Francese Inglese
Trova arte nota
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A process and a plant for treatment of landfill leachates

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Inventori	Pasquale Ferorelli
Candidato	Pasquale Ferorelli
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ESTRATTO

Leachates from sanitary landfills and waste water liquid in general are depurated and converted into clear water (19), ammonium sulphate (24) and polluted mud by gradually heating the liquid, raising its pH (5) to precipitate heavy metals (6), stripping ammonia (7), lowering the pH by treatment with CaCl2 (8), neutralising and precipitating further metals and impurities (14), and evaporating (17; 18; 15; 27) the water into steam that is condensed while gradually heating the incoming liquid.

DESCRIZIONE (il testo OCR potrebbe contenere errori)

A PROCESS AND A PLANT FOR TREATMENT OF LANDFILL LEACHATES. Technical field

The present invention relates to a process and a plant for the treatment of leachates from landfills and for treatment of waste waters and polluted liquids in general. Background Art

Sanitary landfills and waste dumps daily produce a quantity of liquid known as leachates, that sits at the bottom of dump. This liquid is highly contaminated by organic and inorganic pollutants, particularly heavy metals, ammonia and azo-compounds. The quantity of leachates produced by an average waste dump in a day is around 500250 mc. This liquid has to then be treated so that it can be disposed without polluting the water bed. Some known methods for the treatment of leachates involve transporting the liquid itself from the waste dump to special plants where it is treated, for example, by inverse osmosis or by biological process after a chemical-physical treatment. As one can expect, these methods are extremely costly. There are other known methods for treating the leachates such as thermal oxidation, after evaporation or distillation of at least part of the water. In general the process of thermal oxidation is undertaken on the site of the waste dump, in a dedicated plant that uses part of the biogas produced by the waste dump itself. This method is less expensive than the ones mentioned above, it does, however, present some drawbacks, for example it is necessary to clean the exhaust gases of the plant from the heavy metals and the other pollutants present in them. Furthermore this is a "destructive" method, and as such it is energetically expensive. Disclosure of invention The aim of the present invention is to solve the above problems, by providing a process and a plant that will allow the treatment of the leachates produced by a waste dump, on site, economically, with the lowest possible demand of energy and recovering, at the same time, water and raw materials. This aim is reached by means of the present invention, that provides a process for the treatment of waste dumps leachates and other similar liquids, characterised according to claim 1.

The invention also relates to a plant for the treatment of waste dump leachates and other similar liquids, characterised according to claim 7. A further feature of the invention is a filter for the separation of impurities from a flow of liquid characterised according to claim 16.

The process and the plant in the present invention provide several advantages compared to the existing techniques: the leachates are treated on site, and there is thus no need to transport them to specialised plants. Only the concentrated

RIVENDICAZIONI (il testo OCR potrebbe contenere errori)

1. A process of treating leachates from landfills and waste water polluted liquids in general, characterised in comprising the following steps: gradually raising the temperature of the liquid

(4,1 1 ,61 ,81 ,17,18,151); raising the pH of the liquid to alkaline values (5,5a); removing the metals present in said liquid (6, 14); removing at least a portion of the organic substances present in said liquid (14,16); vaporising to steam (15) at least part of the water present in said liquid. 2. Process according to claim 1 , wherein said steam is subject to thermocompression (27) and the heat of the said steam is released to said liquid at different steps of the process.

3. Process according to claims 1 and 2, wherein said release of the metals comprises initially the heating the alkaiised liquid and its treatment in column tanks 6 with a pre-determined stay time, and subsequently a further neutralisation and precipitation treatment (14).

4. Process according to any previous claim, wherein removal of said organic substances from said liquid is comprising the following steps: heating and addition of calcium chloride (8), a first neutralisation and precipitation treatment (14), rising the temperature to above 100° C, evaporation of part of the water present in the evaporator (15), a second neutralisation and precipitation treatment (14).

5. Process according to any previous claim, wherein ammonia present in said liquid (7) is removed and transformed into one of its derivatives (12). 6. Process according to any previous claims, wherein the liquid remaining after said evaporation step is filtered and recirculated within the plant.

7. A plant for the treatment of leachates from landfills and waste water liquids in general, characterised in comprising: a heat exchange means (4,1 1 ,61 ,81 , 17,18,151) located in a sequence for gradually heating said liquid; means (5,5a,BI) of increasing the pH of said liquid; means (6,14) of removing metals present in said liquid; means (8, 8a, B2) of removing organic substances present in said liquid; means (15) of evaporating the water present in said liquid into steam; means (C, PI5) of feeding said steam from said evaporation means (15) to said plurality of heat exchanger means to condense and gradually cool the said steam.

8. Plant according to claim 7, further comprising means (7,1 1) of removing

sediments will periodically be taken to special plants. Furthermore the invention allows to recover products of high agronomic value that can be utilised in agriculture; on the one hand, the process obtains ammonium sulphate by transformation of the nitrogen compounds in ammonia and by total stripping of the ammonia. One the other hand it produces water close to the de-mineralised quality, through a combined process of total evaporation, after removal of metals, ammonia and organic substances. A further advantage is provided by the possibility of eliminating gas emissions, deriving from combustion, in the atmosphere, contrary to existing techniques. The heating of the liquid is, in fact, produced via progressive heat transfer from the condensed steam to the cold liquid and by using a small boiler and a turbo machine. Brief description of Drawings

The invention will now be described in greater detail with reference to the enclosed drawings, that have an illustrative, and not limiting, function, where:

- fig.I is a schematic plan of a plant according to present invention;

- fig.2 and 3 are enlarged, partial and complementary views of the plant in fig.I ;

- fig.4 and 5 are enlarged sectional views of components of means of stripping ammonia;

- fig.6 is a sectional view of a filter according to the invention; and

- fig.7 is an enlarged view of a feature of the filter in fig.6. Best Mode of carrying out the Invention

The plant (fig.1 -3) includes leachate stocking tanks A connected trough a line B to a heat exchanger 4. To the latter condensed water, obtained with the condensation of the steam, as explained below, arrives trough a line C. Before the heat exchanger 4 there are provided a filter 1 , a ' volumetric meter 2 and a butterfly valve 3, usually closed, operated by a single-acting pneumatic actuator. The line B exiting from heat exchanger 4 includes pump devices PI I and is connected to reactor 5 which is provided with means for feeding an alkalinizating solution, usually NaOH, from tank 5a.

As better visible in fig .2, tank 5a is connected to reactor 5 trough circuit BI that allows the circulation of liquid and alkali solution until the required pH (around pH 1 1-12) is reached. A pump PI9 is provided for such re- circulation. An ammonia condenser is located internally to reactor 5 to transfer heat from gaseous ammonia to the liquid circulating in reactor 5. The outlet of the reactor 5 is connected through line B (the leachates line) to a pair of column tanks 6 for the precipitation of the metals. A proportional flow rate valve VM-1 regulates the flow of the alkalinised leachates to column tanks 6. These tanks are provided with a water jacket 62 through which condensate warm water from line C circulates. Internal to these tanks interspace 61 extends vertically along the vertical walls of the tank; the higher end of interspace 61 is welded to tank 6 whilst the lower end is open. In correspondence with the higher end, closed, of the interspace a hollow ring drilled, i.e. a toroid is located, connected to line B for feeding the liquid to the tanks themselves. The outlet of the tanks is located at their upper end and is connected through line B to the means of removing, via stripping, the ammonia. This means comprises a tower 7 placed on the top of a reactor 8 and connected to it. Tower 7 (fig.4) includes a circular drilled ring, 71 , for distribution of the liquid arriving from line B. This ring is placed on the higher portion of the tower, spaced from the overhead outlet 72 for evacuation of the gaseous ammonia. Below the ring 71 a series of plates 73, preferably made out of wire cloth, are placed in an oblique position respect the horizontal axis in order to fractionate the liquid falling by gravity along the column 7 once it has come out from ring 71. The tower 7 is connected through line N to a vacuum pump PI10. On the line N are placed, in sequence and before the vacuum pump PI10, a condenser 1 1 , immersed in reactor 5 to transfer heat to the liquid circulating in said reactor, a reactor 12 for reaction with sulphuric acid and transformation of ammonia in ammonium sulphate, and a tank 13 were the gases arriving from reactor 12 are washed with water (for example water treated by the plant itself). Line N exiting from reactor 12 extends to tank 24, where the ammonium sulphate produced is collected and stocked.

Reactor 8 is provided with an external interspace 81 connected with the line C for the condensate water and an internal body 82 in which are present steam feeding means 83 and means 84 of feeding a solution of $CaCl_2$ arriving from tank 8a along line B2. The devices 83 and 84 are preferably toroids, that is to say drilled circular rings. As with reactor 5, reactor 8, too, is provided with re-circulation line B2 and pump, valves and a Ph-meter, so as to obtain an optimum mixture of the calcium chloride with the leachates. Downstream reactor 8 are provided means for ionic neutralisation and precipitation of traces of metals, organic substances and impurities still present in the liquid.

In the preferred realisation showed, these devices consist in a pair of tanks 14 in which impurities are separated from the liquid and sediment as mud on the bottom. Such tanks are commercially available from, for example, New Sun srl (Milan -

ammonia from said liquid and means (12, 13) of transforming said ammonia into ammonium sulphate.

9. Plant according to claim 8, wherein said means for the removal and transformation of the ammonia include a stripping column (7) with plates (73), a mixing reactor (12) with sulphuric acid and a gas washing tank (13), said column, reactor and tank being connected to a vacuum source (PI10).

10. Plant according to claim 9, wherein said column (7) is mounted on the head of a reactor (8), said reactor being connected with a source of steam (83,F) and with a tank (8a) containing a solution of calcium chloride.

1 1. Plant according to any claim 7 to 10, wherein said means of metal removing includes at least two column tanks (6) provided with an internal interspace (61) and means (63) of feeding the liquid located on the head of said interspace.

12. Plant according to any claim 7 to 1 1 , further comprising at least two tanks (14) of neutralisation and precipitation of metals, organic substances and impurities. 13. Plant according to any claim 7 to 12, wherein said means of evaporating the water from said liquid includes a boiler (17), a heat exchanger (18), an evaporator (15) and a turbomachine (27), the outlet of said turbomachine being connected with the said heat exchanger (18). 14. Plant according to claim 13, further comprising a filter (16) for separation of impurities, said filter being connected downstream to said evaporator.

15. Plant according to claim 14, wherein the said filter (16) include a casing (161) and a number of truncated cone elements (163) with decreasing diameter in the direction of the flow of the fluid, said elements defining an internal area (166) and an external area (167) and a plurality of ascensional passages from said internal area to said external area.

16. A separator for the separation of impurities from a liquid, characterised in that it includes a casing (161) and a number of truncated cone elements (163) with decreasing diameter in the direction of the flow of the liquid, said elements defining an internal area (166) and an external area (167) and a plurality of ascensional passages from said internal area to said external area.

Italy), who sells them under the commercial name of Scherman Wasser. Suitable tanks are disclosed also in Italian patent n. 20802-A/83 filed 27 April 1983. Line B, with pump PI2, connects the outlet 85 of reactor 8 with branch DI of line D of primary circuit for heating and evaporation, which includes boiler 17, heat exchanger 18, evaporator 15, turbomachine 27 and filter 16. The rate of flow of the liquid along the line D should preferably be 15-20 times greater than that of the leachates entering the plant and the temperature should not be below 95-99° C. The outlet of tanks 14 is connected with said line D, which is provided with a pump PI4 for sending the liquid, substantially depurated, to boiler 17; this boiler can be of any kind available, in the preferred realisation it is an electric one and is provided with means for gradual thermal insertion with five steps of intervention (for example five resistances) and with control devices (not shown) for activating one or more means according to the temperature detected downstream boiler 17. The boiler 17 is connected with heat exchanger 18, whose outlet is connected with evaporator 15 where part of the water present in the liquid is transformed in steam. Evaporator 18 is connected through line E to the turbomachine, or turbocompressor 27, which sucks the saturated steam generated in the evaporator 15 and takes it to its maximum thermal content and to a level of cynetic energy sufficient to win the resistance of the circuit. The temperature of the steam entering the turbomachine 27 is around 105-107° C. and the temperature of the steam exiting is around 140° C. The turbomachine 27 is connected to heat exchanger 18 (that could possibly be placed internally to the evaporator), to one or more heat exchangers immersed in the evaporator 15 and in its interface 151 (line F) and, through line F, to means 83 of feeding steam to reactor 8. The turbomachine is obviously provided with the necessary devices to guarantee that the pressures and temperatures do not exceed the established values.

Since inside the evaporator 15 some impurities are formed due to the oxidising reactions of the organic substances still present in the liquid, the outlet of the evaporator is connected with a filter 16 where the separation between impurities and liquid takes place. A first outlet of the filter, relative to the portion of liquid rich in impurities, is connected to line DI and to tanks 14, whilst a second outlet relative to the filtered liquid is connected to line D and boiler 17. The filter 16 is a separator of impurities and is shown in greater detail in fig. 6 and 7. The filter includes a casing 161 having an inlet hole 162 at its higher portion. Inside casing 161 a number of truncated cone elements 163 are placed, with decreasing sizes from top to bottom, where a first outlet 164 is placed . The truncated cone elements, fig.7, are partially superimposed, that is to say that the lower extremity of one element 163' is housed within the higher extremity of the element 163" placed below it. These elements are fixed to each other at a plurality of points 165, and between them fissures are provided with a limited aperture generally in the order of 4-6 mm. In practice, elements 163 define inside the casing 161 a funnel-shaped inner area 166 and an external area 167; these areas communicate with each other through the above mentioned fissures, that define ascending communication ways since the liquid has to re-ascend through the fissures to reach the areas 167 from the area 166, as indicated by arrows FF in fig.6. The ratio between the height H of the pile of truncated cone elements 163 and its maximum diameter, which is the diameter of the higher element, is preferably within the range of 1.8:1.0 to 2.2:1.0 and most preferably of about 2:1. The number of truncated cone elements is variable depending on the level of efficiency required for the filter and in general is within the range of 12 to 15 for each linear meter of the pile. Inside the filter 16 there are two circulation of the liquid: a first one tangent towards the outlet 164 connected to tanks 14 and a peripheral one divergent towards the area 167 and the outlet 168 connected to the line D and, through the latter, to the boiler 17. The impurities follow the central tangent of the separator (with a decreasing dynamics) and are sent to tanks 14, whilst the liquid clear of impurities is directed towards the peripheral divergent entering the ascensional ways between the single scaled elements, having passages able to slow down the localised speed. Heat exchanger 18 and interspace 151 of evaporator 15 are connected to line C for feeding the formed condensate, that has a temperature around 95° C or more, to means corresponding to previous steps of the process. More specifically, line C enters interspace 81 of reactor 8 and from here it extends to interspace 61 of precipitation tanks 6, to heat exchanger 4 and eventually to final water collection tank 19. Preferably, an active carbon filtering column 21 and a column 22 containing zeolites are provided, in which the condensate water is passed through before arriving into tank 19. Tank 19 is provided with instruments 25 for the physical chemical control of the water, such as, for example, pH-meters, conductivity and redox detectors and similar ones. Tank 19 is also connected with an outlet 28 and a line H for the utilisation of part of the water treated for internal use within the plant, e.g. for washing portholes. The tanks 6 and 14 are connected to line L to feed impurities precipitated as mud to thickening tank 20: the mud is periodically removed from this tank and sent to plants for specialised treatment. To summarise, according to the invention one can identify within the plant four distinct circuits. The first circuit is identified by the lines B, D, and DI and corresponds to the lines of treatment of the leachates. From the beginning of the treatment plant to the final evaporation and thermal compression phase, the leachates receive a series of treatments: gradual increase of temperature, pH increase, release of the metals, further temperature increase, release of ammonia, lowering the pH, neutralisation and separation of the low-boiling organic compounds (aldehydes and similar) and complete evaporation of the leachates cleared of the above pollutants.

The second circuit (return phase) is defined by the line C: the steam is condensed in exchanger 18 releasing heat to the arriving leachates and the condensate water, devoid of pollutants, passes a series of interspaces in the various devices present in the process, gradually releasing its heat until the last release in exchanger 4. The third circuit is the ammonia circuit and is defined by line N: the gas produced in the stripping tower 7 is taken to condenser 1 1 and reactor 12 for production of ammonium sulphate. The fourth circuit is defined by line L, which collects the mud discharged from precipitation tanks 6 and 14 and conveys it to thickening tank 20. The functioning of the plant according to the process of the invention includes the separation of the metals and of the ammonia (which is recycled) from the leachates and the gradual heating of the liquid until its evaporation, the steam thus obtained is then treated by thermocompression in a turbomachine.

The liquid (leachates) coming from the dump or from the stocking tanks A, runs along the line B and having passed the filter 1 , the meter 2, and valve 3 enters heat exchanger 4 where it is heated from the condensate water coming from line C. The condensate water exiting exchanger 4 has a temperature of about 30° C or less.

The pump PII sends the liquid to reactor 5 where it is heated by the ammonia condenser 1 1 and is alkaiised by addition of a solution of NaOH from tank 5a. The liquid is recircled along line B I until homogeneous and constant pH (as measured with a pH-meter) is reached. The following step is regulated by the proportional valve VM-1 , controlled by the subsequent steps.

The alkaiised liquid is sent to interspace 61 of column tank 6 for separation of the metals. The liquid descends along interspace 61 from distribution toroid 63 located at the upper portion of said interspace and slowly re-αscends along the central part of the tank. When the liquid re- ascends, the metals are left on the tank bottom and provide a filtering action for the metals in arrival. This step includes further heating of the liquid by condensate water circulating in external jacket 62 and it is of a dynamic-static kind. That is to say that a dynamic phase for the filling of the tank is alternated with a static phase (full and still tank) which allows the precipitation of most of the metals, subsequently discharged in the form of mud through line L. The liquid is then fed to ammonia stripping tower 7 under controlled conditions (pressure, temperature, alkalinity, flow-rate). The fluid arriving from the circular drilled ring 71 , positioned on the top of the tower, falls on the liquid fractionating plates 73 alternated along tower 7. While falling, the fractionated fluid comes into contact with the steam from the distribution toroid 83: the thus freed ammonia is sucked in the line N, whilst the steam condenses and falls into tank 8 underneath where it is admixed with the solution arriving from the distribution toroid 84. The ammonia is fed to condenser 1 1 and reactor 12 where it is reacted into ammonium sulphate. Treatment step in reactor 8 comprises further heating of the liquid, lowering of its pH and neutralisation of low-boiling compounds (aldehydes and similar) through a treatment with $CaCl_2$ solution and homogenising along recirculation circuit defined by line B2. The treated liquid is then fed by pump PI2 to tanks 14, e.g. of Shermann Wasser type, where a further separation of impurities is achieved. Before reaching tanks 14, the liquid is fed into high speed and high temperature circuit D: the circuit D has a constant flow rate twenty times bigger than the maximum flow rate of the arriving liquid (for example 5 mc/h on arrival on B and 100 mc/h on D) and a temperature around 98-99° C or higher. The mixture is sent to electric boiler 17 with a gradual thermal insertion at 5 steps, the functioning of which is obligatory at the start-up of the plant and is activated, only if necessary, after the plant has reached a steady state.

From the boiler the water enters the plate heat exchanger 18 for further increase in its temperature, since the heater 18 is connected to the turbomachine 27. From here the liquid is fed to evaporator 15 (producer of steam) where it comes into contact with other heat exchangers immersed in the evaporator and with the walls of interspace 151 to which steam is fed from the turbomachine 27 at a temperature of around 120° C. The steam generated in evaporator 15 has a temperature of around 105-107° C and is sucked by the turbocompressor that brings it to the maximum thermal content (around 140° C) and gives it propulsion sufficient to win the resistance of the circuit. 60% of its energy is sent to heat exchanger 18 for heating of the liquid in arrival, 25% is sent by the turbomachine to other exchangers immersed in the evaporator 15 and interspace 151 , and the remaining 15% at the previous steps of treatment through line F.

The water exiting from evaporator 15 is containing impurities that are separated from the water in the filter or separator 16 in the way above disclosed. The impurities are sent to line Dl and to tanks 14 for their precipitation, whilst the liquid cleared from impurities is fed to the line D. The condensate water has a temperature higher than 95° C and is sent along line C to reactor 8, to tanks 6 and to heat exchanger 4, releasing heat until it reaches a temperature of around 30° C or less, so that it can be then treated as above disclosed. The mud is discharged from tanks 14 and 6 to the thickening tank 20, the level of which is controlled by a level detector 26.

As mentioned above, the treated water is in compliance with law requirements and can be discharged, whilst the ammonia sulphate can be shipped to end users in the agricultural sector.

CITAZIONI DIVERSE DA BREVETTI

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