



# Hydrodynamic Cavitation Technology

[www.cavimax.co.uk](http://www.cavimax.co.uk)

- Process Intensification
- Sustainable Chemistry
- Upscale Bioresources
- Circular Economies

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Rotocav™



**biogas • bioresources • oils & fuels • food & drink • water treatment**



# Hydrodynamic Cavitation by

CaviMax are the leading UK supplier and knowledge bank for Hydrodynamic Cavitation Process Intensification & world wide distributor and engineering systems integration for the patented E-Pic S.r.l. Rotocav cavitation reactor

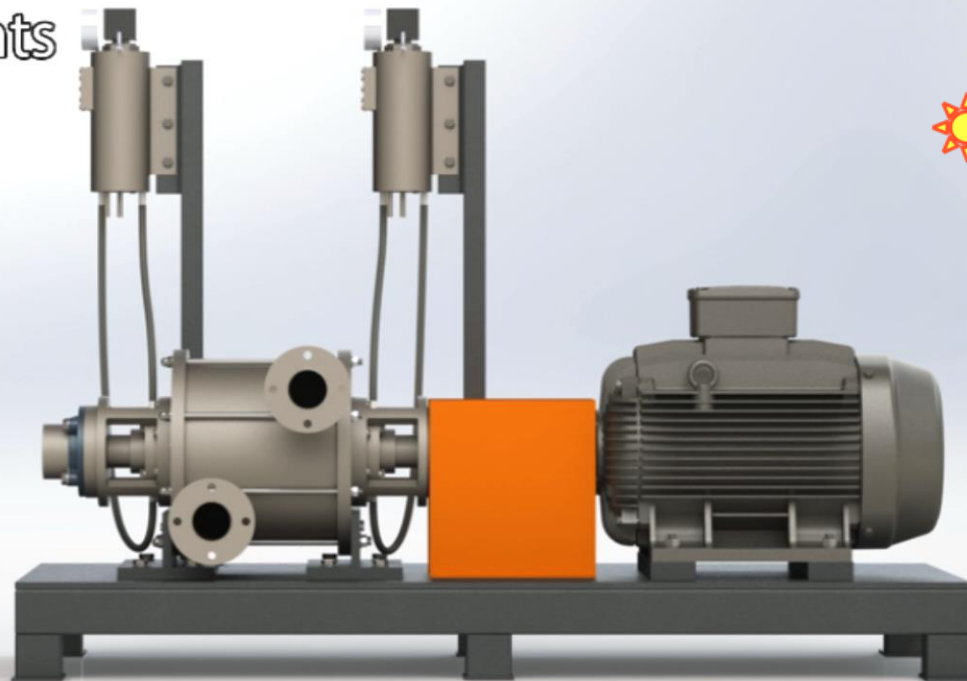


Rotocav



# The Biomass Disintegrator for biogas plants

Maximise  
your biogas plants  
potential





# Cavitation technology for efficient biogas production

**What is hydrodynamic cavitation?**

**Hydrodynamic cavitation for disintegration of high  
lignin feedstocks and recalcitrant substrates**

**CaviMax – The Biomass Disintegrator**

**Benefits of cavitation for anaerobic digestion and  
renewable gas sector**



## What is Hydrodynamic Cavitation? (HDC)

The short version....

The CaviMax reactor induces **hydro** (water) **dynamic** (changing) **cavitation** (bubble formation), the energy released by this natural phenomenon is the principal mechanism for biomass disintegration



# What is Hydrodynamic Cavitation? (HDC)

The long wordy version...

- The CaviMax cavitation reactor produces physical rotational forces that create hydrodynamic shockwaves in liquids, capable of breaking down bonds at a macro and molecular level and forcing together seemingly incompatible gas/ liquid/ solid mixtures into flowing substrates – homogenisation and particle size reduction
- The microjet shockwaves are induced by a liquid moving from a high to low to high pressure environment, causing millions of microscopic bubbles to form and collapse. Each bubble collapse event creates tremendous localised pressures, which shear solid particles, break down cell walls and allow liquids to bind with solids. This in turn creates a substrate of increased surface area which is more readily available to be broken down by anaerobic digestion bacteria

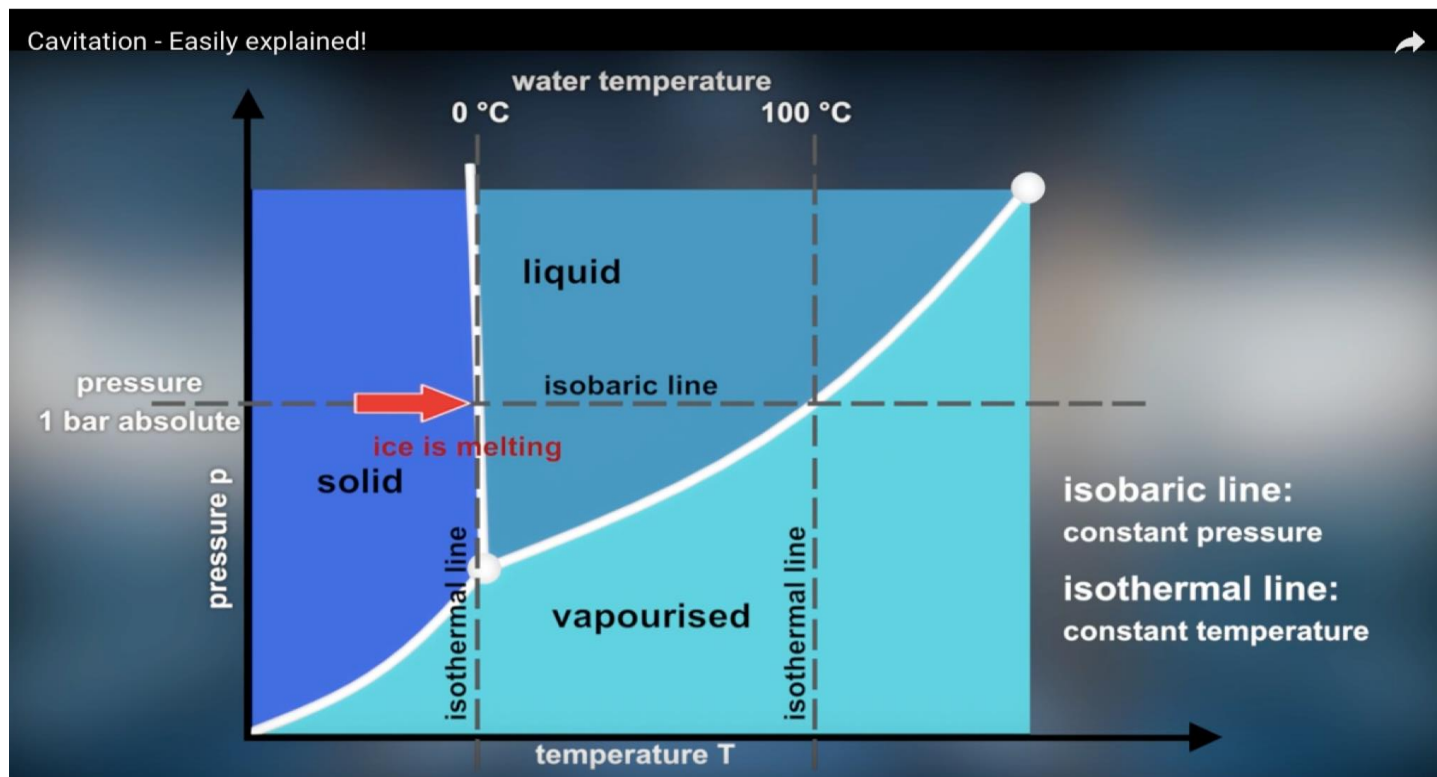
But what does this mean exactly, better explained in pictures...





# Cavitation Explained

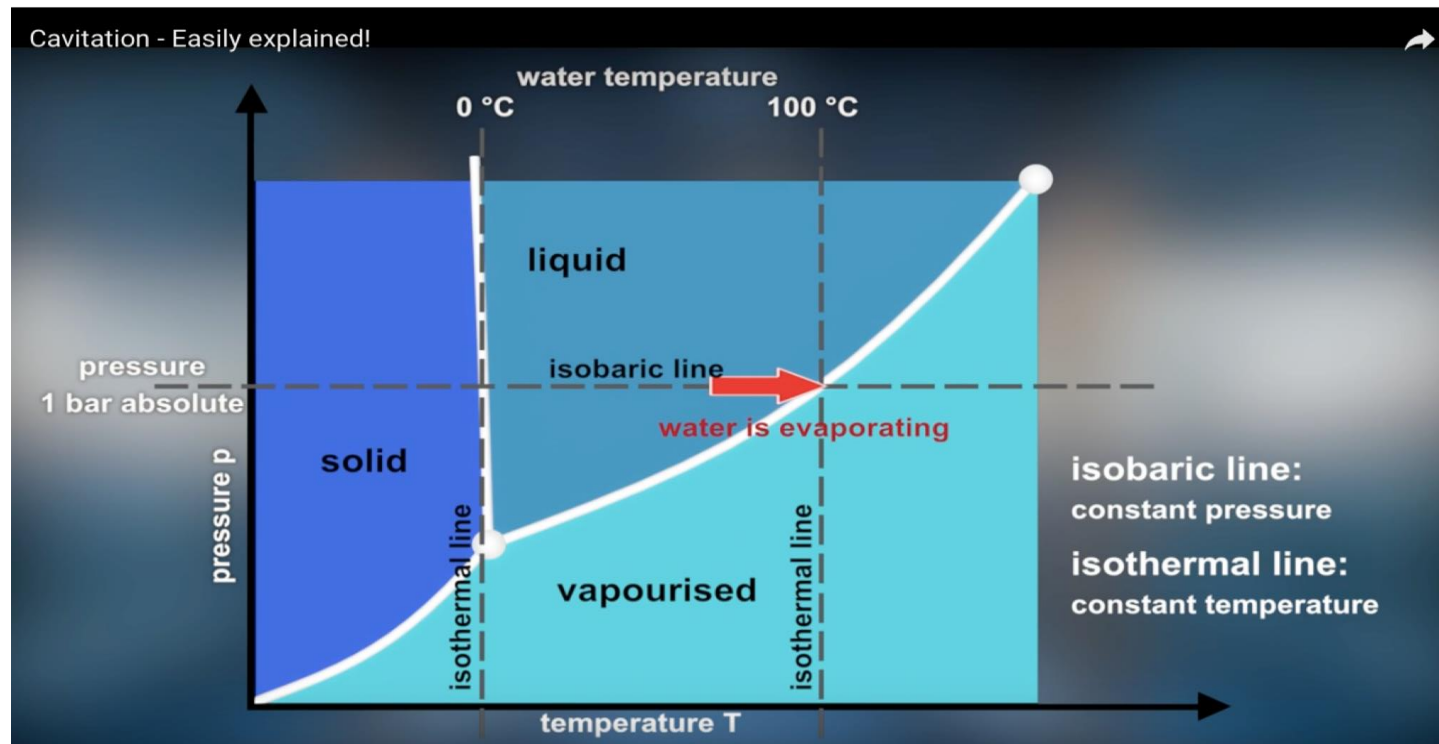
**Vapour Pressure Curve** - pressure determines the temperature that solids/liquids/gases change phase





# Cavitation Explained

Vapour Pressure curve - **control the pressure to manipulate the boiling point of liquids** – create the conditions for bubble formation and collapse, cold boiling







# Hydrodynamic cavitation

Imploding bubbles create millions of cyclical high pressure microjets in the chamber

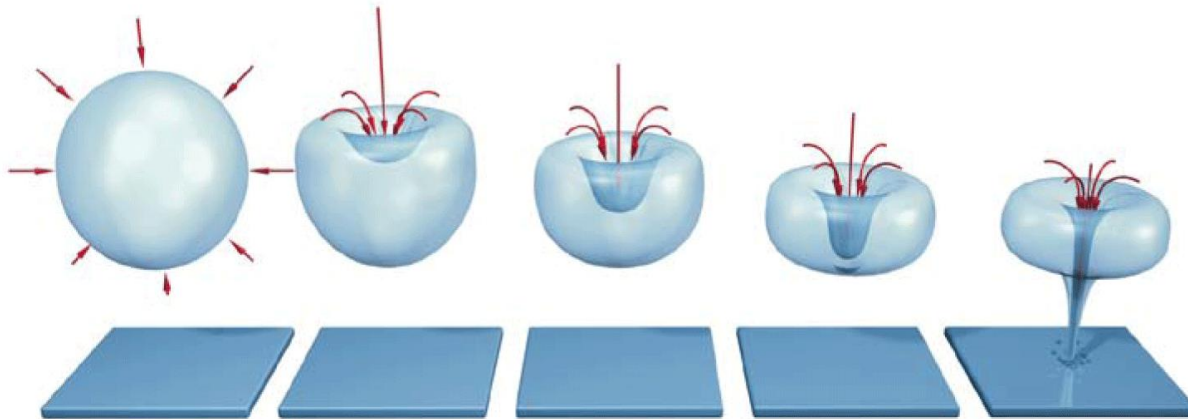
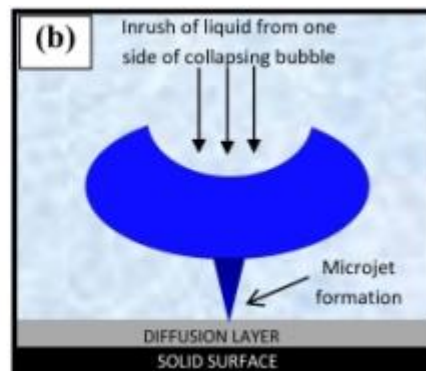
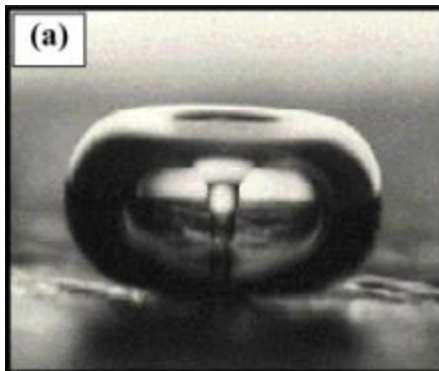


Fig. 1 - Illustration of an imploding cavity in a liquid irradiated with ultrasound

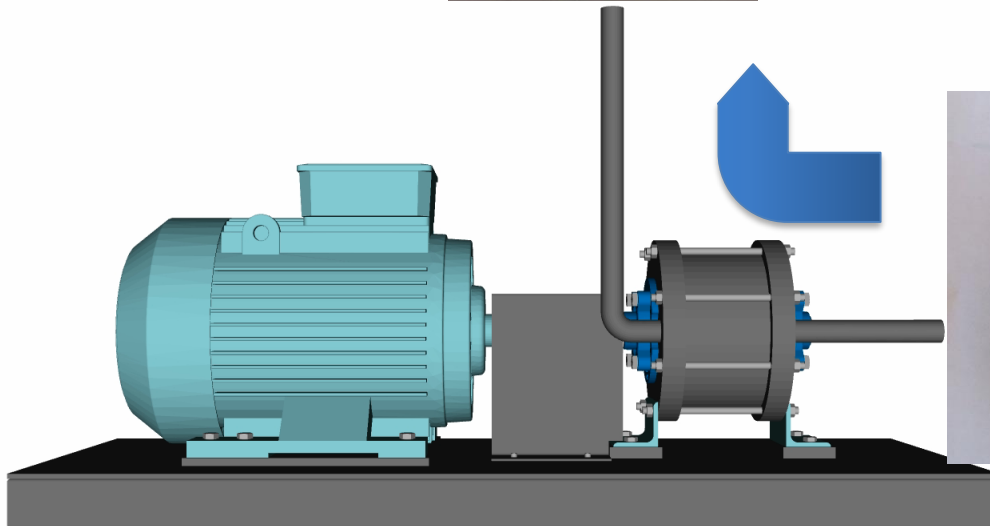
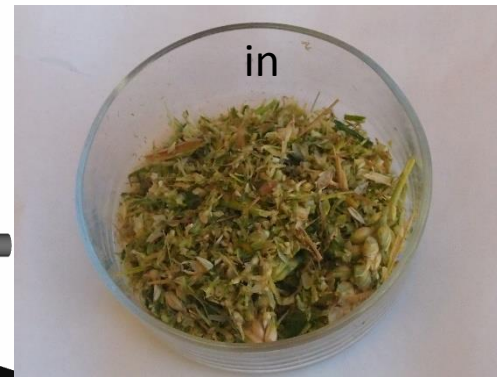
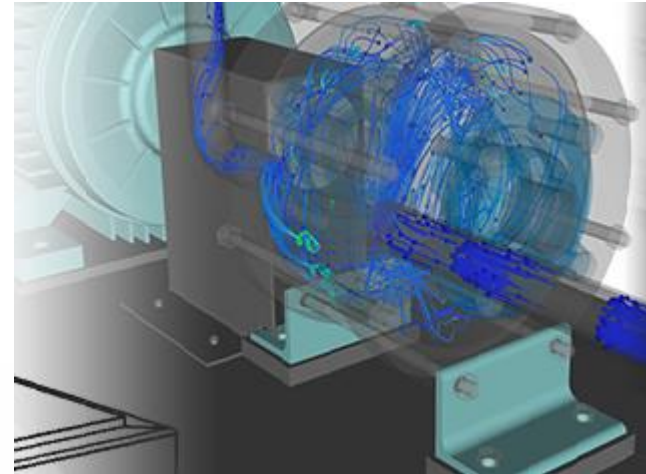
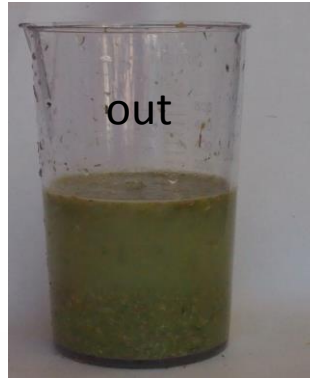


Asymmetric bubble collapse causes high pressure microjets in the liquid these project their energy into the particles in the substrate, causing collateral damage to surrounding biomass / solids

# CaviMax – The Biomass Disintegrator



Inside the cavitation chamber – liquids pumped at speed through a spinning rotor-stator, forcing liquids through channels creates pressure differentials in the liquid





cavitation induced biomass  
disintegration reduces viscosity of  
substrates

= less wear on pumps and mixers





# What do the effects/results look like?

Reduced particle sizes & viscosity

Sample from maize fed AD plant recirculating substrate line – fed back into the same digester



Before cavitation – see lots of fibres and solid material left in the hand after squeezing the water out of the sample



After cavitation – much less left in the hand after the 'squeeze test'





# What do the effects look like?

Cavitated sample on the right uncavitated on the left – see reduced viscosity, thinner, less particles, freer flowing



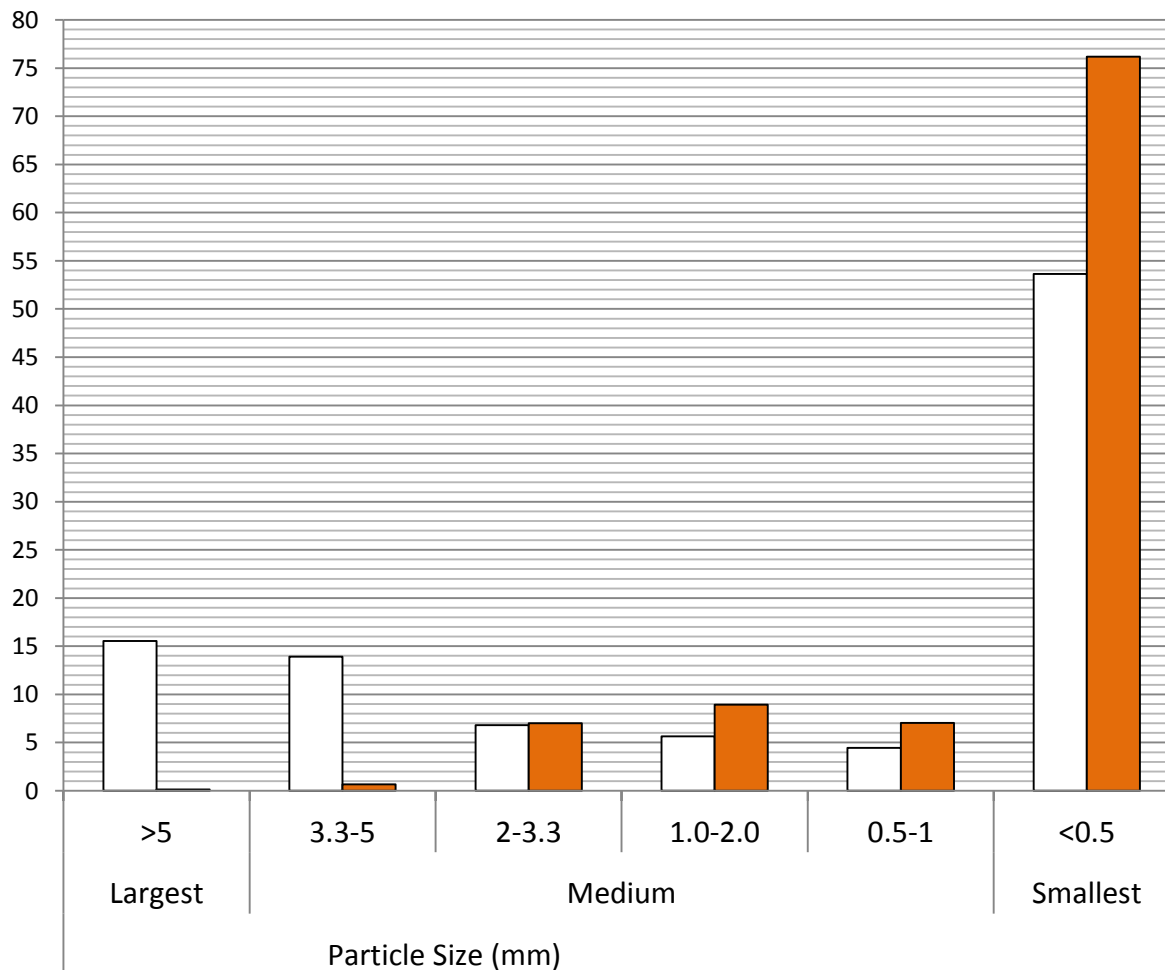


cavitation induced biomass  
disintegration reduces particle sizes,  
this increases surface areas of  
feedstocks and bioavailability for  
anaerobic digestion  
= extra biogas





# Effects of cavitation – reduction in particle sizes



Same dry matter  
content,  
however particle  
sizes are  
redistributed

□ Untreated Substrate  
■ Cavitated Substrate



cavitation induced biomass  
disintegration is powerful enough to  
breakdown lignocellulose to access  
cellular juices for biogas production

= ability to use high lignin feedstocks  
recalcitrant materials as feedstocks



# Results of cavitation of straw = viable biogas feedstock

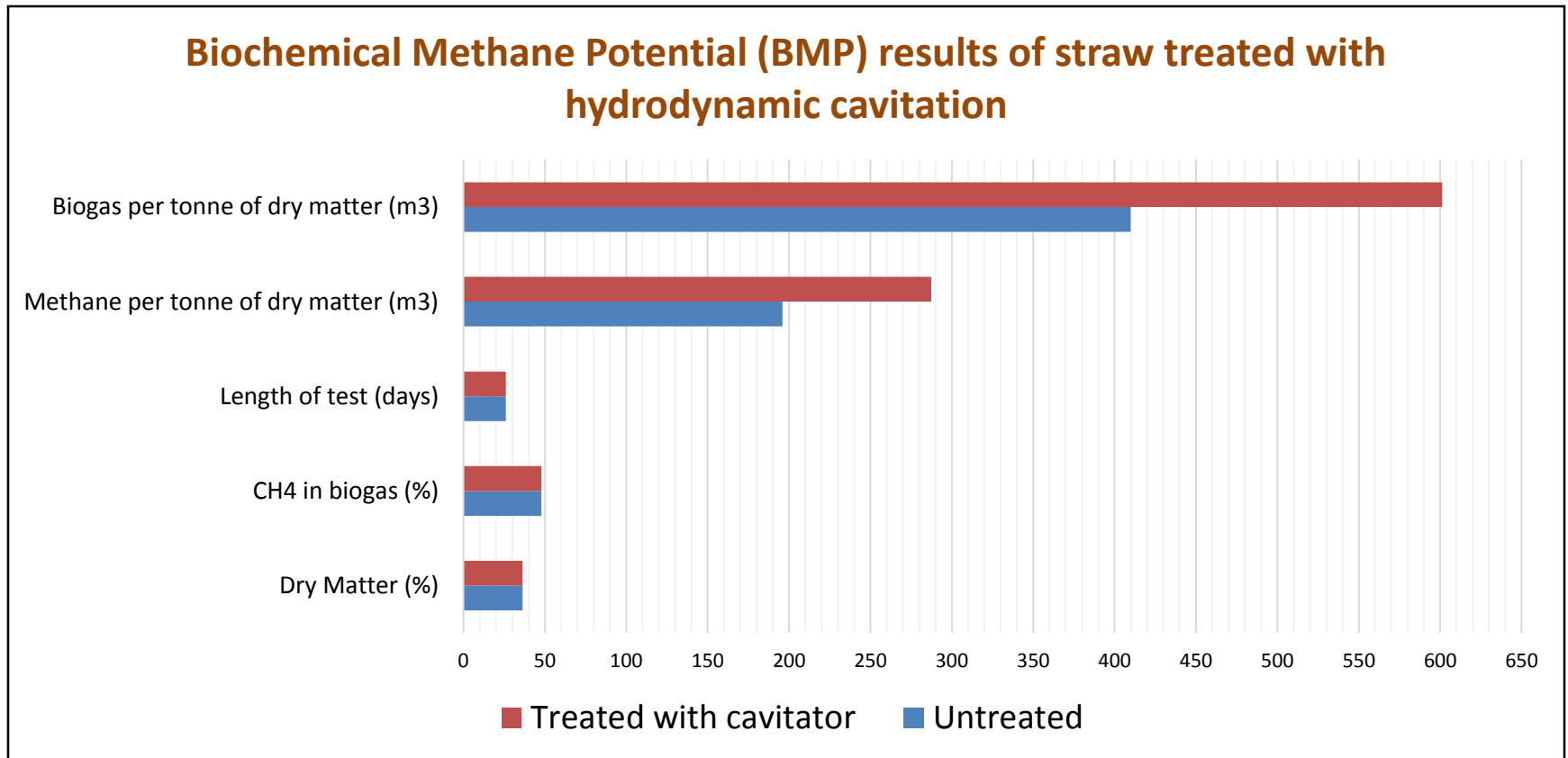
## Biochemical Methane Potential (BMP) Test - STRAW

Batch test results - STRAW	Untreated	Treated with cavitator	% change
Dry Matter (%)	36.31	36.31	0% change
CH4 in biogas (%)	47.8	47.8	0% change
Length of test (days)	26	26	0% change
Methane per tonne of dry matter (m3)	195.9	287.4	68% increase
Biogas per tonne of dry matter (m3)	409.8	601.2	68% increase

**methane percentage increase in cavitated sample = 68%**



# Results of cavitation of straw = viable biogas feedstock



**methane percentage increase in cavitated sample = up 68%**



# Results of cavitation of grass = viable biogas feedstock

Grass - Batch Test Results	Untreated	Treated with Cavicator	% change
Length of test (27 Days)	27	27	0% change
Dry Matter (38.75%)	38.75	38.75	0% change
Ch4 in Biogas %	54.2	56.7	5% increase
H2S content (PPM)	518	211	59% reduction
Methane per tonne of DM (m3)	269.6	368	36% increase
Biogas per tonne of DM (m3)	497	643	29% increase
Biogas per tonne of Fresh matter (m3)	194	253	30% increase

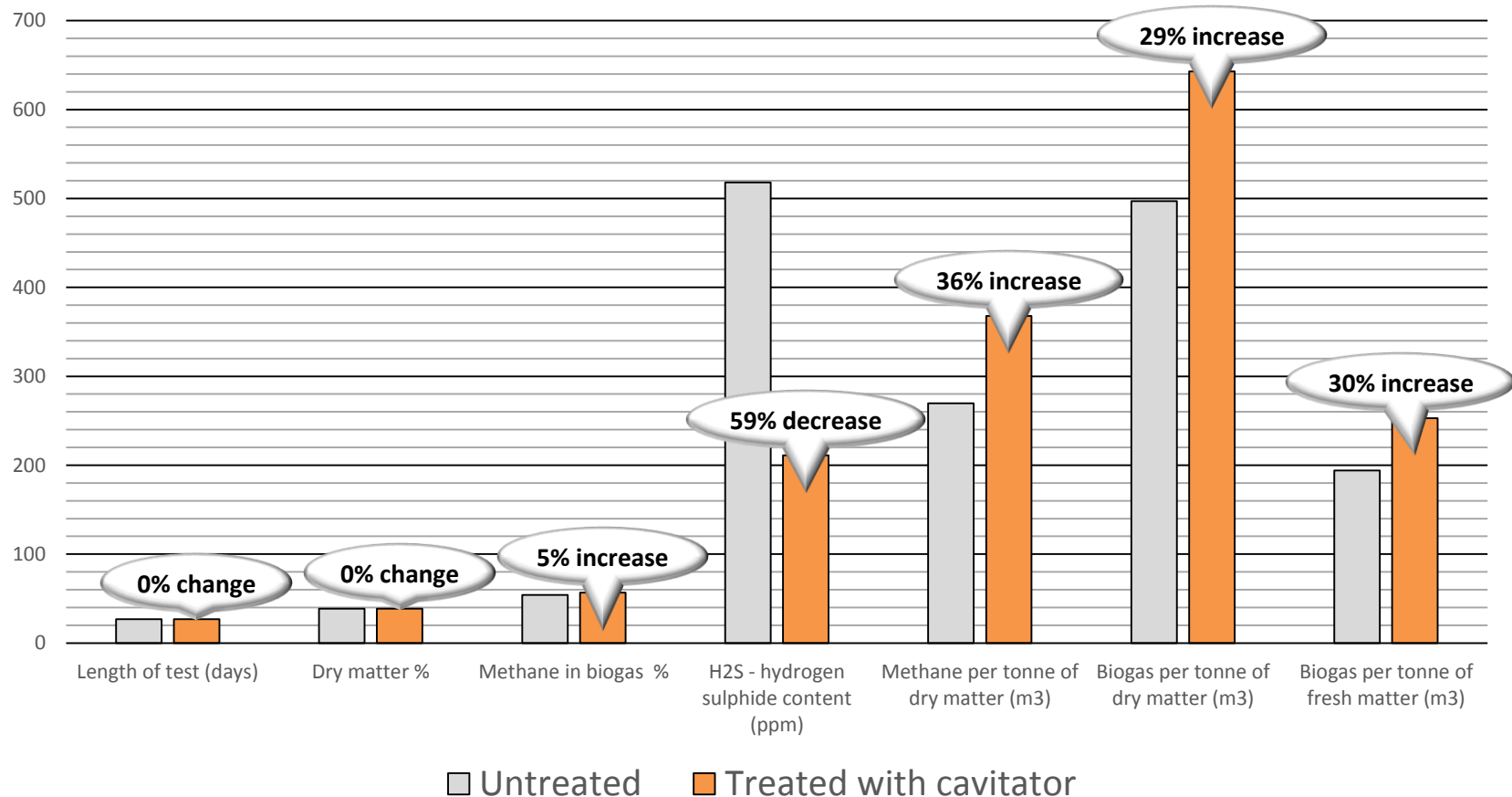
**methane in cavitated sample = 36% increase**

**hydrogen sulphide (H2S) in cavitated sample = 59% decrease**



# Cavitation of grass = viable biogas feedstock

Biochemical Methane Potential (BMP) results of grass treated with hydrodynamic cavitation







# What can the CaviMax Biomass Disintegrator treat in the biogas plant?

- High lignin feedstocks – agricultural residues
- Secondary sewage sludges
- Food and drink production waste
- Floating layers
- Part digested substrate

The greatest biogas % increase is achieved through treating the recalcitrant materials that are indigestible, unusable and the energy usually wasted



# Where does it fit in?

## CaviMax positioned mid-process – treating the floating layer

Draw off floating layer from the top of the digester pass through CaviMax to homogenise the substrate



Return cavitated substrate back to the bottom of the digester for further digestion which increases flow and bioavailability of the substrate

**Access the energy of undigested feedstocks, turn a problem into a bonus of 15% extra biogas**



# Where does it fit in? CaviMax positioned to pre-treat high lignin feedstocks

Traditional feedstocks



Primary digester



High lignin feedstocks



Feed in system



CaviMax



To secondary  
digester / end  
store

Recirculate digestate to  
hydrate feedstock to create  
pumpable substrate

**Unlock the potential of straw, grass, biosolids & secondary sludges**



# Where does it fit? CaviMax positioned mid-process between digesters

Primary digester



The CaviMax in this position will reduce particle sizes of the substrate, providing increased plant efficiencies and biogas yield



Secondary digester



Ideal position to treat recalcitrant materials that did not get fully utilised in the primary digester – extract maximum value from your substrate

**Secondary sludges in waste water treatment / food and drink waste / undigested fractions of feedstocks**



## Features of controlled hydrodynamic cavitation

Process intensification technology

Breaks down lignocellulose

Deals with recalcitrant materials

Drastically reduces particle size of treated substance

Multiple treatment positioning, feedstock pre-treatment or mid process

Low maintenance simple design

Multiple machines can be used to reduce feedstock and manufacturing costs and treat effluent waste waters leaving the site – DOUBLE WIN

Can also be utilised for bio-diesel production and oil refining

A range of sizes available to suit your plant and requirements

Environmentally friendly, efficient and economical in its application



## Benefits of cavitation for biogas plant operation

- Reduce feedstock costs or increase biogas production
- Ability to digest high lignin feed stocks – utilise straw
- Add value to secondary sludges and biosolids
- Decrease problematic floating layer – important when dealing with grass and straw (crust reduction in digester)
- Increased availability of cellular juices
- Acceleration of hydrolysis & the anaerobic digestion process
- Reduce retention time in digester
- Increased pumpability of substrate
- Reduced plant downtime due to blockages
- Reduction in H<sub>2</sub>S levels when using grass as feedstock



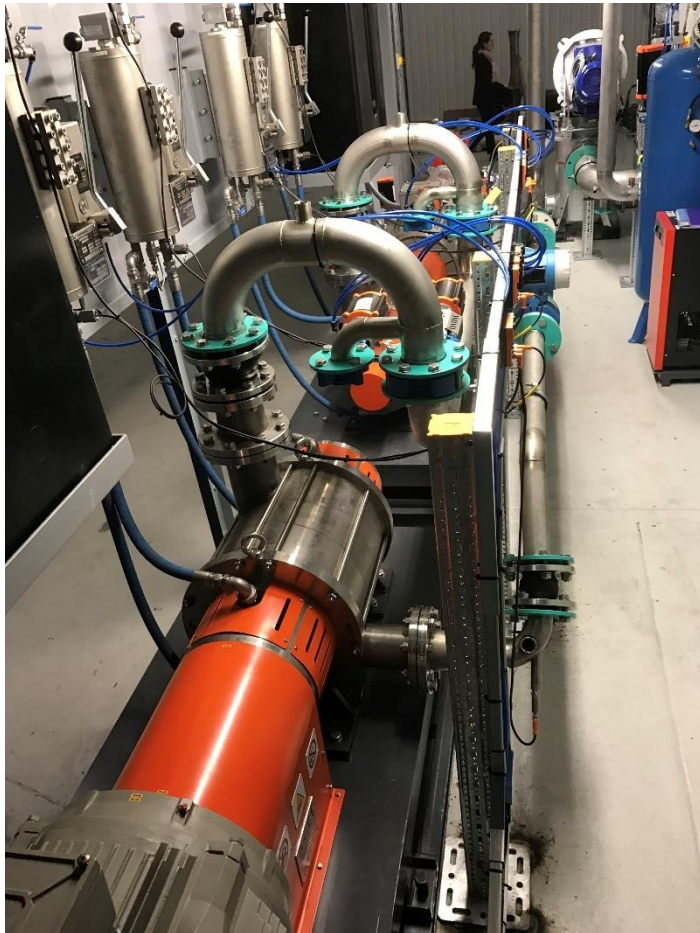


# CaviMax containerised unit fitted out in factory





# CaviMax factory fitout photos







# CaviMax onsite photos





# CaviMax onsite photos

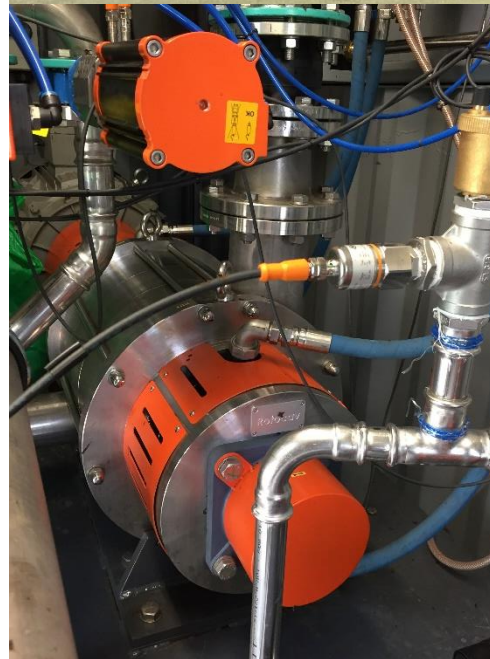


A CaviMax C150 Biomass Disintegrator treating a floating layer in a primary digester of a biogas plant with CHP and biomethane gas to grid plant in Scotland, current data is a 15% increase in biogas and reduced viscosity, there is visual improvement of the digestate





# CaviMax onsite photos





# CaviMax service & callout

Time is money, our ethos is to minimise downtime, so we provide the following:-

- Full UK coverage service and maintenance division
- CaviMax service & maintenance plan
- Remote dial in problem identification worldwide
- Controls and sensors readily available in most countries worldwide, easily replaceable and automatically programmed once integrated into the CaviMax system
- Critical spares onsite with CaviMax
- Training provided for onsite maintenance team
- Camera and audio stream from CaviMax container to UK team to help guide the onsite team





# Process intensification technology - simply do more with less -



**CAVIMAX<sup>®</sup>**

“Get more bang for your  
buck...FIT A CAVIMAX”



Invite us over or send us  
your samples

Send us a sample to cavitate or  
book The CaviLab,  
our laboratory scale test rig to  
see what process or BMP  
(Biochemical Methane  
Potential) uplift you can  
achieve with a CaviMax  
machine so we can calculate  
payback period





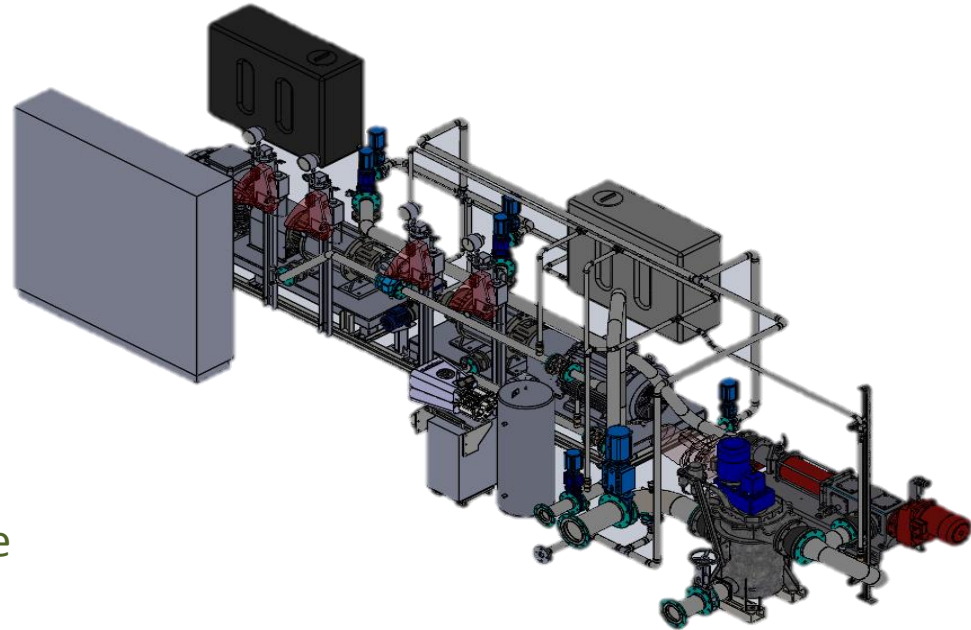
# CaviMax: Hydrodynamic Cavitation Technology

Suitable for all sectors: biogas production, biodiesel production, oil refining, extractions, wastewater treatment, food waste management (waste to energy) and energy efficiency in the agrofood industry

Variety of sized machine available to suit your requirements, we can provide a fully integrated containerised system, or we can work with your team to integrate the Rotocav Cavitator into your system

Save money and provide environmental benefit (through either using less materials, cleaning up your effluent or both) at the same time for maximum benefit

Please include Hydrodynamic Cavitation in your innovative technology evaluations





# Thanks for reading

Team CaviMax have years of experience in planning, designing, building, operating, managing and maintaining biogas / biomethane plants, come discuss your plant with us to see how we can CaviMaximise your biogas production

**Owen Yeatman – Director**

**Matt Powell - Director**

**Emma Greenwood – Business Development Manager**

[www.cavimax.co.uk](http://www.cavimax.co.uk)

CaviMax are members of the World Biogas Association, ADBA - Anaerobic Digestion and Bioresources Association and the Circular Economy Club



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C L U B

