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# DRY ANAEROBIC CONVERSION OF MUNICIPAL SOLID WASTE BY MEANS OF THE DRANCO PROCESS

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## ABSTRACT

The Dranco process has been developed for the conversion of solid organic wastes, specifically the organic fraction of municipal solid waste (MSW), to energy and a humus-like final product, called Humotex. The Dranco process can be compared to landfill gas production, accelerated by a factor 1000. A Dranco installation with a digester of 808 $m^3$ treating 10,500 tons of source separated waste per year will be constructed in 1991 at Brecht, Belgium. A description of the plant is elaborated. A demonstration plant of 56 $m^3$ has been in operation for several years in Gent, Belgium using mixed garbage as a feedstock. The operating temperature in the digester is 55°C and the total solids concentration is ca. 32%. The mean gas production rate is 3.33 $Nm^3\ CH_4/m^3_{reactor}.day$. The volumetric loading is 17.3 kg $COD/m^3_{reactor}.day$ and the COD reduction is 55%. The gas production process is finalized in 3 weeks. The final product is dewatered and further stabilized in a 10 day aerobic post-treatment. The Humotex is free of pathogens. Low concentrations of heavy metals can only be obtained through separate collection of garbage. The Dranco process then also focusses on the digestion of source separated waste such as vegetable, fruit, garden and non-recyclable paper waste.

## KEYWORDS

Dranco; dry anaerobic conversion; municipal solid waste; industrial plant

## INTRODUCTION

Many governments, towns and communities throughout the world are making new rules concerning the treatment of municipal solid waste (MSW). New concepts of waste management are needed in which the idea of recycling is of major importance. Incineration will be used for the easily burnable fraction of what cannot be recycled, and for some kinds of hazardous wastes, such as hospital waste, while the leftover will be disposed of in sanitary landfills.

The recycling of products is initiated by mechanical separation plants or by source separation. During the last decade source separation has been introduced in many countries. The most important reasons to separate waste at the source are the following.

- The difficulty of finding sites for new landfills and the negative attitude of the public towards landfilling and incinerating.
- Source separation improves the quality of the products which will have to be recycled. The fact that the organic fraction is separated from the inorganic fraction means that the organic fraction will have a low concentration of heavy metals and will be free of metals, glass and stones, while the inorganic fraction will be drier and less dirty.

The degree of recuperation depends of the system of source separation and is the largest if the separated waste is picked up at the houses.

A high percentage of recycling can only be achieved by recycling the organic fraction of MSW whereby anaerobic techniques such as the dry anaerobic conversion process are very promising since they not only produce a humus-like residue, comparable to the compost produced in aerobic conversion techniques, but also a form of energy, biogas, which can be easily upgraded to several forms of valuable energy.

## THE DRANCO PROCESS

The Dranco process has been developed for the conversion of solid organic wastes, specifically the organic fraction of municipal solid waste (MSW), to energy and a humus-like final product, called Humotex. If mixed garbage is collected, the first steps in the Dranco process will consist of a size reduction and a separation of the different fractions in the waste stream. If source separated waste is collected these front-end processes can be largely simplified. After pretreatment, the organic fraction is introduced into the fermentors, where it is digested in 2 to 3 weeks. The biogas can be transformed into electricity by means of gas engines and a generator. The Dranco process itself will consume 30 to 50% of the produced electricity. The biogas can also be used as such. The digested residue is subsequently dewatered to 60% total solids (TS) by means of a screw press. The press liquid is used to adjust the solids content of the incoming substrate or is mixed with flocculants and dewatered in a filter press. The filter press liquid can be further treated by an evaporation plant. The cakes of the filter press are mixed with the cakes of the screw press and the dried sludge of the evaporator. The Humotex is stabilized and free of pathogens. Concentrations of heavy metals depend on the incoming substrate. Low concentrations of heavy metals can only be obtained through separate collection of garbage. The Humotex can be used as a soil amendment product or as a daily cover for landfills. A demonstration plant of 56 $m^3$ has been in operation for several years in Gent, Belgium using mixed garbage as a feedstock. The operating temperature in the digester is 55°C and the total solids concentration is ca. 32%. The mean gas production rate is 3.33 $Nm^3$ $CH_4/m^3_{reactor}$.day. The volumetric loading is 17.3 kg $COD/m^3_{reactor}$.day and the COD reduction is 55%. The gas production process is finalized in 3 weeks.

TABLE 1 Results Dranco Demonstration Plant Gent

| | |
|---|---|
| Volume | : 56 $m^3$ |
| Retention time | : 18 - 21 days |
| Loading rate : wet waste | : 2 - 3 t/d |
| TS | : 15 - 20 $kg/m^3_r$.d |
| VS | : 10 - 13 $kg/m^3_r$.d |
| Biogas productivity | : 5 - 8 V/Vr.d |
| Methane content | : 55 % |
| Methane production | : 90 $m^3$ $CH_4$/t wet organics<br>164 $m^3$ $CH_4$/t TS |

## VEGETABLE, FRUIT, GARDEN AND PAPER WASTE: VFG-PLUS

The biodegradable fraction of MSW consists of 2 major parts, namely wet organics and paper. Wet organics include food waste, vegetable and fruit waste, garden waste (except for big pieces such as trunks, thick branches, etc.) and other putrescible matter. In Europe this VFG fraction (Vegetable, Fruit and Garden waste) makes up about 45 to 55 % of all MSW. The paper fraction makes up 20-25 % of European waste and includes a wide range of different types of paper but can roughly be divided in 2 kinds: paper which is easy to recycle, e.g. newspapers, magazines; and paper which is difficult to recycle because of its usage or nature or because of the way of collection, e.g. disposable diapers, tissue paper (towels, handkerchiefs), office paper, wrapping paper, cardboard used for packing of food, etc. In a comprehensive study in Flanders (Belgium) in 1985 the fraction of paper which is difficult to recycle amounted to about 48 % of the total amount of paper waste. Remarkable are the disposable diapers which are reported to represent 2.8 % of all German household refuse (UBA, 1988).

The paper fraction which is easy to recycle should indeed be recycled since it is dry and clean and represents a good raw material. The wet paper however which is difficult to recycle should be added to the putrescible VFG fraction, to form a VFG-plus fraction, and be treated biologically. This results in many advantages compared to the treatment of the VFG fraction only. First of all the amount of waste which can be treated biologically increases considerably, from 52 to 64 % of all MSW in Europe. The seasonal influence on both quantity and quality of the biodegradable fraction is much less since garden waste represents a smaller fraction of the total. Garden waste is only available from March to November with high peaks during spring and fall. The addition of paper attenuates this variation. Although the added paper is wet compared to the recyclable paper, it is still relatively dry and more importantly can absorb a lot of moisture. This makes the practical handling of the biodegradable fraction much easier, e.g. no free water and less odours in the household waste bin, no leakage from garbage trucks, etc. For aerobic composting this improved water management is necessary to avoid the run-off of leachates and to prevent anaerobic conditions in the compost pile. In the centre of the city or in areas with flats, it is too costly to collect separately the relatively small amounts of vegetable and fruit waste, which may only amount to 10-15 % of the waste stream of those areas. If the non-recyclable paper is added it becomes more useful to separate the waste also in these areas.

## DIGESTION OF VFG-PLUS

VFG-plus has been tested in Dranco lab-scale digesters.
An overview of operational parameters and results of the Dranco digestion of VFG-plus is given in Table 2.

TABLE 2 Dranco Treatment of VFGP

| | | | |
|---|---|---|---|
| Feedstock : | TS | : | 43% |
| | VS | : | 63% on TS |
| | Kj-N | : | 4.57 g/kg wet organics |
| | C/N | : | 29 |
| Dranco : | Loading rate | : | 19 gTS/lr.d |
| | Retention time | : | 20 days |
| | Biogas productivity | : | 5.1 V/Vr.d |
| | Methane content (%) | : | 55% |
| | Methane production | : | 62 $m^3$ $CH_4$/t wet organics |
| | | : | 143 $m^3$ $CH_4$/t TS |

lr : litre active reactor volume

## INDUSTRIAL DRANCO PLANT IN BRECHT, BELGIUM

At the end of 1990 a Dranco plant will be ordered by the regional authorities of Brecht and surroundings. The plant is designed to treat 10,500 tons per year of the biodegradable fraction of municipal solid waste and is subsidized by the EEC. The biowaste will be obtained from a source separated collection in which all vegetable, fruit, garden and paper waste, such as diapers, disposable paper products and non-recyclable paper are treated. The waste is first sieved over a 40 mm screen. The oversize of the screen is sent to a high-speed drum and sieved again over 40 mm. The oversize is landfilled and the fraction less than 40 mm is mixed intensively with digested residue from the digester, heated with steam to a temperature of about 50°C and pumped into the digester. The digester will have a volume of 808 $m^3$ with a diameter of 7 m and a height of 21 m. The digested residue will be dewatered after ca. 18 days of digestion to a solids concentration of 50 to 55% by means of a screw press. The press liquor will be handled further with the leachate of a landfill, which is installed next to the plant. The pressed cakes are refined by a sieve and composted aerobically for a duration of about 10 days prior to selling as a high-quality soil amendment. The biogas is stored in a gas bag and partially (about 8%) used to produce steam needed for process heating. The rest of the biogas is transformed into electricity by means of a gas engine so that electricity is supplied for the operation of the installation.

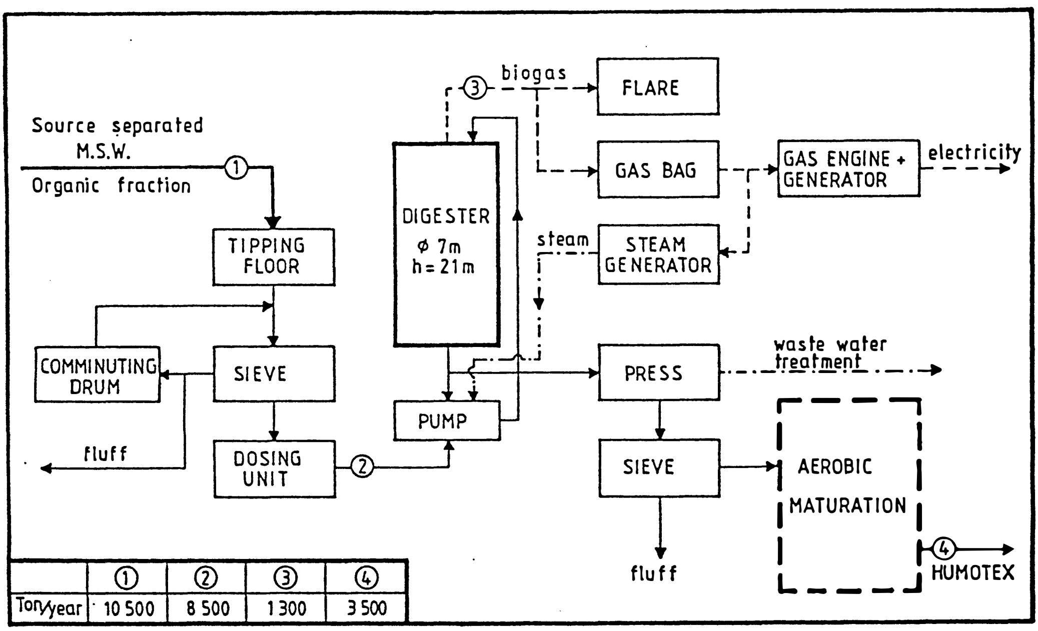
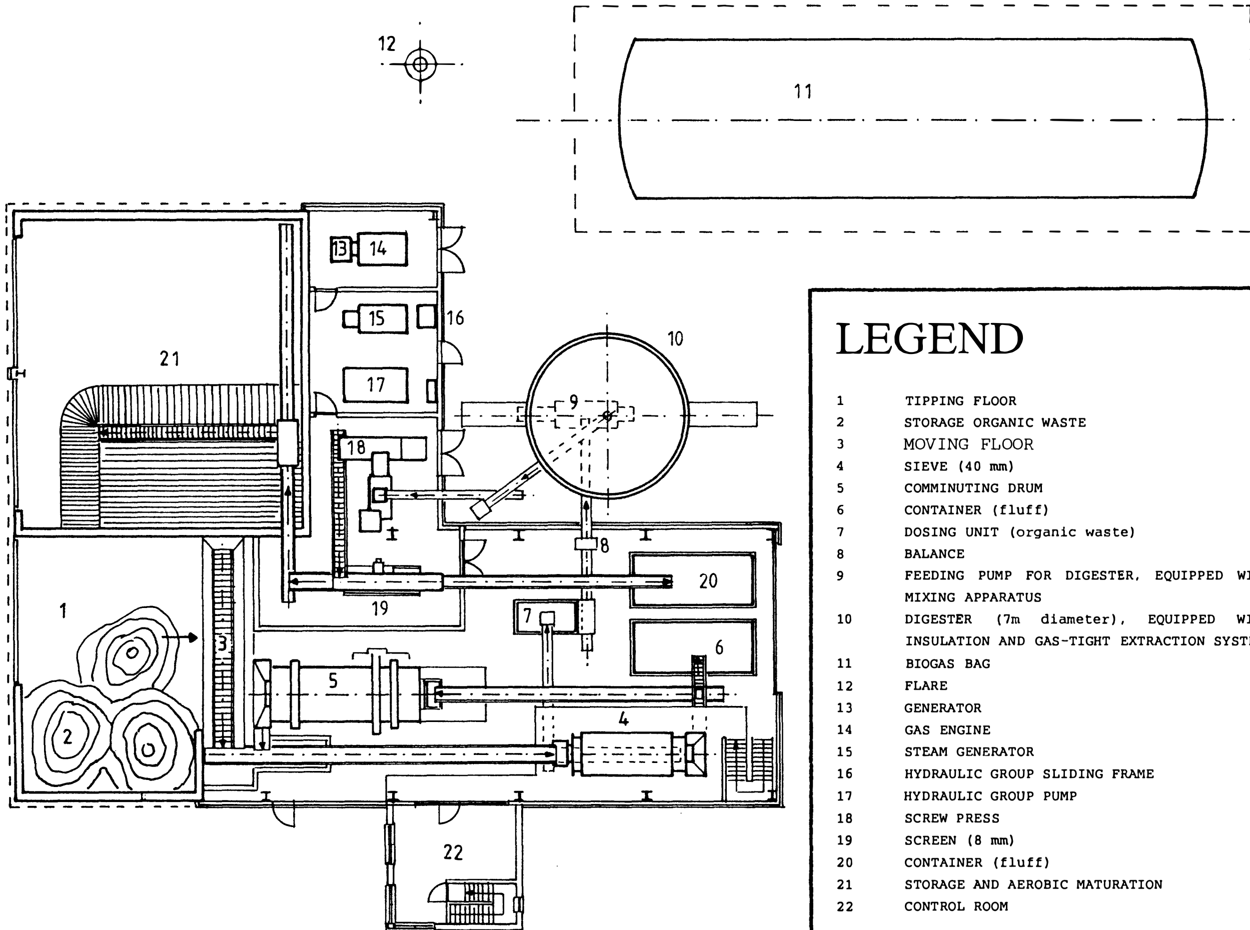



Fig. 1. Flow sheet of Dranco installation Brecht, Belgium




## LEGEND

| | |
|---|---|
| 1 | TIPPING FLOOR |
| 2 | STORAGE ORGANIC WASTE |
| 3 | MOVING FLOOR |
| 4 | SIEVE (40 mm) |
| 5 | COMMINUTING DRUM |
| 6 | CONTAINER (fluff) |
| 7 | DOSING UNIT (organic waste) |
| 8 | BALANCE |
| 9 | FEEDING PUMP FOR DIGESTER, EQUIPPED WITH MIXING APPARATUS |
| 10 | DIGESTER (7m diameter), EQUIPPED WITH INSULATION AND GAS-TIGHT EXTRACTION SYSTEM |
| 11 | BIOGAS BAG |
| 12 | FLARE |
| 13 | GENERATOR |
| 14 | GAS ENGINE |
| 15 | STEAM GENERATOR |
| 16 | HYDRAULIC GROUP SLIDING FRAME |
| 17 | HYDRAULIC GROUP PUMP |
| 18 | SCREW PRESS |
| 19 | SCREEN (8 mm) |
| 20 | CONTAINER (fluff) |
| 21 | STORAGE AND AEROBIC MATURATION |
| 22 | CONTROL ROOM |

Fig. 2. Lay out of DRANCO installation Brecht, Belgium

## QUALITY OF THE HUMOTEX

Separate collection of the biodegradable fraction of MSW results in a Humotex, free of plastics and glass and with a low concentration of heavy metals. Humotex has a C/N ratio of less than 15, which indicates that it is stable.

Besides stability, Humotex is also characterised by the high hygienisation which is due to the conditions of the conversion process (2-3 weeks retention time, 55 °C, absence of oxygen). In a comparative study faecal coliforms could not be detected in Humotex whereas the original fraction contained $3.10^3$ CFU/g DW and a conventional aerobic compost produced in windrows from the same original substrate still counted $2.10^2$ CFU/g DW.

TABLE 3 Characteristics of Humotex

| Parameter | Unit | Humotex (VFG-plus) | Belgian standard for compost KB 20/01/86 | Compost (mixed MSW) (Kreuzberg, 1989) |
|---|---|---|---|---|
| total solids | % (weight) | 70 | > 55 | 65 |
| ash content | % of TS | 55 | < 60 | 71 |
| pH | - | 7.3 | 6 - 8 | 7.3 |
| cadmium | mg/kg TS | 1.0 | 5 | 2 |
| chromium | mg/kg TS | - | 150 | 120 |
| copper | mg/kg TS | 14 | 100 | 120 |
| lead | mg/kg TS | 61 | 600 | 450 |
| nickel | mg/kg TS | 7 | 50 | 45 |
| zinc | mg/kg TS | 85 | 1000 | 600 |
| calcium | mg/kg TS | 42000 | - | 31000 |
| magnesium | mg/kg TS | 2600 | - | 3000 |
| $NH_4^+$-N | mg/kg TS | 465 | - | - |
| $NO_3^-$-N | mg/kg TS | - | - | - |
| Kj-N | mg/kg TS | 18000 | > 1% | 4000 |
| C-total | mg/kg TS | 250000 | - | - |
| P-total | mg/kg TS | 2000 | - | 8000 |
| K-total | mg/kg TS | 7800 | - | 3000 |

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