PRETREATMENT OF ACTIVATED SLUDGE BY ULTRASONIC IRRADIATION

Rana Kidak, Berthe Ratsimba, Anne-Marie Wilhelm, Henri Delmas

Laboratoire de Génie Chimique de Toulouse (LGC), 5 rue Paulin Talabot BP 1301, 31106 Toulouse Cedex 1, France

Introduction

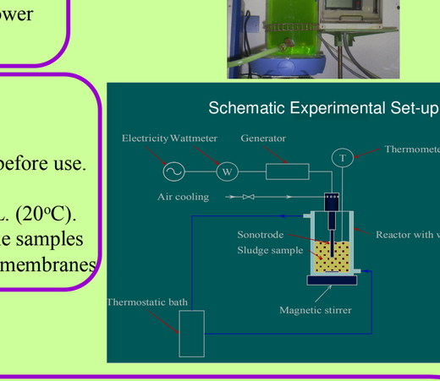
Reduction of vast quantities of waste activated sludge resulting from wastewater treatment plants is a major problem. In 2005, over 15 million tons of solid sludge was produced in Europe. The ultimate solution to this problem is considered to be the complete stabilization of the organic content, complete disinfection of the pathogenic bacteria. For this purpose Wet Air Oxidation was used and here we present the pretreatment process by means of power ultrasound.

Materials & Methods

The ultrasonic apparatus used was an ultrasonic homogenizer Autotune 750W (Bioblock Scientific). This apparatus was equipped with a probe and worked with an operating frequency of 20 kHz and a maximum supplied power of about 225W.

Experimental

- Dry matter content = 25%, by mass.
- Sludge preserved in freezer and defrosted before use.
- Batch experiments of 300 mL.
- The working concentration 8 g dry solids/L. (20°C).
- To measure the liquid phase parameters, the samples were filtered by 5.0 μm and then 0.45 μm membranes



Results

Particle size reduction

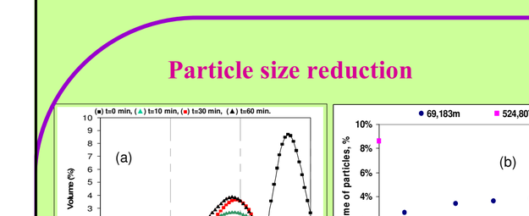


Fig. 1. (a) Particle size distribution curves change their abatements during ultrasonic irradiation at 20 W and (b) the big size particles are reduced while the smaller particles start to dominate the volumic percentage

Application of ultrasonic waves at 20 W has lead to great reduction in the particle size of the manually prepared sludge solutions. The solutions were explored due to their dp_{50}. The dp_{50} indicates the statistical value that shows the diameter of particles which are equal or less than the 50% of the particles in a solution. Fig. 1 shows the evolution of dp_{50} during ultrasonic exposure, while the decrease of large particles (initial dp_{50}) and increase of tiny particles (final dp_{50}) in the solution.

Solubilization of proteins

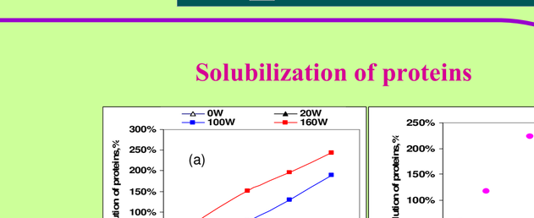


Fig.2. (a) Percentile evolution of proteins in the liquid phase of the sludge solution, by irradiation time while increasing the ultrasonic power. (b) The solubilization of proteins as a function of ultrasonic power

The power ultrasound waves were able to disrupt the bacterial cells and solubilize the proteins which were found in the cells. Disintegration of cells was strongly dependent on the applied power (Fig.2). Higher ultrasonic power supplies high mechanical shear forces caused by jet streams during cavitation bubble implosion

Solubilization of COD

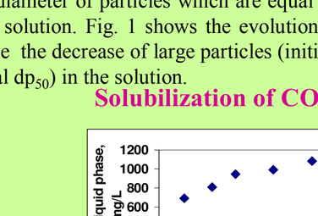


Fig.3. Evolution of COD in the liquid phase of sludge solution. The applied ultrasonic power was 100 W and the medium temperature was 20°C.

Apart from the major role of disruption of the sludge bacteria, disintegration of other sources of solid organics were also important in the process. For this reason, we have measured the availability of the solubilized organic matters in the liquid phase (Fig. 3). Mechanical effects of power ultrasound provide a high solubilization of oxidizable materials.

Ultrasound

Solubilization of TOC

Table 1. Numerical values of COD and TOC concentrations in the liquid phase of sludge solution.

Time, min	COD in liquid phase, mg/L	TOC in liquid phase, mg/L
0	115	48
1	250	-
10	750	-
60	1340	350
90	1600	427
120	1600	577

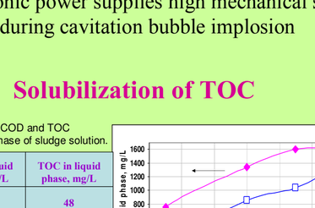


Fig. 4. Evolution of COD and TOC in the liquid phase. The applied ultrasonic power was 210 W and the medium temperature was 20°C.

In order to understand the tendency of solubilization of organics, the TOC was explored in the liquid phase and it was proved that solubilized TOC follows a similar path with the COD.

Conclusions

- *Ultrasound is capable to solubilize the WAS into liquid phase.*
- *It reduces the size of the solid particles until 8-9 μm.*
- *The tendency of solubilization of COD and TOC are following a similar path.*
- *When working at high powers, it is possible to solubilize the bacteria upto 90-100%.*
  E.g. in 60 min it is possible to have 65% efficiency of COD solubilization at 100 W For municipal sludge
- *Ultrasound is a good way of pretreatment before (Catalytic) Wet Air Oxidation.*