# Prosiectslyriproject Progress Report March 2018

## Electro-treatment of farmyard slurries – a brief account work to date.

Electro-coagulation is a technique sometimes used to treat waste water and industrial effluents. Due to the complex nature of cow slurry, electro coagulation must be combined with electro oxidation in order to achieve treatment to the point of being able to safely discharge the effluent to a clean watercourse without causing environmental concerns.

**Laboratory Analysis**

Calculating the capacity of the power supply, transformer and electrode material required to achieve desired treatment begins in the laboratory. Beaker tests are used to determine the best electrode material to use on the sample, current requirement and retention time.

Beaker tests involve:

1. Placing a sample of the slurry in to a beaker with two electrodes (+ve and –ve) connected to a fixed current power supply.
2. The contents are constantly stirred to ensure a homogenous sample throughout. During electro treatment, this allows for an increased probability of the reacting molecules coming into contact.
3. At fixed intervals, small samples are taken and tested for floc generation and density, phosphate, nitrate and potassium concentration amongst others, as well as pH and chemical oxygen demand (COD). COD is a measure of the amount of oxygen that can be consumed by chemical reactions in a given volume of sample and is an important parameter for determining the amount of organic material in the sample and therefore potential pollution of watercourses.

Once these determinants are defined, the data is used to calculate the requirements of upscaling the process.

**Treatment Process**

The process may be divided into separate areas of treatment as follows:

1. Firstly, the solid fraction of the slurry must be separated from the liquid fraction using mechanical separation. The solids are stored - and as they contain a proportion of the vital nutrients naturally contained in cow slurry, can be spread on the fields as fertiliser. The liquid fraction enters the treatment process.
2. The next stage of the process involves electro-coagulation in a purpose built ‘reactor’. The reactor contains conventional, but specific metal plates which, when an electrical charge is applied, act as electrodes. The electric current causes the metal to lose electrons at the cathode and become chemically oxidised. The electrons become available to carry charge from the cathode (+ve electrode) to the anode (-ve electrode) and therefore completing the electrical circuit, with the anode becoming chemically reduced. Scientific evidence indicates that the metal ions formed by the removal of the electrons enter the slurry and interact with the contaminants and form a molecular network which the contaminants adsorb to and acts like a sieve to remove the nutrients, phosphorus and potassium. In the correct conditions, the metal ions become insoluble and fall out of solution, along with the nutrients and coagulate. Eventually a solid precipitate (floc) forms and separates from the liquid by either rising to the surface or settling at the bottom. Much of the floc is contained within a foam which is generated by the action of the electrodes in water, producing hydrogen and oxygen

gas, which carry the impurities to the surface. This effect is increased by the addition of a Dissolved Air Floatation (DAF) tank, where the solids can be easily removed. Any remaining solids are separated in a disk stack centrifuge, which is capable of removing very fine particles. These fine solids also contain a proportion of the total nutrients and are therefore added to the solids that were separated earlier.

3. In addition to the use of mechanical separation and electrolysis to treat slurry, ultrasonic waves are used to help prevent the electrodes from fouling and having a negative effect on current density. This is achieved through the process of cavitation, where high energy bubbles rapidly collapse, releasing the energy contained within. This disrupts the solids from adsorbing to the electrode surface.
4. At this stage the liquid is still brown and looks very much like slurry, when it enters a second 'reactor'. This is where the next treatment process takes place - electro-oxidation. By using specialised metal plates in place of more conventional ones, the remaining contaminants in the liquid, including those which cause discolouration, are heavily oxidised. Oxidation occurs via a number of chemical pathways, but the main one is by the formation of hydroxyl radicals. These are highly reactive and react with the remaining contaminating molecules, including ammonia, breaking them down to their constituent parts. This is the main principle associated with the Advanced Oxidation Process (AOP). Other free radical species may also be generated by the electrolysis of the salts naturally found in cow slurry. This further aids the oxidation process by forming chloride radicals which attack and break down larger molecules to simpler ones. Chlorine also has a microbiological effect and serves as a disinfectant. Again, a dense foam is formed by the action of the electrodes. This foam can contain some Nitrogen and will therefore be recovered and combined with the solids from the earlier stages. After treatment the liquid becomes clear and free of nutrients.
5. Ultrasound is also employed in the second reactor for the same reasons as above. Furthermore, ultrasonic waves have the added benefit of also producing free radicals which again aid in the oxidation of the contaminants. Finally, the energy released through the process of cavitation breaks apart microbial cells, again supporting disinfection of the liquid.

The clear liquid is now safe to recycle on the farm e.g washing down, or to discharge to a local watercourse.