Title: METHOD FOR DEPURATION OF WASTEWATERS WITH REDUCTION OF SLUDGE PRODUCTION AND PLANT THEREOF

Abstract: Method, and plant thereof, for reducing the amount of surplus sludge produced in a wastewater treatment plant, the sludge comprises an organic matrix with a solid fraction and a cellular fraction; the method comprises: a) reducing the dimensions of the components of the solid and cellular fractions; and b) hydrolysis - at room temperature - of the components of the solid and cellular fractions having dimensions reduced in step a).
"Method for depuration of wastewaters with reduction of sludge production and plant thereof"

FIELD OF THE INVENTION

The present invention regards a method and plant thereof for depuration of wastewaters and, in particular, a method and plant thereof capable of allowing reducing surplus sludge production by wastewaters treatment plants.

TECHNOLOGICAL BACKGROUND

Residential wastewaters and some categories of industrial wastewaters are treated in biological treatment plants which, through a combination of physical, chemical and biological processes considerably reduce the concentration of suspended solids, organic matter, nitrogen and phosphorous present in the wastewater in such a manner to allow discharge thereof into the receiving bodies (lakes, rivers, canals, coasts) in compliance with law provisions.

Biological depuration generates a considerable daily mass of surplus sludge, which must be treated further and then conveyed for disposal.

Over the last years management of surplus sludge is becoming more and more important and critical regarding treatment of residential and industrial wastewaters given that:

- the annual production of sludge amounts to about 20,000 tons of dry matter per million people and it is constantly growing following interventions
to adapt depuration plants to ever restrictive discharge restrictions.

Europe increased from $8 \times 10^6$ t of total solids (TS) in 1998 to over $10 \times 10^6$ t in 2007;

- the law regarding disposal of sludge in agriculture is becoming more and more restrictive, due to the orientation of the European Commission and recent National laws which restrict the reutilization of biological sludge, of depuration plants for treating liquid wastes, in agriculture;

- disposal of sludge in waste sites has been restricted by law in many European countries, due to the negative environmental impact and due to the costs of disposal of sludge matrices;

- the cost of treatment and disposal of sludge in Europe currently represents 25-65% of the total running costs of plants (between 350 and 750 € per ton of dry matter) varying depending on the geographical area and disposal technology.

Specifically referring to the Italian context, predictions indicate - associated to the constant growth of sludge production and the restrictions provided for regarding alternative disposal methods - an increase of costs for the final treatment and disposal of sludge, which shall rise to the level of the European values. For example, as of the date of filing of the present application, the province of Trento already spends - for drying and disposal - an amount equivalent to 394 €/t of total solids (TS), which reaches 577 €/t TS should we also consider the cost of transporting sludge.

In this framework there arises an ever-crucial need to reduce sludge production directly at the source, i.e. at the depuration plant before the final disposal of residue sludge.
Technologies currently used for reducing sludge production (as dry matter and not only in volume) directly at the depuration plants are extremely diversified, and they are based on physical, mechanical, chemical, thermal and biological treatments.

Another criterion of division regards that between technologies that operate on the wastewater line and technologies that operate on the sludge line. In case of technologies integrated with the wastewater line, the objective is that of reducing sludge production directly in the wastewaters treatment chain, instead of post-treatment of sludge after it has already been produced.

However, in case of integration with the sludge line, reduction of the sludge mass is obtained after the latter has already been produced in the wastewater line, but pursued, depending on the selected technology, may be further objectives such as increasing the production of biogas in the anaerobic digestion, improvement of sludge dehydration, reduction of pathogenic agents or suppression of the foams in the digesters, depending on the technology applied.

The most common sludge treatment techniques applied today include among others:
- physical techniques: ultrasonication, thermolysis and wet air oxidation.

Ultrasoundation consists in exposing the sludge to high energy ultrasound. This leads to the formation of microbubbles, whose implosion (acoustic cavitation) generates shear stresses that may in turn cause cellular lysis and hydrolysis of the extracellular polymeric substances, which are one of the most important components of activated sludge. Due to the high energetic cost of this technology, currently being
studied in literature are mechanical techniques capable of generating cavitation without using ultrasound (hydrodynamic cavitation). Particularly promising among these is the treatment through high pressure homogenization.

Thermolysis provides for increasing the temperature, possibly alongside the variation of the pH. The main reaction mechanisms are the increase of cellular lysis and hydrolysis of the exocellular substances. Considering the same performance, usually the technologies that provide for the use of aggressive pH, in particular the alkaline ones, require temperatures lower than exclusively thermal ones.

The wet air oxidation provides for high temperatures (usually beyond 200°C) and the pressure required to maintain the liquid state. In these conditions, the sludge is placed at contact with oxygen or air, possibly in presence of catalysts. The oxidation yield is very high, but the related costs alongside the pressure and temperatures attained have limited the application of this technology up to date.

- chemical techniques: ozonation.

The action of this technology is above all aimed at oxidizing part of the organic matter present in activated sludge and thus reduce the amount of solids. Depending on the dose, it is possible to obtain complete or partial oxidation of the molecules, in such a manner to obtain, at least partly, soluble substances that are biodegradable more quickly.

Most real scale applications of the chemical/physical technologies have the main purpose of increasing the production of biogas in thermophilic and mesophilic anaerobic digesters, but there are some studies for application thereof in the circulation of
wastewater line, with the aim of reducing the produced sludge.

- biological techniques: digestion at room temperature in an anaerobic environment.

The most common process is based on the selection of a group of facultative anaerobic bacteria which, in a special reactor, has the function of increasing the cellular lysis of bacteria commonly present in activated sludge and hence reduce the overall production of sludge. In order to improve the overall yield, the process also provides for screening coarse solid parts, the separation of sand with hydrocyclones and the possibility of performing biomass exchanges between the reactor, where the selection of facultative anaerobic bacteria occurs, and the wastewater line. Such process is mainly applied in the United States, where - however - the quality characteristics of the main wastewaters differ from the European wastewaters on which the invention illustrated hereinafter was based, due to the capillary difference of under sink grinders in residential houses, which transfer a considerable amount of the putrescible matter of the urban solid waste to the urban wastewater.

Figure 4 shows the typical diagram of an activated sludge depuration plant of medium capacity (between 10,000 and 50,000 AE) according to the prior art. Observable are a wastewater line, supplied by the wastewaters and made up of a pre-treatment stage (screening, desanding, etc.), activated sludge biological reactor, where the processes of biological removal of biodegradable carbon, nitrogen and phosphorous occur by means of bacteria colonies aggregated in sedimentable flakes (activated sludge), which are separated in the subsequent secondary sedimenter and mostly recirculated in the biological
reactor itself. A small amount of the activated sludge is discharged daily, in that surplus, and represents the so-called surplus sludge to be disposed of (or reutilized in agriculture, after further treatment which occurs in the so-called sludge line. The sludge line is thus the portion of the depuration plant that receives - inflowing - the surplus untreated sludge produced by the wastewater line and produces biologically dehydrated and stabilized sludge to be conveyed to disposal/reutilisation. The sludge line represented in Figure 4 is that typical of a medium capacity plant which comprises a thickening treatment by gravity to reduce the water content of the sludge, an aerobic biological stabilisation to reduce the organic matter content of the sludge and the bacterial load thereof as well as a mechanical dehydration stage for considerably reducing the water content of the sludge.

As mentioned above, according to the current state of the art regarding technologies for reducing the amount of surplus sludge there are different processes applied at industrial scale that introduce additional chemical, physical, chemical/physical stages to the wastewater line or to the sludge line to reduce the surplus sludge production further, such as for example processes regarding patent applications FR-A-2 766 813, WO-A-2004/050566, WO-A-2005/123611 and WO-A-2008/024445. All plants described in the abovementioned documents provide for connecting - to the main wastewaters treatment plant - some reactors that allow reducing surplus sludge production. Specifically, FR-A-2 766 813 provides for performing a chemical ozonation treatment on the surplus sludge; WO-A-2004/050566 provides for using a mechanical treatment plant (referred to as jet collision) for reducing the
dimensions of the cellular components present in the surplus sludge; WO-A-2005/123611 instead provides for that the surplus sludge taken from the wastewater line be alternatively subjected to chemical and/or mechanical treatments. WO-A-2008/024445 describes a wastewaters treatment plant associated to which is a plant for biological treatment, preferably aerobic, of the surplus sludge obtained from the wastewater line.

However, the abovementioned processes reveal drawbacks related to high inefficiency concerning surplus sludge treatment, in that the processes implemented therein do not allow considerably reducing the amount of such sludge which must thus be disposed of. As a matter of fact, according to the state of the art, the ozone-based processes have reduction performance limited by the high cost of producing the ozone itself; the thermochemical, chemical and ultrasonication processes are instead mainly aimed at increasing the production of biogas in the sludge line of large depuration plants (>50,000 AE) and allow obtaining low quantitative reductions of the produced surplus sludge. As a matter of fact, an increase of the reduction efficiency of solids would imply excessive costs and would also have a negative impact on the production of biogas.

**SUMMARY OF THE INVENTION**

The present invention has the aim of providing a method for the depuration of residential and/or industrial wastewaters capable of allowing considerably reducing the surplus sludge production with respect to the traditional plants.

According to the present invention, such object is attained due to the solution specifically referred to
in the claims that follow. The claims form an integral part of the technical disclosure provided herein in relation to the invention.

An embodiment described herein regards a method suitable for reducing the surplus sludge production by means of a wastewaters treatment plant, where such reduction is obtained through the synergic combination of: a) a reduction of the dimensions of the organic components (solid and cellular) of the sludge and b) hydrolysis - at room temperature - of reduced organic components, where such hydrolysis, being made more efficient by the operation of reducing the dimensions of the organic components of the sludge, allows producing a considerably lower amount of surplus sludge.

An embodiment regards a plant for treating residential and/or industrial wastewaters comprising at least one device suitable to reduce the dimensions of the organic components (solid and cellular) of the sludge generated by the treatment of the wastewater, combined to at least one reactor for performing a room temperature hydrolysis reaction of reduced organic components and optionally to a densifier capable of allowing to eliminate part of the liquid component of such sludge, before the latter is supplied to the device suitable for reducing the dimensions of the organic components.

Contrary to the traditional plants and methods, such as for example the one illustrated in WO-A-2004/050566, the technical solution subject of the present description provides for that the surplus sludge treated in such a manner to reduce the dimensions of the organic components of the sludge be not conveyed to the biological compartment of the wastewater line, but be treated in a dedicated plant of
the sludge line, wherein hydrolysis - at room temperature - is carried out.

The present technical solution exclusively operates on the sludge treatment line - entirely separated from the wastewater treatment line - by introducing a physical, chemical/physical or electrochemical treatment of the sludge before the biological stabilization compartment (hydrolysis), to be preferably performed at room temperature.

**DETAILED DESCRIPTION OF SOME EMBODIMENTS**

Now, the invention shall be described in detail, strictly for exemplifying and non-limiting purposes, referring to the attached figures, wherein:

- figures 1 to 3 illustrate three different embodiments of a plant suitable to implement the method described herein;
- figure 4 illustrates a diagram for the treatment of surplus sludge according to the prior art;
- figure 5 illustrates a diagram for the treatment of surplus sludge according to the method described herein.

Illustrated in the following description are various specific details aimed at providing an in-depth understanding of the embodiments. The embodiments may be obtained without one or more specific details, or through other methods, components, materials etc. In other cases, known structures, materials or operations are not shown or described in detail to avoid obscuring the various aspects of the embodiments.

Reference to "an embodiment" in this description indicates that a particular configuration, structure or characteristic described regarding the embodiment is included in at least one embodiment. Hence, expressions
such as "in an embodiment", possibly present in various parts of this description do not necessarily refer to the same embodiment. Furthermore, particular configurations, structures or characteristics may be combined in any suitable manner in one or more embodiments.

References herein are used for facilitating the reader and thus they do not define the scope of protection or the range of the embodiments.

The present invention regards a method suitable for incentivising hydrolysis of organic matter with the aim of reducing the amount of surplus sludge, treating the surplus sludge in such a manner to reduce the dimensions of the organic components of sludge before performing hydrolysis at room temperature.

In particular, the present invention regards a method - schematically illustrated in figure 5 - capable of reducing the surplus sludge production by a wastewaters treatment plant, where such reduction is attained through synergic combination of two steps: a) reducing the dimensions of the organic components (solid and cellular) of sludge produced during the treatment of wastewater and b) hydrolysis - at room temperature - of the organic components having dimensions reduced, where such hydrolysis - having been made more efficient by the step of reducing the dimensions of the organic components of sludge - allows obtaining a considerably lower amount of surplus sludge. As a matter of fact, the hydrolysis reaction performed subsequently to reducing the dimensions of the organic components of sludge allows making the parts of the organic components of sludge soluble and more biodegradable reducing the solid mass that shall form the surplus sludge.
In an embodiment, the plant is made up of an activated sludge wastewater treatment line, which may be managed in a traditional manner or through discontinuous systems (SBR) or through alternating step processes (anoxic/aerated) and an innovative sludge line.

The wastewater line may separate the activated sludge from the treated wastewaters by gravitation or through membranes.

The sludge line may operate according to the traditional aerobic digestion or through more innovative processes such as anaerobic hydrolysis at room temperature or biological stabilisation with spatial or temporal alternation of aerobic zones, anoxic and anaerobic, but it must provide for the presence of a device capable of - operating on the organic matrix of sludge, i.e. reducing the dimensions of the organic components - allowing making the hydrolysis reaction of the organic matrix itself (solid fraction and cellular) as efficient as possible. As a matter of fact, the hydrolysis of the organic matrix was identified by the present inventors as one of the most important steps for biological treatment of surplus sludge making most of the organic components of sludge soluble in water and more biodegradable.

However, such step is notoriously slow and limiting for biodegradation processes.

The present inventors realised that the combination of reducing the dimensions of the organic components of sludge and a hydrolysis of the same at room temperature in a dedicated compartment of the sludge line (entirely detached from the wastewater line) causes a synergetic effect on the reduction of the amount of surplus sludge, in that the efficiency of biodegradation of the organic components of sludge is
accelerated and improved obtaining a greater presence of organic and inorganic matter dissolved in the liquid step that can be fed to the wastewater treatment line and lower solid component that shall form the so-called surplus sludge.

Thus, the present invention provides for that the method takes some sludge from the sludge line (from the line for supplying the sludge hydrolysis reactor or from the hydrolysis reactor itself) and treats such sludge through an electrochemical, chemical/physical or physical method capable of simplifying the structure of the matrix, the reduction of the dimensions of the sludge particles (disintegration of the flakes) and possibly cellular lysis, in such a manner to increase the efficiency of the hydrolysis process (preferably performed by means of anaerobic hydrolysis at room temperature) and biodegradation of the particulate organic matter which is present on the sludge line.

In order to increase performance, the sludge to be subjected to mechanical, physical-chemical or electrochemical treatment may be thickened by gravitation, or through membranes or through a dynamic thickener.

The techniques for reducing dimensions of the organic components of sludge which can be used to increase the efficiency of the hydrolysis at room temperature comprise, among others, mechanical treatments (particularly high pressure homogenisation and hydrodynamic cavitation) and/or chemical/physical treatments such as ultrasonication and/or electrochemical treatments.

Tests performed at laboratory level, simulating the sludge line alone, have revealed that the application of a high pressure homogenisation technique (150 bar) allows increasing the removal of solids by an
aerobic digestion line with a sludge retention time equivalent to 10.5 days. The reduction of the amount of outflowing solids is equivalent to 42% of the inflowing solids, while without applying the step of reducing the dimensions of the organic component of sludge upstream of the hydrolysis, the reduction amounts to just 20%.

Other tests were performed to verify the effects of the application of the step of reducing the dimensions of the organic component of sludge upstream of the hydrolysis performed through an anaerobic digestion at room temperature, using - as a reducer of the dimensions of the organic component - a homogenization technique at 150 bars: with different sludge retention times (6-10 days), the reduction of production of solids in sludge is in the order of 25-40% against 10-20% of the control line.

Provided for hereinafter are some examples of techniques for reducing the dimensions of the organic components of sludge which may be advantageously used in the wastewaters treatment methods. It should be observed that in the examples that follow, sludge is taken from the dedicated hydrolysis reactor of the sludge line and not directly from the line for supplying sludge to the hydrolysis reactor.

**Example 1: Homogenisation and anaerobic digestion at room temperature**

The first application example of the invention - illustrated schematically in figure 1 - uses a homogenisation treatment for reducing the size of the sludge particles and thus increase the biological kinetics of the combined anaerobic reactor, in particular the restrictive kinetic represented by the hydrolysis of the complex organic matter which forms most of the volatile solids.
The plant of figure 1 - indicated in its entirety with reference number 1 - comprises a first pipe 2 for taking sludge from the wastewater line of the wastewaters treatment plant (non illustrated), where such sludge is supplied to a combined anaerobic reactor 3. The sludge is subsequently supplied through a second pipe 4 to a densifier 5, which separates at least one part of the liquid component of such sludge conveying the abovementioned liquid component to the wastewater line through a third pipe 6. The sludge thickened in the thickener 5 (in this case a static or dynamic thickener) are thus supplied through a fourth pipe 7 to a device for reducing the dimensions 8 of the organic components (solid fraction and cellular fraction) of sludge, and subsequently supplied to the reactor 3, where the anaerobic hydrolysis at room temperature occurs with ensuing reduction of the amount of sludge. The reactor 3 may - in a variant of the process - also be directly supplied partly or entirely by the sludge taken from the wastewater line (pipe 2). Periodically, the surplus sludge is discharged through the pipe 10.

In this particular embodiment the device for reducing the dimensions 8 of the organic components of sludge is made up of a high pressure homogenizator.

The high pressure homogenisation treatment (50-200 bar) causes the considerable reduction of the medium diameter of the particles, but without a substantial production of rapidly biodegradable matter, thus contributing to maintaining - in the combined anaerobic reactor - the conditions of absence of substrate that best stimulate the anaerobic hydrolysis. The homogenisation treatment also allows improving the sedimentation capacity of the wastewater.

The thickener 5 may be static or dynamic and allows increasing the concentration of solids in the reactor
3, in such a manner to reduce the required volumes and the liquid flow rates to be treated through homogenisation.

The wastewaters separated by the thickener 5 are rich in soluble organic matter and nutrients produced by hydrolysis at room temperature and thus they are to be treated in the wastewaters treatment line. Also a part of the thickened sludge may be recirculated in the wastewater line to increase the efficiency of the process.

To prevent the sludge in the anaerobic reactor 3 from triggering fermentation processes, such event possibly leading to the production of evil-smelling substances, it is advisable to install oxygen diffusers in the reactor 3 and provide for measuring the oxide-reduction potential (ORP): should the ORP reach values lower than the threshold fixable in the range of \(-250 \div -350\) mV slight aeration is carried out until the ORP is raised above such value.

**Example 2: Ultrasonication and aerobic digestion**

This application, more conventional with respect to the previous one, provides for a smaller number of modifications to a small-medium depuration plant which uses aerobic digestion for stabilizing the surplus sludge and for reduction thereof.

The plant of figure 2 - indicated in its entirety with reference number 11 - comprises a first pipe 2 for taking sludge from the wastewater line of the wastewaters treatment plant (not illustrated), where such sludge is supplied to an aerobic reactor 3. The sludge is subsequently supplied through a second pipe 4 to a densifier 5, which separates at least one part of the liquid component of such sludge conveying the abovementioned liquid component to the wastewater line.
through a third pipe 6. The sludge thickened in the densifier 5 (in this case a thickener) are thus supplied through a fourth pipe 7 to a device for reducing the dimensions 8 of the organic components (solid fraction and cellular fraction) of sludge, and subsequently supplied to the reactor 3, where aerobic hydrolysis occurs with ensuing reduction of the amount (in terms of dry matter) of sludge. Periodically, the surplus sludge is discharged through the pipe 10.

In this particular embodiment the device for reducing the dimensions 8 of the organic components of sludge is made up of a sonicator.

Ultrasonication allows disintegrating the flakes of activated sludge and thus reduces the times required for hydrolysis at room temperature. An example of possible operational conditions comprises a specific applied energy comprised in the range between 5-20 kWh/m³.

The combination of a chemical/physical treatment for reducing the dimensions by means of biological treatment of sludge allows reducing the amount of solids produced by the plant. In this case, aerobic hydrolysis has the advantage of reducing the required volumes, which are however reduced even by applying a thickener 5.

**Example 3: SBR Reactor and electrochemical treatment**

This application provides for a sludge line managed as a sequencing batch reactor (SBR) and it is more suitable in cases where the wastewater line poorly bears overloads of nitrogen and thus requires providing for alternating aerobic and anoxic steps for nitrification and denitrification respectively,
alongside the anaerobic steps in the strict sense for incentivising anaerobic hydrolysis.

The plant of figure 3 - indicated in its entirety with reference number 100 - comprises a first pipe 2 for taking sludge from the wastewater line of the wastewaters treatment plant (not illustrated), where such sludge is supplied to a reactor 3. The sludge is thus supplied through a second pipe 4 to a device for reducing the dimensions 8 of the organic components (solid fraction and cellular fraction) of sludge, and subsequently supplied to the reactor 3, where there occurs the hydrolysis of the organic components having dimensions reduced. Periodically, surplus sludge is discharged through the pipe 10.

In this particular embodiment the device for reducing the dimensions 8 of the organic components of sludge performs an electrochemical treatment, which - according to laboratory tests - has proven to perform partial oxidation and lysis of the organic matter and thus increasing hydrolysis velocity thereof in the SBR reactor.

The electrochemical treatment provides for exposing the sludge to a constant electric field in terms of intensity and direction. The device is made up of a reactor which contains the sludge and two or more electrodes, which may be made up of different material: stainless steel for the anode in conditions of absence or low concentration of chloride ions, materials more resistant to corrosion (graphite, platinum-plated titanium) for the cathode under harsher conditions. During the treatment, the ions contained in the sludge migrate towards the electrodes. Most of these ion substances are organic substances which thus react with the electrodes themselves, with partial mineralisation.

The particles in suspension, which comprise polar
groups, are subjected to heterogeneous catalysis processes facilitated by the presence - in the sludge - of metals, such as iron and, at lower amounts, manganese, which cause reactions of partial oxidation of the organic matter. The weakening of the flake structure causes, in case of movement of the sludge and thus shear stress, the destructuring of the flake itself into smaller and more reactive particles.

Another effect of the electrochemical treatment is that of improving the sedimentation capacity of the sludge; in addition, it causes partial oxidation of ammonia nitrogen into gaseous nitrogen, which is released into the atmosphere, and nitrates; in this manner, on one hand, it is possible to maintain a higher concentration of solids in the sludge line, while on the other hand it is possible to reduce the aeration steps of the SBR reactor for biological stabilisation of sludge in a such a manner to increase efficiency thereof.

The electrochemical treatment may be performed in the SBR reactor or in a special reactor with recirculation of sludge, as shown in figure 3.

Suitable sedimentation steps allow maintaining the concentration of sludge in the reactor 3 at high values, which depend on the characteristics of the sludge itself, but which may be approximately equivalent to 2-3% in solids.

An example of operational conditions may be a potential difference of 5-60 V and a specific energy equivalent to 1-30 kWh/m³. The duration of the treatment instead depends on the conductivity of the sludge and on the distance between the electrodes (times ranging between 10-480 min).

Obviously, the details and embodiments may widely vary with respect to what has been described and
illustrated without departing from the scope of protection of the present invention, as defined by the attached claims.
CLAIMS

1. Method for reducing the amount of surplus sludge produced in a wastewater treatment method, said sludge including an organic matrix with a solid fraction and a cellular fraction, said method including:
   a) reducing the dimensions of said solid and cellular fraction components; and
   b) hydrolysing said components of said solid and cellular fractions having dimensions reduced in step a).

2. Method according to claim 1, wherein said step of reducing the dimensions is performed by mechanical homogenisation and/or ultrasonication and/or hydrodynamic cavitation and/or electrochemical treatment.

3. Method according to claim 1 or claim 2, wherein said step of hydrolysis is an anaerobic or aerobic hydrolysis, or an aerobic/anaerobic alternating hydrolysis step, at room temperature.

4. Method according to any one of claims 1 to 3, wherein said step of reducing the dimensions of said components of said solid and cellular fractions is preceded by a step of thickening said solid and cellular fractions with elimination of at least one liquid portion constituting said solid and cellular fractions.

5. Method according to any one of claims 1 to 4, wherein said step of thickening is performed by gravitation.
6. Method according to any one of claims 1 to 5, wherein said step of thickening is performed in the same reactor in which hydrolysis is performed.

7. Plant for reducing the amount of surplus sludge produced in a wastewater treatment plant, said sludge including an organic matrix comprising a solid fraction and a cellular fraction, said plant including:
   - a stage for reducing the dimensions of said solid and cellular fraction components; and
   - a stage for hydrolysis at room temperature of said components of said solid and cellular fractions having dimensions reduced in said reduction stage.

8. Plant according to claim 7, wherein said reduction stage comprises at least one from among a mechanical homogenizator, a sonicator, a hydrodynamic cavitator and/or an electrochemical plant.

9. Plant according to claim 7 or claim 8, wherein said hydrolysis stage provides for the performance of an anaerobic or aerobic hydrolysis or an alternating aerobic/anaerobic step hydrolysis, at room temperature.

10. Plant according to any one of claims 7 to 9, wherein said reduction stage is preceded by a stage for thickening said solid and cellular fractions with elimination of at least one liquid portion constituting said solid and cellular fractions.

11. Plant according to any one of claims 7 to 10, wherein said thickening stage comprises a membrane or a static or dynamic thickener susceptible to eliminate at
least one liquid portion constituting said solid and cellular fractions.
Figure 1

Figure 2
Figure 3
**WASTEWATER LINE**

Untreated wastewater → Pre-treatments → Activated sludge biological reactor → Secondary clarifier → Treated wastewater

Untreated surplus sludge → Thickener → Biological sludge stabilisation (aerobic) → Mechanical dehydration → Stabilised and dehydrated surplus sludge

**SLUDGE LINE**

*Figure 4*

**WASTEWATER LINE**

Untreated wastewater → Pre-treatments → Activated sludge biological reactor → Secondary clarifier → Treated wastewater

Untreated surplus sludge → Mechanical or chemical or physical or electrochemical treatment → Anaerobic hydrolysis of sludge at room temperature → Static or dynamic or membrane equipped thickener → Mechanical dehydration → Stabilised and dehydrated surplus sludge

**INNOVATIVE SLUDGE LINE**

*Figure 5*