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(54) **Cheese whey treatment and valorisation process with continuous ethanolic fermentation**

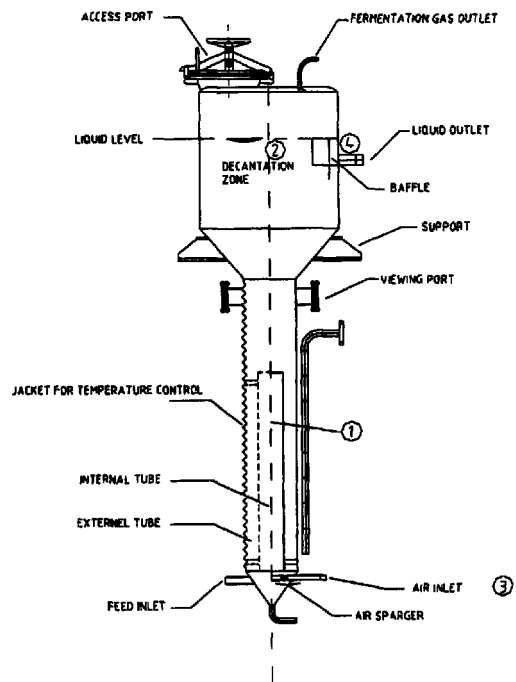
(57) The invention deals with a process used for **Cheese whey treatment and valorisation.**

The plant where this process is applied includes three main components - an ultrafiltration unit, a bioreactor and a distillation unit. Final products of this process are a whey protein concentrate and ethanol.

Ultrafiltration and distillation units are similar to the ones being used in other cheese whey treatment plants.

The innovative characteristics of this process lie on the design of the bioreactor and its operation mode and on the microorganism being used. The bioreactor, with a total volume of 1000 liters at the installed scale, is a concentric tube internal loop air-lift bioreactor with a degassing zone at the top; the mode of operation is continuous; the lactose fermenting used yeast strain has the ability to form flocs. By using a flocculating yeast strain and operating the bioreactor continuously a higher productivity in lactose conversion to ethanol may be achieved with a simultaneous reduction in the volume of residual solids. This process allows for a 90% reduction in the pollution caused by cheese whey disposal.

The innovative character of this invention lies on the use a continuously operating bioreactor with a new design. The integration of the fermentation unit in the overall cheese whey treatment and valorisation process forces the extension of the request for protection of the patent to the entire process.



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## Description

[0001] This invention describes a process for a cheese whey treatment and valorisation plant that incorporates a continuously operating concentric internal tube airlift bioreactor with a sedimentation zone at the top. A lactose fermenting yeast with the ability to form flocs is used. In this process a high protein concentration effluent for further processing and food grade ethanol are obtained, with a reduction in the cheese whey pollutant charge.

[0002] The main objective of this invention is the implementation of a process that, when compared with existing plants, allows for the obtention of a higher productivity in the alcoholic fermentation with decreased operating costs.

[0003] The bioreactor used in the fermentation process is the main innovative characteristic of this invention, since all the others operations involved are similar to already existing processes.

[0004] The proposed unit for cheese whey valorisation is implemented at pilot plant scale. It includes the following processes: after being stored in a retention tank, cheese whey is fed to a 40000 MWCO organic membranes ultrafiltration unit where two fractions are obtained - the permeate and the retentate. Whenever necessary, cheese whey is pasteurised. The protein rich fraction - retentate - is stored in a tank for further processing. The deproteinized cheese whey is fed continuously to the bioreactor where fermentation occurs. The outlet flow of the bioreactor, with a 2.5/(w/v) ethanol content is stored in a retention tank for distillation in a batch distillation unit. The solid residues of the distillation process as well as the biomass purged from the bioreactor are treated in an existing solid wastes treatment plant.

[0005] In fig. 1, the bioreactor used in the conversion of lactose from deproteinized cheese whey to ethanol is presented. Dimensions are also indicated.

[0006] The bioreactor has a total volume of 1000 litres and is composed of two main zones: a central body formed by two concentric tubes and a decantation zone (2). The air used to promote biomass circulation is injected at the bottom of the interior tube (3), after adequate sterilisation. Air is fed through a perforated disc (diameter - 130 mm) with 4 mm holes.

[0007] Inside and outside tube diameters are, respectively, 180 and 392 mm, in order to assure an adequate biomass circulation for high cell densities.

[0008] In the top part (2) degassing of the liquid phase and biomass decantation occur. Biomass is recirculated to the central body of the bioreactor. In this way, biomass accumulation is improved and the biomass in the outflow is minimised. When an excessive biomass accumulation occurs, purges are done.

[0009] Biomass retention is improved by the use of a retention device - baffle - installed in the outlet of the bioreactor.

[0010] Temperature and pH control systems are also installed.

[0011] A lactose fermenting yeast - *Kluyveromyces marxianus* ATCCC 10022 - with the ability to form flocs in the continuously operating bioreactor is used. This yeast property allows for the obtention of high biomass concentrations in the bioreactor.

[0012] The conjugation of these two factors - use of a flocculating yeast strain and an innovative bioreactor design - makes possible to continuously ferment lactose to ethanol with higher productivities than the conventional batch processes.

## Claims

1. Cheese whey treatment and valorisation process where conversion of lactose to ethanol is done using a flocculating lactose fermenting yeast - *Kluyveromyces marxianus* ATCCC 10022 at the top.
2. Cheese whey treatment and valorisation process according to 1, characterised by the use of a continuous fermentation process that allows for the obtention of 12 g<sub>ethanol</sub> l<sup>-1</sup> hr<sup>-1</sup> productivities.
3. Cheese whey treatment and valorization process according to 1, characterized by the use of a bioreactor with an enlarged decantation zone at the top, forming a 60° angle with the main body of the reactor, so that an efficient biomass retention inside the bioreactor is assured and biomass concentration in the outflow is minimized.
4. Cheese whey treatment and valorisation process according to 1, characterised by the use of a concentric tubes airlift bioreactor. Air is injected in the bottom of the internal tube being 2.18 the diameter ratio between internal and external tubes.
5. Cheese whey treatment and valorisation process according to 1, 3 and 4, characterised by its simple construction and operating mode due to the absence of mechanical devices.
6. Cheese whey treatment and valorization process according to 1, characterized by the use of flocculating lactose fermentation yeast - *Kluyveromyces marxianus* ATCCC 10022 - that biomass retention in the bioreactor.
7. Cheese whey treatment and valorization process according to 1, 3 and 5, characterised by the placement of a baffle in the decantation zone near the effluent outlet to increase biomass retention in the bioreactor.
8. Cheese whey treatment and valorisation process according to 1 to 7, characterised by the use of a

continuous bioreactor with higher productivities and smaller investment and operating costs that make this process an interesting alternative to existing ones.

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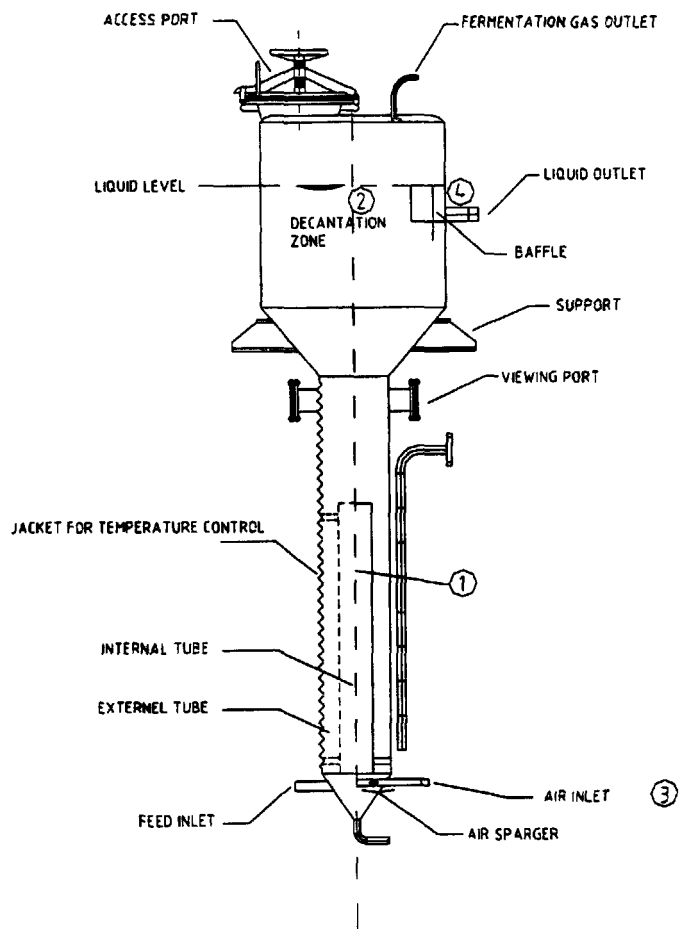
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