumption by reusing water in industrial washing processes, preventing dehydration of the planet”. JEANOLOGÍA performs the design, construction and market implementation of the ANHIDRA technology through a scaling process that will be patentedinternationally with a high potential for global replicability.

PIZARRO

PIZARRO is an SME founded in 1983. Its main activity consists of washing, dyeing and printing among other finishing processes, both in denim and knitwear. PIZARRO is the first Portuguese company with an integrated quality, environmental and occupational health and safety management system, which indicates its awareness of the environment and workers' conditions.
PIZARRO has incorporated the system developed by JEANOLOGÍA into its actual industrial processes, using it to recover the water used in the washing processes with industrial washing machines.

aitex®
research & innovation center

AITEX is a private non-profit technical center made up of textile companies, aiming to enhance their competitiveness through modernization, new technologies, and improved quality. It represents over 900 textile companies in Spain and abroad.
Its main activities include standardization and quality, R&D projects, training, and laboratory services. AITEX also evaluates fabrics treated with reused water, valorizes recovered short fibers, ensures regulatory compliance, promotes sustainable practices, assesses the system’s life cycle (LCA), and develops dissemination materials both online and in scientific-technical forums.

# Market

The implementation of actions over 5 years is expected to grow progressively across all three scenarios (optimistic, baseline and pessimistic), with significant differences in the final scope:

| Pessimistic forecast | Baseline forecast | Optimistic forecast |
|---|---|---|
| 59 cumulative actions by year five | 85 projected actions | Up to 110 projected actions |

The textile industry is a major consumer of water and a significant contributor to environmental pollution, particularly in the garment finishing sector. With denim production alone estimated to consume vast amounts of water and generate substantial wastewater, the market for sustainable water management solutions is primed for innovative technology like LIFE ANHIDRA.

The textile and garment industries are responsible for approximately 20% of the world's industrial wastewater pollution and 8% of global carbon emissions. Denim finishing, in particular, consumes around 40 liters of water per garment, translating into millions of liters annually for large-scale production facilities.

LIFE ANHIDRA project offers a sustainable, cost-effective, and innovative solution to the textile industry's water challenges. By implementing LIFE ANHIDRA, garment finishers and textile producers not only contribute to water conservation efforts but also gain a competitive advantage by embracing eco-efficient technology. ANHIDRA CONSORTIUM invites industry stakeholders to be part of this transformation, supporting a sustainable future in textile manufacturing.

The primary target market for LIFE ANHIDRA includes textile finishing facilities, and international brands committed to sustainability. The system's modular design makes it adaptable to a variety of production environments, from small batch production to large industrial facilities. Key market segments shall include replicability and transferibility:

| | | | |
|---|---|---|---|
| **Replication** | It means that the ANHIDRA used in the project will be used again in the same way and for the same purposes by other entities | → | **Denim** Finishing on garmet |
| **Transfer** | It means that the ANHIDRA used in the project will be used in a different way or for a different purpose | → | **Textile industry** (not only denim, not only garment) |

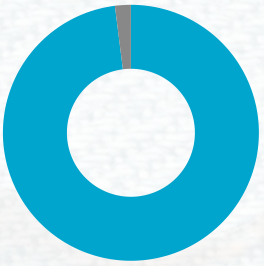
# Technical performance and main results

## Validation tests of the technology

### Water reuse efficiency of the system

The ANHIDRA system has achieved water reuse efficiencies between 96% and 98% per month, reaching a maximum of 98% in May 2025.

These figures demonstrate excellent performance under actual production conditions, although they can be affected by maintenance, shutdowns or types of textile processes.

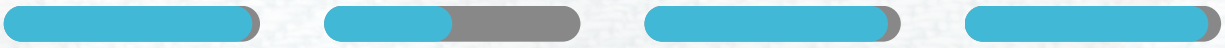


96% - 98% reuse water

### Validation of water treatment

Comprehensive analyses have been performed at the different stages of the water recovery process.

The treatment achieves significant reductions in turbidity, color and COD:



Turbidity reductions of up to 97.8%.

COD reductions of more than 50%

Color reductions of up to 95%.

Color reductions of up to 95%.

The quality of the treated water is confirmed as suitable for reuse in industrial processes, specially in textile washing: In the left, inlet blueish water vs cyclonic-treated. In the right: after ozone and membranes (clean water).

### Performance against different processes

Different types of wastewater from different processes (enzymatic, bleaching, neutralization) have been evaluated.

The system maintains its effectiveness in all cases, although the initial pollutant loads vary significantly.

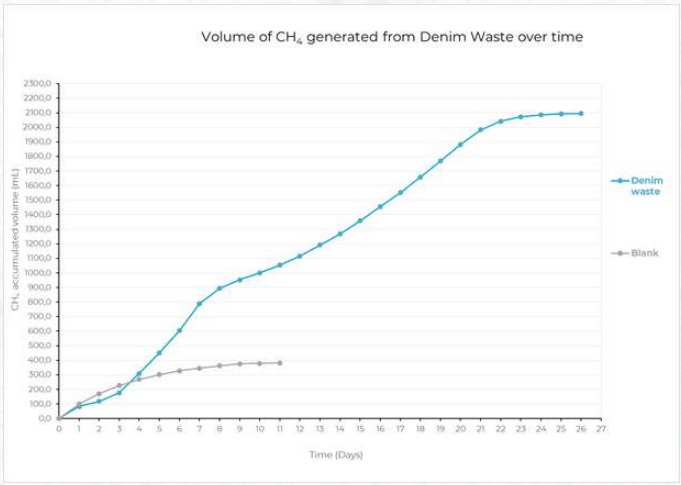
Enzymatic processes generate wastewaters with higher levels of solids and COD, but the system manages to treat them effectively.

# Technical performance and main results

## Revalorisation of fibers

## Biochemical methane potential

This parameter allows to know the amount of methane a substrate can produce and study its biodegradability.
Using anaerobic reactor inoculum from WWTP, bacteria can use cellulose present in the waste to produce methane.




| Parameter | Results |
|---|---|
| I/S ratio | 1 |
| Max. CH generated (mL) | 1714 |

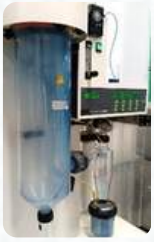
## Pigment transformation

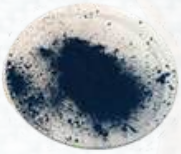
In order to obtain a pigment that can be applied to textile processes, fibre waste is reduced in particle size. Two methods has been explored:

**Dry milling:**
44% size particle reduction

**Wet milling:**
95% size particle reduction

**Wet solution:**





Dyeing

Printing

# Pigment dyeing process

The process involves the use of pigments in exhaust dyeing, requiring a cationization or fixation treatment to ensure proper adherence. It aims to replace synthetic pigments with more sustainable alternatives and is particularly suitable for achieving a distressed or worn look in garments.

| Fastness (ISO 105) | | Results achieved |
|---|---|---|
| Light fastness | 100 hours | 2 |
| Rubbing fastness | Dry staining | 4 - 5 |
| | Wet staining | 3 - 4 |
| Washing fastness | - | 5 |

# Printing process



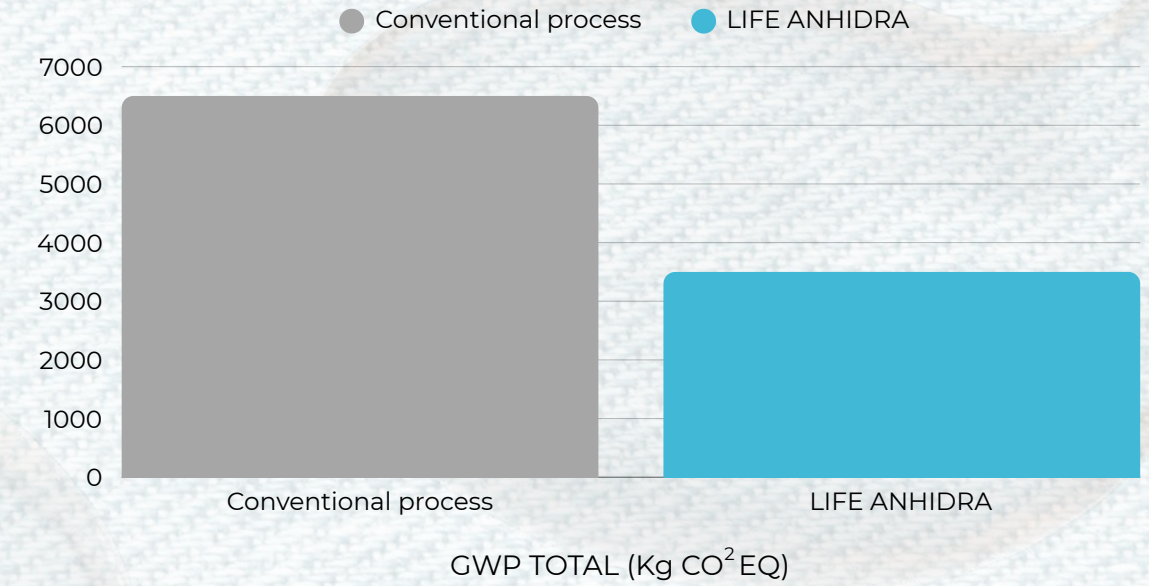

# Other considered routes

Cutting / gringind and panels by hot press plates.
Nonwovens for composites and panels (by wet - laid technology).
Reinforcement for composites.
Chemical transformation to obtain new cellulose based yarns.

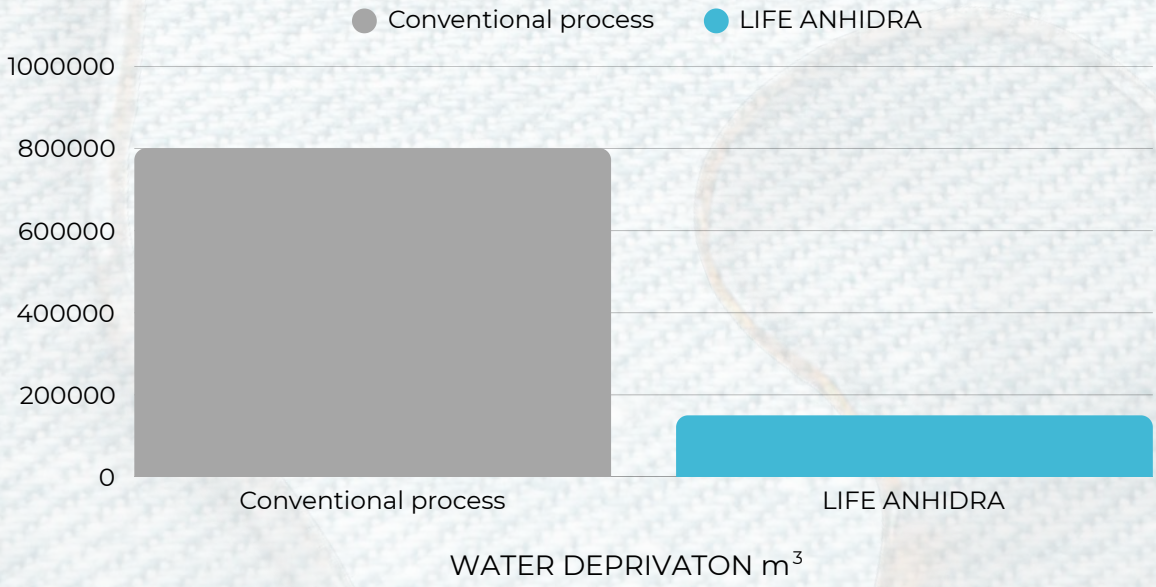
# LCA and environmental benefits

Life Cycle Assessment (LCA) was conducted to evaluate and compare the environmental performance of a conventional denim washing process with the LIFE ANHIDRA water reuse system. The LCA follows ISO 14040/14044 standards and focuses on key impact categories, including carbon footprint (Global Warming Potential) and water usage (water deprivation). Using SimaPro software and a combination of primary and secondary data, the study quantifies the environmental benefits of integrating closed-loop water treatment technologies.

Results for Global Warming Potential and Water deprivation indicators are shown:




GWP TOTAL (Kg $CO^2$ EQ)




WATER DEPRIVATON $m^3$

The LCA results confirm that the LIFE ANHIDRA system offers a significant environmental improvement over the conventional denim washing process. By incorporating a recirculation loop, the system reduces greenhouse gas emissions by approximately 44% and cuts freshwater consumption by over 80%.
Despite the added energy demand for this process, the overall environmental performance is clearly more sustainable. These findings highlight the potential of the LIFE ANHIDRA solution to reduce the environmental footprint of textile finishing processes and support the transition toward a more circular and resource-efficient industry.

| Stage | GWP (kg CO eq) | WD (m depriv.) | % Contribution to GWP | % Contribution to WD |
|---|---|---|---|---|
| Washing | 1.07E3 | 1,34E5 | 31,0% | 98,8% |
| Filtration | 53,2 | 34,9 | 1,5% | 0,0% |
| Ozone | 1.27E3 | 833 | 36,8% | 0,6% |
| Ultrafiltration | 635 | 416 | 18,4% | 0,3% |
| Recirculation | 424 | 278 | 12,3% | 0,2% |
| **TOTAL** | **3452,2** | **135561,9** | 100% | 100% |

The results show that GWP emissions are distributed across multiple stages, with the ozone treatment contributing the most (36.8%), followed by washing (31.0%) and ultrafiltration (18.4%). In contrast, water deprivation is almost entirely due to the washing stage (98.8%), while all other stages combined account for less than 1.2%. This highlights the effectiveness of water reuse in reducing water impact and the need to further optimize energy use, especially in ozone treatment.

*Only filtration, ozone and gills stages were considered for LCA calculations. Complete Anhidra system will be calculated in the After Life plan.

# Environmental benefits

By integrating water recirculation and advanced treatment technologies, the system contributes to more sustainable textile production. The main environmental benefits include:

- ✓ Reduction of greenhouse gas emissions by approximately 44%.
- ✓ Over 80% reduction in freshwater consumption.
- ✓ Lower wastewater generation.
- ✓ Improved resource efficiency with energy and water savings.
- ✓ Support for circular economy objectives

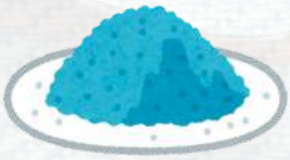
# Conclusions

The prototype of the LIFE Anhidra system has been successfully developed and has been operating correctly since August 2024.

Thanks to the implementation of the Anhidra system, the following achievements have been made:

- ✓ A 44% reduction in carbon footprint and an 85% reduction in water deprivation.


- ✓ Different valorisation routes for fibre waste have been explored, mainly as pigment in textile applications and in energy valorisation through methane generation.



- ✓ Operation of the system in real production conditions for up to 60 days.


LIFE anhidra

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