

# Project title: NanoPulse Industrial Laundry Waste Water Recycling



*Picture - Johnson Laundry Operations*

## Summary

The Industrial laundry sector uses significant amounts of energy and water to wash everything from hotel linen to workwear. The UK industrial laundry industry puts over 4 million cubic metres of hot waste water to drain per annum. The latest membrane technology has now shown that hot waste water can be cleaned and put back into the wash cycle saving energy, water and chemicals.

A Hydrasyst NanoPulse waste water recycling system was installed at the Johnsons Industrial Laundry site in Shaftesbury, Dorset. The system uses durable ceramic membranes coated with a special graphene treatment provided by Evove (formerly G20). This industrial demonstrator provided Evove and Hydrasyst with the ability to optimise the set up for this combined technology. By recycling 66% of the wastewater and putting the hot water back into the washing cycle, significant savings of gas and water have been demonstrated and quantified. Further savings are expected from reducing the chemical dosing requirements and will be quantified in further trials.

## The Industrial Energy Efficiency Accelerator (IEEA)

The IEEA programme supports the development of innovative technologies that will help industry reduce energy consumption and cut carbon emissions. It focuses on innovations with large potential cross-sector energy and carbon reduction impact - either new technologies or established technologies applied to new sectors. Over £15 million in public and private funding has been committed to develop solutions through partnerships between technology developers and industrial companies willing to test technologies on-site. The programme is funded by the UK government (BEIS) and managed by the Carbon Trust, with support from Jacobs.

## Introduction

The Hydrasyst team have spent the last 15 years developing a recycling solution for industrial laundry waste water. They came to Evove in 2017 to determine if our coating technology could provide a step change in membrane performance. When comparing to California for example, industrial water is c.8-10 times cheaper to buy and dispose of in the UK, with much lower regulatory standards in place for water that can be put to drain. This means that an efficient anti-fouling membrane was required to hit the price point necessary to make UK industrial laundry recycling a commercial proposition.

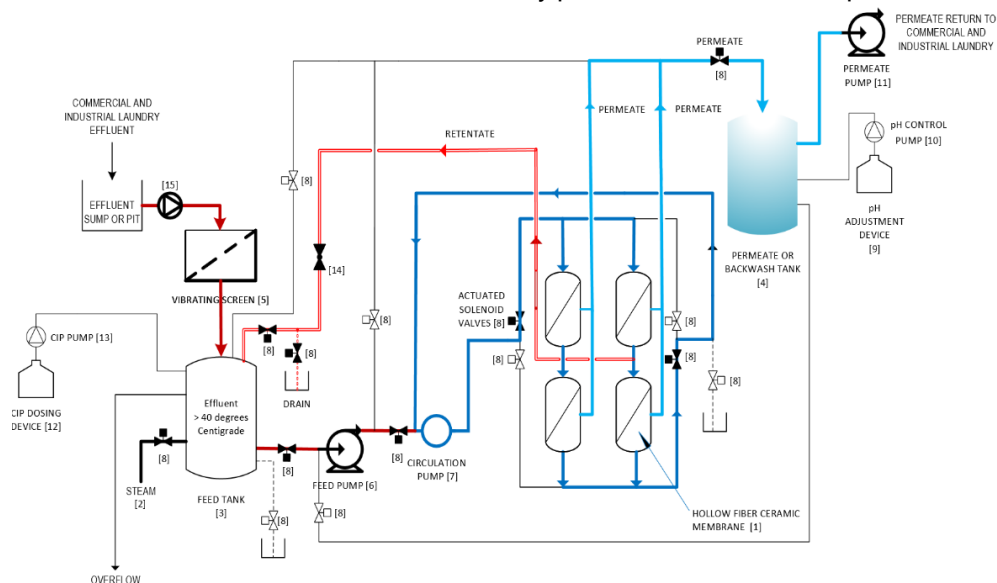
Many companies have historically tried and failed to convince the relatively small number of players in the UK industrial laundry market that membrane technology was viable. Over 95% of the current plants in the UK operate no form of recycling. Hydrasyst had trialled their technology in the US, but regular fouling of the membranes reduced the cost savings delivered by the system.

The UK market needed an industrial demonstrator of Evove and Hydrasyst's technology, but none was willing to absorb the large up-front cost. Evove and Hydrasyst as SME's were also not able to fund this between them, without some element of financial support. The IEEA programme provided a superb opportunity to part fund the demonstrator and promote the technology to the industry. Evove made a successful bid on behalf of the consortium and the project started in September 2019.

The project sought to recycle as much of the waste water as possible, putting the hot water back into the washing cycle, thus providing significant savings in gas and water, as well as potential chemical savings.

## About the innovation

The NanoPulse filtration system works by pumping the hot effluent through a series of hollow fibre membranes incorporating Evove's coating technology. This produces a high quality permeate of recycled hot water ready for re-use in the laundry washing machines, giving rise to a significant reduction in energy consumption within the laundry, as recovered heat is delivered back into the laundry process. A schematic is provided below:



**NanoPulse: Filtration system schematic**

The membrane filters are ceramic based so they can withstand the typical 50°C plus temperatures that industrial laundries operate at. The membrane filters are then coated with Evoke's graphene based coating technology which has the following characteristics:

- It is extremely hydrophilic, i.e. it attracts water to pass through the ceramic membrane, thus providing an increased flow rate.
- It creates a super oleophobic surface on the membrane, i.e. it creates a very high contact angle, creating an anti-fouling surface which can reduce maintenance requirements, as well as energy and water consumption.

## The demonstration

### Johnsons Service Group (JSG) – Shaftesbury, Dorset, UK

The demonstrator unit was successfully commissioned in January 2021 at JSG's Shaftesbury operation. Work since this date has focused on optimising the set up and evaluating different membrane coatings. The prefilter stage is critical in this application, as lint in the wastewater can clog the membranes if not successfully removed. Evoke applied an anti-fouling coating to the steel prefilter to reduce cleaning requirements and increase up time.



*NanoPulse Waste Water Recycling system*



*Pre filter stage taking water from the waste water pit*

## Membrane testing

Evove have developed a wide range of coating formulations appropriate for the membrane substrate and wastewater composition. These were first tested on 1" trial membranes to determine the optimum formulation.



*A 1" trial membrane together with the wastewater feed, before and after filtration*



*The 1" membrane test loop installed at JSG*

Dedicated test equipment was purchased under the project to allow testing at both Evove's laboratory in Daresbury and on the Johnsons site in Shaftesbury.

## Scale up

To scale up coating onto 8" commercial scale membranes, Evove purchased a coating rig and developed the coating methodology such that the coating could be applied to the membrane inner surface with a high degree of consistency. Further work is ongoing to industrialise this process.

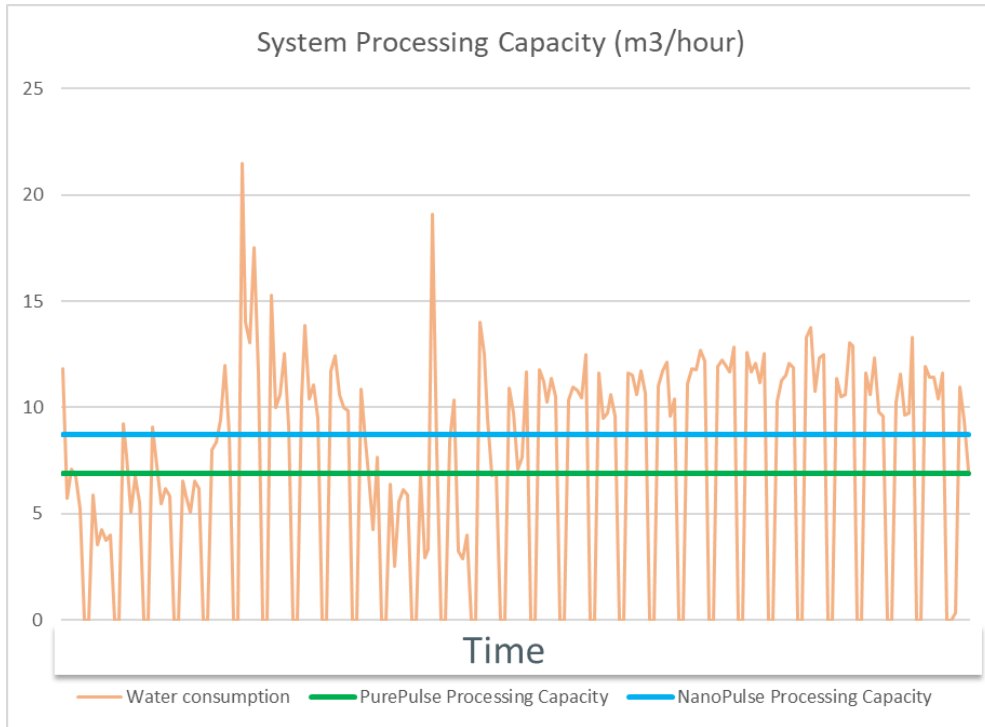
## Monitoring

Evove's coatings were applied to the latest generation of ceramic membranes provided by the Hydrasyst supply chain. The project team measured the volume of water recycled, the lower level of water discharged to drain and the reduced gas consumption. The additional electricity cost of running the pumps on the NanoPulse system were then deducted to determine the overall net savings from using the system. As the NanoPulse system recycles the water, the pH differs to that of fresh water, and it is expected that this will result in a reduced chemical dosing rate. The project team intend to work with the chemical supplier post project to determine how the dosing can be reduced and the quality of linen maintained.



## Results

The PurePulse membranes (manufacturer standard membranes) were successful in recycling 52% of the waste water or 6.9 m<sup>3</sup>/hour. When the graphene oxide coating was applied to create the NanoPulse membranes, the recycle rate of the wastewater increased to 66% or 8.7 m<sup>3</sup>/hour. The average recycle rates are shown below vs the real time output of wastewater.



Gas savings were calculated with respect to the amount of water that no longer needed to be heated. The site boiler has estimated gross efficiency of 50 – 80%. A typical industry assumption of an 80% efficiency was applied to the boiler for gas saving calculations.

	Savings achieved			
	£	kWh	M3 water	CO2 (tons)
<b>NanoPulse Coating Enhancement</b>				
Gas *	17,087	1,110,685	n/a	204
Effluent	76,126	28,017	24,015	7
Water	43,947	15,348	24,015	4
Electricity (offset)	(4,518)	(74,827)	n/a	(17)
<b>TOTAL Savings - NanoPulse</b>	<b>132,641</b>	<b>1,079,222</b>	<b>24,015</b>	<b>197</b>
Shaftesbury Utilities spend	550,982	%age saving	24%	
* - Gas savings based on 80% boiler efficiency				
black - savings made directly by JSG				
red - savings made by third parties in relation to JSG activity				

The resource consumption figures are shown below, with the bottom line representing the savings achieved with the NanoPulse membrane.

					
<b>No treatment system</b>	15.2 GWh	39,000 m <sup>3</sup>	64 tons	2,947 tonnes	£551k
 <b>PurePulse</b> WATER RECOVERY SYSTEMS	14.3 GWh	19,000 m <sup>3</sup>	TBC	2,795 tonnes	£446k
 <b>NanoPulse</b> WATER RECOVERY SYSTEMS	14.1 GWh	15,000 m <sup>3</sup>	TBC	2,750 tonnes	£418k
<b>NanoPulse savings</b>	1.1 GWh	24,000 m <sup>3</sup>	TBC	197 tonnes	£133k

The key assumptions using the savings calculations are noted below:

<b>Assumptions</b>	
Working days	270
Cost of effluent per m3 paid to Wessex Water	3.17
Cost of clean water per m3 paid to Wessex Water	1.83
Cost of electricity per KWH (£)	0.0604
Cost of gas per kWH (£)	0.0154
Conversion of gas from m3 to KWH	11.1903
<b>CO2e assumptions</b>	
CO2e (kg) per kwh for grid electricity	0.23314
CO2e (kg) per kwh for natural gas	0.1839
CO2e (kg) per m3 of water treatment	0.272
CO2e (kg) per m3 of water supplied	0.149

## Future impact

The UK industrial laundry industry sector puts over 4 million cubic metres of hot wastewater to drain per annum. The latest membrane technology has now shown that hot wastewater can be cleaned and put back into the wash cycle saving energy, water and potentially chemical savings.

JSG have c.45 laundry sites that can be evaluated for the installation of a NanoPulse system. Our calculations show that if the technology were installed in 40 sites, CO<sub>2</sub> savings could amount to 5,300 tonnes p.a. with a recurring financial saving of at c.£3.6m.

The IEEA have helped connect the project team with the UK's Textile Services Association, who are keen to support the roll out of the technology to the entire UK industrial laundry market. Applying this technology to the 110 sites across the UK (out of a total market size of 140 sites) savings would be expected to amount to 15,000 tonnes p.a. of CO<sub>2</sub> and a total process saving of at c.£10m p.a.

Applying a very conservative estimate of rollout to a global market of 500 sites out of market size of 4,500 sites, CO<sub>2</sub> savings would exceed 67,000 tonnes p.a. with process savings of c.£45m p.a.

Technology rollout savings potential - p.a.	£'000	GWh	M3 water	CO2 (tonnes)
JSG - Shaftesbury	133	1	24,015	197
Johnsons UK - 40 out of total of 45 sites	3,600	29	649,000	5,300
UK market - 110 out total of 140 sites	10,000	80	1,785,000	15,000
International markets - 500 out of total of 4,500 sites	45,000	365	8,113,000	67,000

Hydrasyst have recently signed a licence to Evove's technology and plan to use the coated membrane in wider industrial markets in the UK, North America and EMEA.

## Innovation lessons

The technology now exists and has been proven to work, thus reducing the environmental impact of industrial laundry operations. The demonstration has been time consuming and costly with sponsorship by the IEEA being a critical factor in ensuring success. It is three years since discussions started with the IEEA. It is a credit to the project team that this project has progressed to this stage despite the challenges presented by the Covid-19 pandemic.

The project has cemented strong relationships between the partners. Evove plans to bring out a range of further enhanced and engineered membrane solutions in the next two years, and the Shaftesbury site provides the perfect test bed for this next generation of technology. The project partners now need to focus on scale up and building low carbon supply chains to deliver this energy efficient wastewater recycling technology.

## Contact information

### Who to contact for more information

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